TEACHERS' PERCEPTIONS OF WHOLE-CLASS MATHEMATICAL DISCOURSE:
A QUALITATIVE MULTI-PHASED CASE STUDY OF MIDDLE LEVEL PUBLIC SCHOOL MATHEMATICS TEACHERS

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DEDICATION
For Amanda, Leif, and Kian;
my family near and far;
Dr. Jerry Johnson and Dr. Chris Ohana at
Western Washington University; and
my extended Hawaiian ‘ohana
for your patience, guidance, and support.
ABSTRACT

This four phase qualitative case study examined middle level mathematics teachers’ perspective on the use of whole-class discourse as an instructional strategy to help all students learn mathematics. The primary research question that guided this study was what were middle level teachers’ perceptions towards classroom discourse and how did their perceptions compare with their actual classroom practice? Since teachers’ perceptions were the focus of this study, a phenomenon that is naturally dynamic and flexible, a grounded theoretical approach was employed because it allowed for a more authentic and natural representation of the teachers’ understandings and experience using whole class discourse. This study helped clarify common beliefs and understandings that teachers have towards the use of whole-class discourse as an inclusive instructional method as well as revealed strategies that were most commonly used to facilitate whole-class discourse. This study also identified two types of classroom culture that support the use of whole class discourse as an instructional strategy to help all learners of mathematics.
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The learning experiences students encounter within schools are fundamental to their academic achievement and attainment (Marzano, 2004). However, the selection, nature, and design of these experiences are largely left up to the teacher which means that teacher preferences in the design and implementation of these experiences will often determine how the curriculum content is presented to the students. In essence, the ways in which teachers perceive particular instructional strategies, which in turn dictate the type of learning experiences that students will be exposed to, has a central role in the overall quality of a student’s education.

Recently I became a National Board Certified Teacher (NBCT) in Early Adolescence Mathematics. One of the requirements as an NBCT candidate, a portfolio demonstrating effectiveness as a teacher of mathematics to early adolescent students, ages twelve to sixteen, was assembled and submitted for evaluation. This portfolio was comprised of four separate components, one of which was an unedited video of me facilitating an inclusive whole-class discursive interaction that supported students’ understanding of a particular mathematical concept. This portion of the portfolio exemplified what previous research had established; that students’ understanding of content is strengthened through communication (Gose, 2009; National Council of Teachers of Mathematics [NCTM], 2000; Pugalee, 2001; Roberts & Billings, 2009; Way, 2008). While I have always been an advocate of discourse in the classroom, I initially found, upon watching the recording, that my interactions and ability to facilitate meaningful discursive interactions among students was not congruent with my own
perceptions of my practice. Thus, I became aware that perceptions toward particular research-based instructional practices, in this case, whole-class discourse, can affect the implementation and effectiveness of these practices within the classroom.

Problem Statement

Discourse can take many forms (Truxaw & Defranco, 2009) and can exist among individuals, small groups, or within larger groups of people. However, for this study, I was concerned with discourse as it exists within a whole-class setting. I decided to use Piccolo, Harbaugh, Carter, Capraro, and Capraro’s (2008) definition of mathematical discourse as an “interactive and sustained discourses of a dialogic nature between teachers and students aligned to the content of the lesson that addresses specific student learning issues” (p.378). This definition, when considered within a whole-class setting, rather than small groups or pairs of students, will be referred to as whole-class discourse (WCD).

However, teachers’ having favorable perceptions towards WCD is not enough to effectively implement WCD; students must also be willing to participate for meaningful WCD to occur but such participation is not often forthcoming during adolescence. In fact, generating mathematical discourse amongst adolescents can be especially challenging, particularly within a whole-class setting because social acceptance by adolescents’ peers is paramount; they wish to avoid embarrassment or appearing incompetent (Van Hoose, Strahan, & L’Esperance, 2001). Canfield and Wells’ (1976) Poker Chip Theory states that some students experience more success; these are the ones with more chips, so to speak, and thus come to class willing to take more intellectual
risks as they can afford to lose some chips. These risks include voluntarily participating in discussions or contributing to the discussion if called upon by the teacher to do so. Whereas other students, who have not experienced as much success, and who have fewer poker chips, are less likely to take such risks unless they are assured success. Voluntarily participating in WCD is too great a social risk and may lead them to withdraw from further whole-class interactions. Adolescent students want to learn what the teachers are presenting, many just don’t want to be the one called upon to speak in front of the class, go up to the board, or otherwise justify or defend an idea in front of their peers for fear of damaging their perceived social standing (Wormeli, 2001). In order to help these students build up their perceived cache of chips, they need to experience success; this may include situations that require greater intellectual risk taking such as participating in WCD. Students often feel more comfortable participating in discourse if it is within a small group setting (Roberts & Billings, 2009), but for the teacher, this strategy can be incredibly time consuming, counterproductive, and all but impossible to facilitate if several simultaneous small group discussions are in progress.

As a secondary mathematics teacher and a new teacher mentor for the last several years I had frequently observed and experienced students’ lack of verbal interaction in large group settings. And even though small group interactions were often observed, I believed that teachers needed to utilize WCD; inclusive interactions that supported students to help them improve communication and understanding of the content (Hmelo-Silver & Barrows, 2008; Lobato, Clarke, & Burns Ellis, 2005; Mercer,
This meant that WCD, from the teacher’s perspective, needed to be further understood.

While previous research has examined the extent to which students participate in classroom discourse (Huang, Normandia, & Greer, 2005; Nelson, 2009), the roles of the participants in conducting discourse (Hmelo-Silver & Barrows, 2008; Moschkovich, 2008; Piccolo et al., 2008; Staples, 2007), and the patterns or structure of discourse in the classroom (Hoffman, Breyfogle, & Dressler, 2009; Huang, Normandia, & Greer, 2005), there is insufficient research investigating teachers’ perspectives on discourse including the strategies that they believe to be the most successful and effective in promoting and facilitating WCD as an instructional strategy that supports all students in the learning of mathematics.

Huang et al. (2005) recommended that future research examine how teachers design and implement instructional strategies that promote student discourse. Parker and Hurry (2007) remind researchers of the importance of examining pedagogy and not just content in the curriculum while Staples (2007) states that in order to understand the learning experiences of students, an understanding of the strategies that teachers use must also be examined; this would include strategies to facilitate and promote WCD. This study sought to better understand teachers’ perceptions of the utility of discourse and the instructional strategies that teachers’ believed to be most useful in engaging students in WCD.
Purpose

The purpose of this qualitative multi-phase case study was to better understand teachers’ perceptions towards WCD as it relates to the facilitation of WCD, the utility of WCD as an instructional strategy to support all students in the learning of mathematics, as well as to better understand the methods that teachers tend to implement to support the facilitation of WCD. While this study may benefit practicing middle level mathematics teachers the most by providing a framework describing strategies used to promote WCD within the classroom, school leaders such as academic coaches, department chairs, and other mentors who work directly with middle level mathematics teachers to support and strengthen their practice will also benefit. Since one of the areas school leaders strive to improve upon are effective instructional strategies and methods, a better understanding of teachers’ perceptions could help provide targeted support within this context. By comparing teachers’ perceived beliefs toward the benefits of WCD along with practices they use to facilitate WCD, understandings on how to better support teachers may become more evident and can thus be used to improve assessment and instruction. Furthermore, post-secondary faculty who assist in the development of pre-service teachers could also benefit from this study as beliefs held by practicing teachers are better understood; knowing how teachers view their practice today can help leaders in education redefine and shape the classrooms of the future.

Significance of Study

By definition, discourse is a shared phenomenon between the teacher and the students of a classroom (Falle, 2004; Mercer, 2008b; Roberts & Billings, 2009); it
requires the teacher to be a facilitator, a coach, and a listener who ultimately guides a discussion of ideas and the students to actively take the lead in contributing and generating knowledge. To the layman, such an explanation may seem simplistic but according to Roberts and Billings (2009) discourse does not occur naturally; it needs a strong facilitator to make it meaningful, worthwhile, and appropriate.

However, Falle (2004) indicates that conversations that take place in classrooms are far too often one-sided with the majority of the talking being done by the teacher. So while research has shown that discourse is a highly effective tool in promoting deeper understanding of the content, fosters critical thinking and problem solving skills, and supports students’ developmental needs during adolescence (Falle, 2004; Hoffman et al., 2009; McMurray, 2007; Michaels, O’Connor, & Resnick, 2008; Wormeli, 2009) many teachers fail to utilize discourse, even if they believe discourse to be beneficial (Huang et al., 2005; Mercer, 2008b; Wiltse, 2006). It is from this discrepancy between teachers’ beliefs and praxis with current research based theory that pertinent research questions appear.

Research Questions

There were several driving research questions that were a direct result of the problem described above. There was one question that had considerable potential to provide understanding into why the aforementioned discrepancy occurred. This question was: what are middle level teachers’ perceptions towards classroom discourse and how does this perception compare with their actual classroom practice? However, there were several subsumed questions that supported this primary question, each of which clarified
the stated problem as it related to WCD. These questions were separated into two categories; teachers’ perceptions and practice.

**Questions on Perceptions**

McMillan and Schumacher (2006) attest to the benefits of understanding how others, in this study the teachers, regard the world around them. That is, to further comprehend the nuances of WCD and some of the conflicting issues that prevent the appropriate implementation of WCD, it was important to realize teachers’ perceptions towards discourse. Brown (2001), who utilized interviews to determine teachers’ perceptions, states, “first person accounts of events and actions are necessary to provide a basis for researcher inferences about perceived meanings (p. 6).” Therefore, several questions were generated that sought to gain further insight into teachers’ perceptions and a more detailed understanding of WCD. The research questions that guided this study were:

1. How do teachers define discourse?
2. How do teachers perceive the utility of discourse to help increase student understanding?
3. How do teachers perceive their capability to engage all students in discourse?
4. How do teachers describe meaningful discourse in their classroom?
5. What instructional strategies do teachers utilize to engage students in discourse?

In learning more about these perceptions, greater meaning was generated on the relationship between teachers’ perceptions, their classroom practices, and WCD as a whole. Furthermore, because I wished to better understand the relationship between
teachers’ perceptions and their actual praxis, additional questions focused specifically on this area and were used to generate meaning that could not easily, if at all, be readily measured or understood via other means (Denzin & Lincoln, 2005).

Questions on Practice

The instructional opportunities that teachers provide are fundamental in the learning process (Darling-Hammond & Friedlaender, 2008). The decisions they make as to what instructional strategies will be, and actually are, used make a difference in developing an effective teacher praxis that contributes to students’ learning. It is easy to claim a belief, to state that one agrees with a particular philosophy of learning, but quite another to implement that philosophy with fidelity. Therefore, examining how teachers implemented WCD within the classroom further helped in understanding the context in which WCD occurred and the extent to which teachers’ beliefs coincided with their practice (Alvidrez & Weinstein, 1999). As with the questions that sought to understand teachers’ perspectives, there were questions that related to teachers’ actual practices within the classroom and they were:

1. What instructional strategies do teachers use to facilitate discourse?
2. How are the instructional strategies implemented?
3. To what extent are these strategies inclusive to all students in the classroom?

By gaining additional insight into what happens in the classroom with respect to WCD, a more precise understanding between teachers’ perspectives toward discourse and their actual praxis was constructed. Through this marriage of teacher perceptions and
interpretations along with what teachers actually did in the classroom, a more complete and richer understanding of the overarching research question were created.

Summary

This study focused on the perceptions middle level mathematics teachers, grades six to eight, had toward the use of WCD within their classrooms along with the strategies that these teachers used to facilitate meaningful WCD for all students. Previous studies have recommended that future research examine the pedagogy of discourse which would include teachers’ perceptions towards WCD as well as actual strategies that they employed based on their perceptions. In this study I followed the recommendation mentioned. I sought to better understand both the perceptions of middle level mathematics teachers towards WCD, and how those perceptions compared with actual classroom practices of teachers who valued WCD.
CHAPTER 2 LITERATURE

Introduction

The NCTM states in its *Principles and Standards for School Mathematics* (2000) that “communication is an essential part of mathematics and mathematics education” (p. 60). While communication can take on several forms, one of these forms is through the use of discourse as defined by Piccolo et al. (2008) but with an emphasis within a whole class setting, or WCD. By using WCD as an instructional method for testing, confirming, and challenging mathematical ideas teachers and students alike can benefit. However, WCD within a middle level classroom presents challenges for the teacher because of the developmentally unique social, emotional, and cognitive needs found in adolescence. Therefore, this review of literature will discuss some of the substantial benefits of WCD, the need for discursive interactions rather than “conversational” interactions, and the specific developmental needs and characteristics of adolescents to help frame the difficulties associated with facilitating WCD within a middle level classroom.

Benefits of Discourse

As previously stated, the communication of mathematical ideas is critical and fundamental in the learning and doing of mathematics. Focusing first on the learning of mathematics, communication is of great importance because there are several benefits to the student as well as the teacher. The benefits of WCD for the students are presented first with the benefits for the teachers following thereafter.
Communication Benefits for Students

When students have opportunities to discuss mathematics, to have conversations about methods and procedures, they gain deeper insights and are better able to clarify their thinking (Roberts & Billings, 2009). This clarity then leads to more convincing arguments for solution processes and more complex connections; connections that stem from the open sharing of multiple perspectives (Kuhn, 2005; NCTM, 2000). On several occasions, while I discussed mathematics with students, one student would interject with a connection that they made as a result of this type of interaction. At times they would ask, “Is that like…” and proceed to make a connection to prior topics, procedures, or learning experiences or they would exclaim, “I get it now!” These expressions of confirmation also added to the credibility of the discussion at hand as peer reviews and critiques were important in formalizing and justifying content knowledge (NCTM, 2000; Michaels et al., 2008). In mathematics, for a solution to be considered correct, the proof must be recognized and deemed acceptable by others. This is true in the professional mathematics community and a similar process of arriving at shared understandings should also exist within the classroom. That is, when other students add to the mathematical discourse within the classroom, when they participate in WCD either through supportive confirmations or by asking clarifying questions, students are creating greater meaning of the mathematics being discussed and are becoming more engaged in their learning. In numerous studies and reports (Alvarez, 2002; Black, 2005; Bryson & Hand, 2007; Carini, Kuh, & Klein, 2006; Jackson & Davis, 2000; Klem & Connell, 2004;
Smith, Rook, & Smith, 2007), this level of engagement has been linked to higher levels of student achievement.

**Communication Benefits for Teachers**

For teachers, mathematical WCD provides assessment opportunities that may not be evident in other forms of assessment (Falle, 2004). It can be common for students to struggle in communicating their understanding of mathematics in writing, especially when they encounter new vocabulary or problems that require methods for a solution that is not immediately apparent. During such situations, utilizing oral communication, and the ways in which students verbally construct their response, teachers can more accurately assess students’ understandings or misunderstandings (Clarke & Sullivan, 1990; Falle, 2004). Through this informal assessment teachers can then make more informed decisions on the sequencing of learning experiences. That is, the understandings communicated through WCD support the teacher’s decision making process in determining whether or not the students are prepared for the next step in the instructional process or if they need to readdress a particular concept or procedure due to misconceptions (NCTM, 2000). There is a strong symbiotic relationship between assessment and instruction; WCD is one of the ways in which this vital relationship is fostered.

Within the classroom, WCD also provides teachers with opportunities to support students’ understanding by interjecting ideas and questions to refocus, clarify, or expound upon essential learning concepts that may otherwise be overlooked by the students (Lobato et al., 2005; Staples, 2007). Identifying misconceptions early on and helping
students learn how to precisely convey their understanding is important for teachers as further learning and more in depth mathematical connections may rely on the concepts at hand. Thus, having opportunities to address such issues with the entire class can be a more efficient use of classroom time and can strengthen the WCD because of the teacher’s greater pedagogical and content knowledge. Students also learn to clarify their thinking even if they are not the ones speaking. They learn to validate, justify, and contend essential concepts and procedures as well as provide invaluable insight into their own thinking; insight the teacher can use to modify instruction to meet the cognitive needs of their students.

Discourse Instead of Conversations

The NCTM (2000) stresses the importance of communication and conversations; the representation of understanding either in spoken language or in a written expression. Both of these methods of conveying mathematical understanding is important in the learning and teaching of mathematics and thus WCD has significant value in the learning of mathematics as well. However, mathematical conversations are not synonymous with mathematical discourse. Conversations can take on many forms and involve various participants, teacher and student alike, but in varying degrees of participation. The term “conversations” is simply too general of a term to highlight the importance, critical nuances, and shared responsibilities of mathematical discourse. The difference between classroom conversations and WCD is far from trivial as there is a marked difference in design, responsibilities, and structure. There is a difference between a teacher talking to a few students who are willing to participate and many students talking to each other as
well as the teacher about mathematics. In the latter, meaningful connections will be made by many more students as many more are active in the learning experience. Therefore it is important to highlight what is perhaps the biggest difference; a difference in the roles and responsibilities. Meaningful discourse, and thus WCD, includes an element of debate (McMurray, 2007) and seeks to include several students (Michaels et al., 2008; Roberts & Billings, 2009). In essence, two important distinctions can be made between conversations and WCD. WCD creates and includes a shared responsibility by all participants in the classroom which then results in dynamic and inclusive interactions between all the students and the teacher in the classroom. A brief discussion on these two distinctions follows.

**Shared Responsibility**

Perhaps the most important difference for WCD lies in the shared responsibility, an inclusive reciprocity between teachers and students alike. One might argue that conversations can be an interactive and sustained interaction that takes place between teachers and students alike. However, conversations can lack a shared responsibility; a give and take reciprocity that requires all students and the teacher to contribute as listeners and speakers. It is from this shared responsibility that all students, and the teacher, can create and build upon knowledge.

However, several studies (Falle, 2004; Kawanaka & Stigler, 1999; Piccolo et al., 2008; Wiltse, 2006) indicate that what teachers often deem as discourse is substantially more one sided; teachers talk and students answer. Wiltse (2006) refers to this type of classroom talk as an Initiation-Response-Evaluation (IRE) process wherein teachers ask
an initiating, simple, “known-information” question and then wait for a response from a student after which the teacher evaluates the response from that student. In following with this process it is clear that there is no shared responsibility; it is heavily weighted towards the teacher. Even using the more loosely defined term of conversations, during which time people share a vested interest in the exchange of ideas, one would be hard pressed to consider IRE interactions as a conversation. There is no real exchange of ideas, there is no debate upon which to strengthen students’ connections to the content, and the teacher is likely the only one interested in the answer to the question.

It should be made clear that discourse, and thus WCD, is not merely the sharing of individual ideas as this is not effective in promoting students’ collective or individual thinking and reasoning (Kuhn, 2005; Lobato et al., 2005). Instead, a more inclusive approach needs to be used wherein students provide support for or against the arguments of other students.

*Discourse: An Inclusive Model*

Kuhn (2005) offers a model that illustrates this shared responsibility (Figure 1) between several students in the class, as well as the teacher. In this model the arrows represents to whom, S1-S8 represents eight students and T represents the teacher, a question or statement is addressed and the number by the arrow indicates the sequence in which the questions was asked. Thus, one can construct to whom and by whom a statement or question was made as well as the order in which these statements occurred. Notice that some students are more involved in discussing the topic than others and that even some may not contribute at all. One might argue that including nearly every student
in a class is too time consuming and this is likely true for many discursive interactions. The number of people involved will vary depending on the importance of the topic at hand, the intended learning outcomes, the relevance of the topic, and students’ prior learning experiences which might dictate their ability to participate in a meaningful manner. The purpose of WCD is not to create situations that require all students to participate but rather to create situations wherein several different students want to contribute to the collective understandings of the class. Regardless, this model exemplifies the inclusive and interactive nature of WCD.

![Diagram of Kuhn's authentic classroom discourse model](image)

*Figure 1. Kuhn’s authentic classroom discourse model*
Difference in Definition

The term “conversation” needs to be used with caution as it has an entirely different meaning than WCD; conversations are not as complex, inclusive, or as challenging to facilitate as meaningful WCD. The process of communicating mathematical understanding should sustain levels of engagement that challenge students’ thinking and reasoning and should be used to determine the validity of a mathematical viewpoint or solution (Huang et al., 2005). This should be done in a manner that promotes inclusion and shares the responsibility of learning with all members of the classroom, students and teacher alike. While various forms of communication are important in the teaching and learning of mathematics, WCD is a distinct form and process by which mathematical understanding is derived as it is distinctly different in purpose, design, and implementation. The question, then, is what is mathematical understanding? This issue is addressed below.

Mathematical Understanding

Mathematical understanding is the pinnacle of learning mathematics and previous studies (Falle, 2004; Mercer, 2008a; Michaels et al., 2008; Roberts & Billings, 2009; Skemp, 1976) have shown a clear link between students’ understanding of the mathematics and their participation in classroom discourse. The question then becomes what is the relationship between mathematical understanding and WCD. However, before this question can be addressed a working definition of “understanding” needs to be established. Skemp (1976) warns us that it can have two meanings within the same context. Skemp suggests that there are two forms of mathematical understanding;
Relational and Instrumental Understanding. Each of these two types of understanding operates within two separate spheres of meaning and varies in purpose, intent, procedures, and learning outcomes. Such extreme variations in the same word warrant clarification so that further use of this word is understood by all.

**Relational Understanding**

The first meaning for the term understanding is what Skemp (1976) refers to as relational. In this type of understanding students possess two pieces of knowledge; they know how to complete a mathematical task as well as why the procedures they use are appropriate. In Relational Understanding students could be presented with a problem whose solution requires methods that may not be immediately evident. Students might need to “play” with the problem to see what type of skills and processes might be needed; abandoning those that seem not to work but revising others with the intent of realizing a solution process through their efforts. Throughout this process they conceptually develop a mathematical process that allows them to arrive at a solution. Being able to implement this approach to doing mathematics requires the students to work to solve the problem and later to explain why their steps are appropriate.

**Instrumental Understanding**

However, Instrumental Understanding only requires the ability to use mathematical rules in a particular situation. Skemp (1976) likens this to students using rules but without any reason as to why they are using the rules. An example would include when students are given a problem for which the solution process is easily determined. Students have likely just been shown how to solve a similar problem or have
learned an algorithm that will help them arrive at a correct solution and are able to follow this algorithm to arrive at a solution, but they are not aware of the reasons for using such a process. In this situation students need to only select what rule to use to solve the problem and will likely have difficulty applying the desired strategy in a novel or less obvious situation.

Working Definition of Understanding

With the increased emphasis over the last few decades to make the learning of mathematics a more collaborative, student-centered experience wherein students are encouraged and expected to contribute to their learning and construct knowledge through supportive social interactions (Kawanaka & Stigler, 1999; NCTM, 2000; O’Brien, 1999; Romagnano, 1994; Staples, 2007), mathematical understanding must be viewed as referring to Relational Understanding. Educators want their students to understand the content and this means being able to know what to do, foundational in Instrumental and Relational Understanding alike, as well as why they chose their given methods, which is exclusive to Relational Understanding. With the clarification of mathematical understanding as being Relational Understanding, the relationship between mathematics and classroom discourse can now be established.

Understanding and WCD

The relationship between Relational Understanding and classroom discourse is symbiotic and mutually supportive. When either is happening with fidelity, then the other will be occurring as well. For example, if the teacher and students are engaged in classroom discourse then they are simultaneously developing Relational Understanding.
The same is true in reverse. In order to fully develop Relational Understanding, students must be socially engaged; they must receive feedback on their ideas or be exposed to alternative or additional supporting arguments. There are two areas in which the relationship between mathematical understanding and WCD interact: 1) the development of greater thinking skills and strategies and 2) in making stronger connections to the content.

Development of Thinking Skills

Furthermore, WCD and understanding are linked in how they contribute to the development of students’ thinking skills (Kuhn, 2005). Mercer, (2008a, 2008b) supports this connection by asserting that discourse develops more creative and independent thinkers while simultaneously strengthening procedural knowledge, which is one aspect of understanding. In essence, mathematical discourse is a social mechanism that promotes, supports, and further develops individuals’ thinking and mathematical learning (Kuhn, 2005). Once discourse leaves the realm of mere conversations, that is, students sharing individual ideas that are unconnected to previous statements of other students in the classroom, it becomes an individualistic vehicle that operates within a social medium to develop, make more coherent, and advance students’ thinking. In turn, more advanced thinking means greater understanding, higher achievement, and more sophisticated learning (Harvey & Goudvis, 2007; Kuhn, 2005; Mercer, 2008b; Roberts & Billings, 2009). Roberts and Billings (2009) said it best when they reminded educators that, “the simple lesson that teachers sometimes forget is that learning to communicate is learning to think” (p. 82). Thus, classroom discourse directly addresses both of the foundational
tenets of Relational Understanding at once; the development of knowledge that informs students what to do to solve a problem and why those strategies are effective.

**Stronger Connections to Content**

Classroom discourse’s main purpose is to help students understand the content (Michaels et al., 2008). In essence, due to the rich and meaningful academic experience that is created as a result of discourse, knowledge is increased as well (Marzano, 2004); discourse helps students make deeper, more meaningful connections to mathematics. Huang et al. (2005) state that when students are placed in situations where they are required to articulate methods, strategies, and the rationale for using these techniques to solve a problem then students also have the “opportunity to reinforce and deepen their understanding of higher-level knowledge structures in mathematics” (p. 45). In mathematics, ideas that are required for one particular concept are often useful in other concepts as well (Hmelo-Silver & Barrows, 2008; Skemp, 1976). What this means is that classroom discourse can be the medium by which Relational Understanding cultivates in a social setting, thereby making mathematical concepts more accessible in future applications. However, Skemp also warns that while educators want students to be able to apply what they learn in novel mathematical problems, students often only want to know what “rule” to use to get the right answer. Educators may need to instigate interactions that cause students to focus more on developing Relational Understanding; classroom discourse is one such method.
Supporting Learning and Understanding

The intricate and reciprocal relationship between mathematical understanding and classroom discourse also supports students’ learning and understanding of mathematics. Utilizing discourse, and thus WCD, as a method for students to become better mathematical thinkers has already been discussed. However, there are other areas that also address how classroom discourse supports the learning and understanding of mathematics. Three of the more central areas are based on the social nature of discourse, the need for differentiation, and the creation of an environment around which the teacher can better assess student understanding.

Social Construct of Learning

There is noteworthy research that demonstrates learning is a highly social endeavor that relies upon meaningful interactions between individuals (Bandura, 1977; Vygotsky, 1978; Wenger & Lave, 1991). By nature, discourse is a social process and therefore those who are involved, by default, are engaged in a method of learning. Kuhn (2005) links discourse to the development of thinking, and thus learning, and stresses that thinking is something that is typically done collaboratively; it “rarely remains a solitary activity conducted inside people’s heads” (p. 13). But what about those students who are not contributing to the discussion? Learning occurs for them, too. Learning is not strictly dependent on an individual’s participation in a social activity; they can learn through observation as well (Ormrod, 1999). For learning and discourse this means that when a majority of students are engaged in a discursive exchange of ideas and questions, others
can benefit and learn, even if they do not contribute to the discussion, so long as they are actively listening to the discussion at hand.

**Differentiated Learning**

Another aspect of learning that one must consider in regards to discourse is the diverse learning styles of students. Gardner (1983) was one of the first to organize this concept into discrete categories and they are often referred to as multiple intelligences (Armstrong, 1993). Armstrong also states that one of the seven intelligences is called a “Linguistic Intelligence” and that it is related to the ability to more comfortably respond to new situations and experiences through verbal and written events. What this means for students is that some will be more actively engaged in the learning process if they are provided with opportunities to verbally partake in the learning experience as it is more suitable to their learning preferences. While some students may prefer working independently or in small groups others will thrive on classroom discourse. No method of instruction will help every learner all the time and thus mathematics teachers need to employ various methods to help all students become better learners of mathematics.

Utilizing various instructional strategies to meet the learning needs of different students is commonly known as differentiated learning (Posamentier, Jaye, & Krulik, 2007). Differentiated learning seeks to create learning environments that are inclusive to all students that incorporate commonalities amongst the students as well as differences (Tomlinson, 2001). Tomlinson (1999) stresses the importance of learning as being a collaborative process but one that is still student-centered. This means two things: 1) the students should play an active role in contributing to the learning process and 2) teachers
need to create lessons that expose students to learning situations that are most appropriate to their needs. Unfortunately, far too often mathematics teachers frame classroom discussions around Instrumental Understanding, only checking for factual information, thus limiting and inhibiting students’ cognitive growth in mathematics (O’Brien, 1999; Roberts & Billings, 2009; Skemp, 1976). By utilizing classroom discourse that inherently relies upon the development of Relational Understanding, teachers will be using student-centered instructional strategies that simultaneously require students to play an active role in their learning. Thus, classroom discourse provides another medium by which students with linguistic learning preferences can better learn mathematics.

Assessing for Understanding

Mathematics teachers also want their students to become competent and proficient problem solvers as well as independent thinkers; they want students to possess Relational Understanding. However, teachers need to find ways in which to assess this understanding to help support them in their strengths as well as help clarify their misunderstandings (Billstein, Libeskind, & Lott, 2001; Kuhn, 2005; Van De Walle, Karp, & Bay-Williams, 2010; Wilson & Smetana, 2009). One way in which this assessment could be done is through the analysis of student work.

Unfortunately, even detailed student work only represents Instrumental Understanding which is not the level of understanding that teachers ultimately want their students to possess. This would mean that students would then need to include a written commentary for, at least, a few of the problems attempted; a task which could be frustrating for the student and challenging for the teacher to read and assess in a timely
manner. Given one day's worth of homework, roughly ten to twenty problems, of which four to six would require a written response; for one hundred students would mean reading four to six hundred responses each day. Therefore, another method for assessing student understanding should also be employed. This is where WCD becomes an invaluable method as there is a strong and intricate link between Relational Understanding and WCD.

An Invaluable Relationship

The experiences that support students’ learning of mathematics, and the understandings that are created as a result of these experiences are closely linked. By providing experiences that support varied learning preferences, in an environment in which all students can benefit, and in a way that helps students become better thinkers and further develops their mathematical understanding teachers have better and more frequent opportunities to accurately assess student learning and thus provide better instruction. Classroom discourse is a highly effective method that should be strongly supported and encouraged within the mathematics classroom. However, when examining discourse in the middle level mathematics classroom, the nature and needs of adolescent learners creates a unique challenge that warrants further attention (Jansen, 2008). Thus a discussion of adolescents’ needs and how they relate to discourse will follow.

Adolescence: A Time of Great Change

The National Middle School Association (NMSA, 2003) asserts that adolescence, a time ranging from when students are ages ten to sixteen or in grades four to ten, is a period of immense change and growth physically/biologically, socially, emotionally, and
cognitively. Considering such a claim, the impact on students’ developmental and learning needs is likewise significant. Often teachers of adolescent students experience a conundrum as they do not understand the implications of these changes and how they affect learning within the classroom. Furthermore, middle school teachers are often classified as secondary teachers and are expected to have content knowledge appropriate for learners in secondary schools. While these teachers are expected to be “highly qualified” as set forth by the national legislation known as No Child Left Behind (United States Department of Education, 2002), they are often unprepared to deal with the elementary-like behaviors of their students, and lack appropriate pedagogical knowledge to span the cognitive range of these students (Jackson & Davis, 2000; NMSA, 2003).

Social/Emotional Needs

At first glance it may seem incongruous to link the social and emotional needs of adolescents. However, these two areas are tightly intertwined as students’ emotional support is frequently provided by their peers (Jackson & Davis, 2000). In fact, in most situations, peer influences will be of greater significance to the middle school student than other people because adolescent students are continuously seeking acceptance from their peers (NMSA, 2003).

Previous research clearly supports the connection between adolescents and their supportive social networks, whether constructive or destructive (Lee, 2002; Brown, 2005; Garner, Bootcheck, Lorr, & Rauch, 2006; Deering, 1996; Jackson & Davis, 2000). As adolescents search for and formulate a personal identity that is acceptable to them, they rely heavily on the support of their peers. Social relationships take on significant roles,
especially within peer groups, in such areas as helping adolescents “experiment” with their identity; learn appropriate and acceptable social and cultural behaviors; and by providing motivation in and out of school (Jackson & Davis, 2000; Lee, 2002; Oettingen & Zosuls, 2006).

Thus, the strong influence from peers, whether a positive or negative influence on the individual’s personal and emotional well-being, will likely trump prior experiences and advice from adults in an adolescent’s decision making process. It’s not that adults don’t matter in the daily interactions of adolescents; it is simply that they typically matter less. As a result, this internal and emotional conflict can create so much tension, anxiety, fear, and depression that an abrupt change in behavior can occur (Deering, 2002); which in turn can lead to disruptions in the classroom, social withdrawal, or a lack of motivation to learn (Ryan, 2001). Simply stated, relationships with friends matter to adolescent students and their emotional stability partly relies upon the strength and security of these relationships.

Physical/Biological Needs

Adolescence is one of two times in the human lifespan that undergoes dramatic biological changes; the other occurring during the first few years of life (NMSA, 2003; Van Hoose, Strahan, & L’Esperance, 2001; Pangrazi, 2007). Students of this age also experience elevated hormonal secretions along with rapid, and often painful, bone growth which can lead to frequent feelings of discomfort and a need for more frequent movement (Van Hoose et. al., 2001). This is often why adolescents are more physically active, even in the classroom when they exhibit a need to get up and move about. Maslow (1943)
found that when physical and biological needs are not met people are not able to transcend this immediate physical need.

Many adolescents also experience difficulty sleeping (Warner, Murray, & Meyer, 2008). During adolescence, sleep cycles shift to later time periods with sleep occurring between ten o’clock at night and midnight and lasting until eight or nine o’clock in the morning. For many adolescent students school begins around eight or nine o’clock in the morning which means students frequently come to school tired because they did not receive enough sleep the night before.

For adolescent students this means if they are hungry, feeling physically uncomfortable, or feeling tired then their ability to focus on academics is greatly impeded, resulting in disengagement and decreased learning. Physical and biological needs must be met and satisfied before focused engagement, critical thinking, meaningful discourse, and thus learning, can occur.

Cognitive Needs

The social and physical domains of adolescence are not the only area in which significant developmental changes occur. Middle school students also undergo major transitions in their reasoning, critical analysis, and abstract conceptualization (Sylwester, 2007; Wormeli, 2001). These developmental changes are markedly apparent and evident in middle school mathematics. Van Hoose et al. (2001) indicate that cognitive hurdles arise for students because not all adolescents have developed the formal reasoning to accommodate the increase in abstraction inherent in pre-algebra and algebra classes.
Piaget (1977) classified cognitive development along a continuum with adolescence falling within a transitional phase between the Concrete Operational stage, wherein physical (or concrete) representations are still needed to logically make sense of situations and phenomenon, and the Formal Operational stage, wherein people can make inferences and apply skills based on abstract phenomenon. Within the mathematics classroom this equates to some students still needing to use manipulatives to make sense of mathematical relationships whereas other students will not only be able to understand the relationship but can express it algebraically.

Considering these major changes in cognitive development and students’ capacity to think and reason in more intricate, abstract, and complex ways, teachers of middle school students need to prepare learning experiences that can accommodate all kinds of learners and at various developmental stages (Jackson & Davis, 2000). Adaptable lessons and learning activities that reflect this variability are considered to be developmentally appropriate and should be in the forefront of any curriculum designed for middle school students (Deering, P.D., Hilson, N., Kohler, M., Gallardo, R., Ahuna, R., Watanabe, C., Arakaki, J., Blaisdell, M., Kanetake, J., McGivern, H., Adair, M., Simpson, C., Kaneshiro, B., & Guerrera, T., 2006; NMSA, 2003; Van Hoose et al., 2001).

Supportive Instructional Strategies

Instructional strategies that support the learning needs of adolescents should be intricately woven into the curricular and assessment needs of these students (Shepard, 2001). Furthermore, supportive instructional strategies will not only incorporate
supportive curricular and assessment needs but will take into account the physical, emotional, and social needs of adolescents. While not all supportive instructional strategies will infuse all of these needs all the time, whole class discourse can build upon other developmentally appropriate instructional strategies, such as cooperative learning, flexible grouping, using manipulatives in mathematics, and varied assessments (Falle, 2004; Jansen, 2008; Mercer, 2008a; Roberts & Billings, 2009), to help adolescent students be better learners and thinkers (Roberts & Billings, 2009).

Summary

Discourse varies enough from other forms of communication to be classified as a unique instructional strategy used in the teaching and learning of mathematics. The major differences include the dynamic, inclusive, and maieutic nature (Robert & Billings, 2009) that require the students to have a more substantial role than what has traditionally occurred (Mercer, 2008b). Discourse in the mathematics classroom is strongly supported by the research community (Falle, 2004; Hoffman et al., 2009; Huang et al., 2005; NCTM, 2000) and has been shown to promote greater understanding as well (Michaels et al., 2008; Staples, 2007). However, eliciting discursive responses and promoting mathematical WCD among adolescent learners can pose a particular challenge due to the unique biological, emotional, and social developmental needs of these students (Deering, 2002; Van Hoose et al., 2001).
CHAPTER 3 METHODOLOGY

Rationale

Considering the dynamic and social nature of WCD and the teacher’s role in facilitating WCD, I designed the research questions to produce data that would allow me to understand the interaction between the teachers’ beliefs towards WCD and their actual use of WCD. Therefore, a qualitative multi-phase study was used. In this study I relied primarily on qualitative data in the form of semi-structured interviews and observations, though a questionnaire was initially used to aid in the identification and selection of participants who believed WCD was an effective instructional strategy for teaching adolescents mathematics. As a result of the rich data from the interviews and observations, a more in depth understanding of teachers’ perceptions of WCD within the classroom, the strategies that they used to facilitate WCD, and their reasoning as to why such methods were best suited for adolescents became evident (Hmelo-Silver & Barrows, 2008; Jansen, 2008; Kawanaka & Stigler, 1999; Wiltse, 2006).

This study was developed around a grounded theoretical approach (Guba & Lincoln, 2005; Maxwell, 2005); significant emphasis was placed on the interpretations and meaning that teachers had towards discourse as evident in their interviews and observations. Also, as a result of the teachers’ observed interactions in a naturalistic setting, during which thick descriptions were created, theory was inductively generated (Bogdan & Biklen, 2007) on their perspectives towards WCD.
Numerous studies have been conducted employing a qualitative methodology studying teachers of middle level students (Bayer, 2009; Brophy, 1998; Brown, 2001; Chin, 2006; Deering, 1996; Feldman, Stone, & Renderer, 1990; Parker & Hurry, 2007; Piccolo et al., 2008); the methods used included interviews, observations, and field notes. The diversity of data collected is of no surprise since middle level teachers work alongside adolescent students with unique and complex social, emotional, physical, and cognitive needs (McFarland, 2007; NMSA, 2003; Wormeli, 2001); which means teachers must utilize a multitude of diverse instructional strategies to keep students focused, engaged, and learning (Deering, 2002; Jackson & Davis, 2000; Parker & Hurry, 2007; Van Hoose et al., 2001). I captured the essence of the middle level teachers’ praxis with respect to WCD, which includes the social and verbal interactions between students and the teacher that occur as a result of the teacher’s planning, instruction, and decisions during their instruction. Therefore, a qualitative methodology is ideal because it is dynamic, flexible, and open to multiple interpretations (Bogdan & Biklen, 2007, Denzin & Lincoln, 2005; Maxwell, 2005). Furthermore, taking into consideration that this study focused on teachers’ beliefs and perceptions toward instructional strategies that they used in facilitating WCD (as well as those they chose not to use) the benefits of utilizing a qualitative methodology are realized further.

A qualitative methodology also implied appropriate methods would be employed to construct meaning. Maxwell (2005) states that while a good qualitative study should begin with a structured design with the methods and procedures that will be carried out, it should also be flexible and open to new areas depending on any emergent themes that
may arise. However, in order to study those teachers who valued WCD and seek to capitalize on the benefits of WCD for their students, a method for identifying such teachers was needed. Thus, a questionnaire was employed as it was ideal in indentifying the desired sample group (Tashakkori & Teddlie, 2003). The questionnaire, semi-structured interviews, observations, and the resulting field notes from the interviews and observations were used to generate theories and understandings that answered the research questions.

Research Design

To get appropriate data for this qualitative cast study I used a four phase study was utilized (see Figure 2). Phase One began with a four question questionnaire that was used to identify those middle level teachers who placed a greater value on WCD in their classrooms. Phase Two consisted of semi-structured teacher interviews with a smaller but purposefully chosen sample from the teachers who also completed the questionnaire in Phase One.

These interviews were used to generate understandings and a teacher-generated framework (TGF) on instructional strategies that they believed make for meaningful and supportive WCD for all the students within the classrooms.

In Phase Three, the observational phase, I chose a purposeful sample based on the responses from the interview sample of Phase Two. The observations were conducted to determine the extent to which WCD was used and how closely it compared with the perceptions of teachers who strongly believed in the use of WCD. While these same teachers contributed to the theoretical base that described meaningful instructional
strategies to facilitate and promote WCD, the observations along with accompanying field notes assisted in verifying, comparing, and identifying additional practices that teachers’ employed to support WCD.

Figure 2. The four phase design used in this study

Methods

Questionnaire

It would be counterproductive, a waste of resources, and naïve to assume that all teachers place significant value on the use of WCD and thus to choose any teachers to study. If teachers did not value WCD then it was likely that they would not implement
this instructional strategy; which meant time and resources would be spent collecting data that would not address the research questions. Thus, the questionnaire was beneficial in that it was an economical way of selecting participants to interview and observe (Creswell & Plano Clark, 2007). It should be noted, and as advised by Tashakkori and Teddlie (2003), questionnaires should be piloted prior to implementation so that questions are not misconstrued by participants resulting in data that is misaligned to the research questions.

Interviews

Interviews were appropriate because they allowed the teachers to share their perceptions and conceptions of WCD within the classroom (McMillan & Schumacher, 2006). Interviews can be implemented and designed in several ways but in following a semi-structured approach (Teddlie & Tashakkori, 2009) I was able to ask questions that they believed were relevant (see specific questions under Questions on Perceptions) to WCD but allowed for additional, yet directly related, topics and insights that teachers considered to be important in understanding and framing WCD within a teacher’s actual practice. The semi-structured interviews served to examine teachers’ perceptions of WCD and were used to create an initial theory relating to teachers’ beliefs as to what made for meaningful discourse and why such instructional practices were beneficial. Without talking to teachers and hearing their perceptions, it would have been difficult to create a deeper understanding of their perspectives.
Observations (Denzin & Lincoln, 2005) were the next method used to investigate teachers’ perceptions of WCD. Observations were conducted to determine the extent to which WCD was used; including instructional strategies used to encourage and support WCD. While I established questions that related to these observations that seemed pertinent and relevant (see Questions on Practice), the specific details that described and defined the questions were derived from the previous interviews with the teachers. When observing, the role of the researcher may vary depending on intent. However, for this study I used an etic, or outsider’s, perspective which allowed for a more naturalistic environment in which to make inferences and construct understandings on the relationship between teachers, students, and their discursive and behavioral interactions with respect to WCD (Teddlie & Tashakkori, 2009).

Field Notes

I wrote descriptive and reflective field notes during and after interviews and observations, as suggested by Bogdan and Biklen (2007). These notes focused on teachers’ interpretations during the interviews and observations. These notes served to record data that was otherwise not conveyed in the transcripts from the interviews or the recorded verbal interactions within the classroom. Data from the field notes included descriptions of non-verbal responses, the physical classroom setting, events that occurred in the classroom, or the actions and behaviors of the people involved.
Binding of the Case

Maxwell (2005) discusses many ways that researchers can bind their case including, time, setting, sampling and role. He encourages researchers to be specific and pinpoint research questions as early as possible. The following sections describe my role as the researcher, how participants were selected, the setting, and the duration of the study.

Role of Researcher

Due to the dynamic social nature of discourse and the need to better understand teachers’ personal beliefs and perspectives towards the utility of, and their capability to implement, WCD, I believed a social-constructivist worldview, often referred to as an inductive bottom up approach, was ideal in making meaning of the phenomenon of WCD (Bogdan & Biklen, 2007; Maxwell, 2005). The understandings generated from the subjective social interactions, which took place between myself and the teachers, guided me in generating meaningful interpretations; from individual experiences, to broader and more common themes, and finally to theory.

My social-constructivist worldview allowed me to develop a framework to represent reality (ontology), the interpretation of knowledge as generated by the data within the phases of analysis (epistemology), and an understanding of the values underlying this study (axiology). In other words, I believe that knowledge and reality are shaped and influenced by the perspectives of the participants and the meaning that they make from their individual histories.
Additional insight was gleaned through the triangulation of multiple data sources. As supported by the greater research community (Christ & Makarani, 2009; Crotty, 1998; Stake, 2004; Teddlie & Tashakkori, 2009), my ontology, epistemology, and axiology all influenced the design of the methodology as well as the inferences and interpretations that were generated as a result.

**Time and Setting**

This study was conducted in Hawaii during the 2009-2010 and 2010-2011 school years. Four middle level schools from three different school districts were included; Mountain Middle School, Island Middle School, Ocean Middle School, and New Town Middle School (see figure 1). The interviews for Phase Two were conducted at locations that were mutually agreed upon by me and the participants and the interviews were between forty-five and sixty minutes in length. Each observation occurred within the participant’s normal classroom setting at their school and lasted for an entire class period with class periods ranging between fifty and eighty minutes.

Two of the schools, Island Middle School and New Town Middle School, were within the same school district but represent the only middle schools within each of the communities. While Mountain Middle School is the only middle level school within its district, Ocean Middle School is one of two such schools within their district. A narrative of each of these schools follows including a brief description of the community within which each school is located.
Mountain Middle School

Mountain Middle School is a middle level school comprised of only the seventh and eighth grades. It is located within a somewhat older urban community and has ties to the military bases nearby. As the only middle level school within the district, and given the boundaries of this school district, some of the students’ homes are likely several miles from the school itself.

The communities from which the students come represent substantial diversity within the school. The ethnicities that the most number of students and families identified with were Filipino, at 25.9 percent; Japanese, at 18.4 percent; and Part-Hawaiian, at 15.5 percent (HIDOE, 2010). Other larger ethnic groups include Caucasian, Hawaiian, Chinese, Samoan, and African-American at 7.8 percent, 4.1 percent, 3.5 percent, 3.4 percent, and 3.1 percent respectively. School Status and Improvement reports indicated that students claimed identity to several other ethnic groups and these groups combined represented about 18 percent of the school’s student body.

During the 2009-2010 school year, 940 students were enrolled between the two grades. Of these students 28.3 percent of them were identified as receiving free or reduced-cost school lunches. Since the federal National School Lunch Program provides assistance to families who are at or near nationally recognized poverty levels (Mirtcheva & Powell, 2009) this means that over a quarter of the students’ families were identified as being below, or close to, national poverty levels. Furthermore, 10.7 percent of the student population reported to be receiving Special Education programs.
Student academic performance at Mountain Middle School has had fluctuating growth over the last few years, as identified by public documents (HIDOE, 2010), but has matched statewide proficiency levels for each of these years. For the 2009-2010 school year, the proficiency target was at 49 percent, which is exactly the achievement level obtained by Mountain Middle School. Student proficiency was at 52 percent for the 2007-2008 school year, well above the statewide average of 43 percent, but fell during the 2008-2009 school year to 48 percent.

Island Middle School

Island Middle is a seventh and eighth grade only middle school located in a rapidly growing suburban community. While there have been substantial changes to the community due to an increase in housing development, several thousand new homes in the last ten years; the community is not far removed from its historical agricultural past.

The families of the students that comprise Island Middle School were also culturally and ethnically diverse with the two largest reported ethnicities within the school being Filipino, 41.1 percent, and Part-Hawaiian, 15.9 percent (HIDOE, 2010). Other common ethnicities included Caucasian, Samoan, Japanese, African-American, and Hawaiian; 7.1, 4.7, 4.3, 3.9, and 3.6 percent respectively. There were six other identified ethnicities within the school, as found within the same public documents, which comprised roughly six percent of the entire student bodies’ population.

For the 2009-2010 school year, Island Middle School’s enrollment for the two grades was 1367 students. Considering that Island Middle School only has two grade levels, the size of the school, when measured in students per grade, meant that Island
Middle School was one of the largest middle schools in the state. Furthermore, forty-one percent of these students received free or reduced-cost lunch, again an indicator for poverty levels, and 9.4 percent of the students were identified as being enrolled in Special Education programs.

Academic student performance at Island Middle School was comparable to other middle level schools within the state (HIDOE, 2010); forty-three percent of the students demonstrated proficiency in mathematics, as determined by state accountability systems, during the 2009-2010 school year. The two previous school years for which data was available, the 2007-2008 and 2008-2009 school years, had similar levels of student academic performance with a 43 percent proficiency rate and a 42 percent proficiency rate, respectively.

Ocean Middle School

Ocean Middle School is also a middle school with only seventh and eighth grades. Ocean Middle School, and the surrounding communities from which the student population originated, were well established. The surrounding communities are a blend of quaint rural and residential communities consisting of diverse socio-economic, cultural, and ethnic backgrounds.

According to state records on student ethnicity, which was also indicative of the communities’ ethnic profile, Caucasian and Part-Hawaiian were the most prevalent ethnicities; the former comprised 34 percent of the student body and the latter consisted of 25 percent of the same student population. Other major ethnicities include Filipino,
Japanese, Hispanic, and Hawaiian, which consisted of 7.2, 6.4, 5.4, and 3 percent respectively.

Ocean Middle School was the smallest school included in the study with student enrollment for the 2009-2010 school year at 654 students; 250 less than the next smallest school and less than half the number of students for each of the two other schools. Of these 654 students 27.7 percent were reported as receiving free or reduced lunch and 14.2 percent were reported as having received Special Education programs.

According to state indicators (HIDOE, 2010), students’ academic performance at Ocean Middle School was slightly higher than other middle level schools within the state with student proficiency rates in mathematics at 51 percent for the 2009-2010 school year. Also per state performance records, Ocean Middle School’s percentages have risen a few percentage points for each of the last two school years. For the 2007-2008 school year student proficiency in mathematics was at 42 percent and for the 2008-2009 school year the rates increased to 47 percent.

New Town Middle School

New Town is a growing urban community with one of the largest industrial centers and commercial shipping ports adjacent to the town center, as per school-community documents (HIDOE, 2010). It was a planned community that first broke ground in the early 1990’s and has continued to grow commercially and residentially at a consistent rate since then. This rapid growth caused the school to shift from a school following a typical school calendar to a year-round multi-track school wherein three of the four tracks are in session at any given time of the year.
The families with students attending New Town Middle School were socio-economically, ethnically, and culturally diverse as well but there were some ethnicities reported which were slightly greater than others. These ethnicities, in descending order, were Part-Hawaiian at 26.2 percent, Filipino at 22.2 percent, and Caucasian at 13.2 percent of the student body. Other populous ethnicities included Japanese, Hawaiian, Samoan, Hispanic, and African-American; 6.6, 5, 4.1, 3.8, and 3.1 percent respectively. The public documents (HIDOE, 2010) also reported that students identified with five other ethnicities each representing less than 1.5 percent of the student population.

At the beginning of the 2009-2010 school year, New Town Middle School had a total enrollment of 1463 students. However, New Town Middle School was the only school included in this study that also had a sixth grade. Thus, the mean number of students per grade was approximately 488 students. According to School Status and Improvement Reports (HIDOE, 2010), 29.3 percent of the students received free or reduced lunch and only 9.7 percent were reported as receiving Special Education programs.

Student academic performance in mathematics, as indicated in state accountability reports (HIDOE, 2010), had increased over the last three years, but these were still similar to statewide student performance. For the 2007-2008 school year, 33 percent of the students demonstrated proficiency in mathematics with proficiency rates climbing to 45 percent the following year, and to 49 percent for the 2009-2010 school year; 49 percent was the statewide performance target for mathematics for the 2009-2010 school year.
Participant Selection

All participants, as well as each site, were purposefully chosen so that a wealth of necessary information would be provided to answer the research questions (Creswell & Plano Clark, 2007; Maxwell, 2005; Tashakkori & Teddlie, 2003 & 2009). Phase One of this study involved 30 middle level mathematics teachers from four middle level schools throughout the island of Oahu in Hawaii. The primary purpose of this phase was to identify those teachers who were most likely to provide extensive and comprehensive insights that addressed the research questions. Phase Two, which involved nine teachers from Phase One, sought to generate common themes and an initial theory as to fundamental beliefs and practices used by middle level mathematics teachers to facilitate WCD; the TGF. Phase Three focused on observing the actual practices of three of the teachers from Phase Two to determine the extent to which their perceptions coincide with their practice.

In addition, previous research has also shown that students of more affluent families have more advanced language skills (Perez-Johnson & Maynard, 2007); these students typically score higher on standardized tests as well. Thus, selecting teachers whose students were already adept at, and comfortably participate in, WCD may not be as representative of the common classroom in Hawaii’s public schools. This study used public documents to focus on middle level public schools with similar and comparable academic performance indicators in mathematics to the State’s mean performance indicators. The same public documents were also used to identify schools that had similar student and family demographics. While I was unaware if student demographics
and academic performance indicators dictated or influenced a teacher’s perception of WCD, these indicators were relevant because teachers frequently need to use diverse strategies due to diverse groups of students. It should also be noted that I have had past professional and personal experiences with some of the mathematics faculty and/or administrators within these schools. Specific selection procedures for each phase are explained in further detail below.

Phase One: Questionnaire

Since the purpose of this study was to better understand teachers’ perceptions towards WCD as well as identify specific strategies that classroom teachers employed to facilitate this type of instructional activity, it was imperative that teachers who valued WCD be identified. Hence, a questionnaire was used (See Appendix A) to identify teachers who seemed to ardently support the use of WCD. Even though a sufficient number of teachers needed to be sampled (Kranzler, 2007) this study was not looking to make any claims about teachers in general, but rather create a thick and descriptive understanding of my sample.

Phase Two: Semi-Structured Interviews

This second phase aimed to create an initial theory and framework, referred to as the TGF, on middle level mathematics teachers’ perceptions towards classroom discourse through semi-structured interviews (see Appendix B). Participants were selected by collecting data from two sources. The first data source came from the teachers’ responses from the questionnaire in Phase One and the second was a set of judgments of levels of WCD effectiveness provided by school teachers. That is, school leaders, such as
academic coaches, curriculum coordinators, or administrators identified teachers they believed to be effective users of WCD and the names of these teachers were cross referenced with their responses from the questionnaire. The first data source also supported the selection of teachers for Phase Two by allowing me to stratify the sample and screen out those teachers that did not support WCD (Bogdan & Biklen, 2007). Only those teachers that indicated that they believed WCD was a useful strategy to help all students learn mathematics were considered for participation in Phase Two. Thus, participants for Phase Two were chosen by cross-referencing the responses from the questionnaire along with the recommendations from relevant school personnel who had previously observed these teachers.

**Phase Three: Observations**

This phase of the research employed stratified purposive sampling (Teddlie & Tashakkori, 2009) based on the results of the semi-structured interviews in Phase Two. Three teachers were chosen for observations to better understand how WCD was facilitated in their actual practice. These teachers indicated in their interviews that WCD was of substantial value to them and their students as a method for developing greater learning and understanding of mathematics. The observations with these teachers served two purposes:

1. They were a form of triangulation with the data from Phase One and Phase Two.
2. They were a means to determine the extent to which the teachers’ perceptions mirrored their actual classroom practice.
**Phase Four: Follow-Up Semi-Structured Interviews**

For Phase Four I conducted semi-structured interviews again with the same sample as Phase Three because additional questions arose from the observations. These questions were: 1) can WCD be used to support adolescents’ affective development and 2) how has each teacher come to their understanding of WCD? After observing several lessons during which teachers had planned for WCD I wanted to investigate these additional questions so that a better understanding of the relationship between teachers’ perspectives and their actual practice could be generated. Since these questions were based on specific teachers’ practice, these same teachers became the sample for Phase Four.

**Data Collection**

Qualitative studies often rely on multiple forms of data collection to help create a more complete and thick description of the phenomenon under study (Creswell, 2003). This qualitative study focused primarily on semi-structured interviews and classroom observations. The interviews from Phase Two served as an opportunity for the participants to share their thoughts, beliefs, and perspectives on WCD in regards to the research questions. After the interviews were conducted, I transcribed and then analyzed them to determine common and emergent themes to use as a TGF for analyzing teachers’ perceptions in relation to their actual practices. Finally, additional semi-structured interviews were conducted with the three teachers from Phase Three so that they could provide greater insight into, and expand upon, questions that arose during the observations. Thus, the initial semi-structured interviews, the observations, and the
follow-up semi-structured interviews were used to triangulate (Teddlie & Tashakkori, 2009) the data and ultimately to create a richer and more accurate understanding of WCD as it relates to the teachers in my study.

Semi-Structured Interviews

Individual, semi-structured interviews were carried out with teachers before any observational data was collected. While these interviews sought to answer the research questions as they related to WCD within a mathematics classroom, they also allowed for elaboration on the research questions and for divergent ideas from the participants that were still related to WCD. All interviews were recorded and later transcribed to ensure accuracy. Subsequent semi-structured interviews, which occurred in Phase Four and based on the observational data, were conducted with each teacher from Phase Three to seek participant input in clarifying notes or other emergent questions from the observations. Additional field notes were recorded on the teachers’ comments, attitudes, and reactions during the Phase Four interviews.

Observations

As part of Phase Three, classroom observations were conducted and recorded to determine the extent to which teachers’ perceptions of WCD coincided with their facilitation of WCD within an actual classroom setting. The observations of particular traits, behaviors, or instructional methods were included in the observations and were dependent on the TGF, which stemmed from common themes, which arose from Phase Two. Also, as a non-participatory member of the classroom, I was able to observe
behaviors, practices, and other actions that might otherwise have been overlooked or unnoticed as a result of participation.

Data Analysis

Further field notes of the interviews and the observations were written later each day. Then the overall analysis of data from interviews and observations together with these field notes was guided by the research questions (Christ, 2007), as well as by emergent constructs and not limited to any predetermined or particular technique. Transcripts from the observations and interviews were analyzed from a grounded theoretical process (Christ, 2007) wherein memos were created (Charmaz, 2006), or thoughts and ideas that came to me during the data collection and analysis. The memos were then used to create a list of common themes, or codes, which best described the phenomenon. As a qualitative case study, emphasis was placed on constructing a valid portrayal of the specific individual context, rather than on generalizable assertions.

Data Merging

Data from both of the semi-structured interviews and observations were merged at the conclusion of the study. A further review of literature was also conducted to determine if there was support for any emergent themes. The merging of data allowed me to make inferences based on literature as well as understandings, explanations, theories, and conceptual frameworks as generated and derived from the data (Teddlie & Tashakkori, 2009).
Credibility and Reliability

Being that interviews and observations were the primary methodologies for collecting data, and that this data was collected over several months and during two separate school years, a continuous assessment of the data occurred in order to provide the clearest representation. Christ (2008) suggests using a “reiterative hermetrical process” wherein newer data was evaluated with respect to previously collected data in order to make more accurate meaning of the phenomenon. Triangulating the data from the initial semi-structured interviews with the observational data and then with the data from the follow-up semi-structured interviews (Creswell, 2007; McMillan & Schumacher, 2006) also helped in presenting a more credible and inclusive representation of the beliefs, attitudes, and behaviors of the participants.

Semi-Structured Interviews

Maxwell (2005) wrote that the researcher was the fundamental tool, or instrument, in qualitative research and thus the relationships that were established with the participants (and others at the sites) must be fostered and nurtured in order to collect accurate data. Even though the interviews were recorded and later transcribed, the meaning and interpretation from interviews could be misunderstood if the relationships with the participants were not transparent and forthcoming. In order to reduce the likelihood of such misunderstandings, I took two precautions. First, the questions for the initial semi-structured interviews were piloted to increase clarity. Secondly, I shared all data with the participants as a form of member check, the process by which interpretations were shared with the participant to ensure that the understandings were
accurate. By utilizing a member check, participants helped create more accurate descriptions that matched their intent. This process continued until the participants and I believed the interpretations were accurately described. Finally, I reminded each participant that they had the right to remove statements or interpretations that may have been inadvertently inaccurate or statements that may have been disagreeable to them for whatever reasons.

Observations

In Phase Three of this study, the interactions between the teachers and the students were of great importance as these interactions were directly related to the research questions. Thus, a running narrative (Teddlie & Tashakkori, 2009) was used. In this study, the running narratives aimed to record the exact language used by the teachers, along with other verbal and non-verbal cues (such as, but not limited to; intonation, inflection, body language, and pauses) to assist in understanding the techniques used to promote and support classroom discourse. In order to ensure that precise language was collected, audio recordings were made of the observations and were transcribed at a later date.

Finally, I wrote detailed notes during the observations. These notes were shared during the subsequent semi-structured interviews (Phase Four); again relying on member check to determine authenticity and the precision of my interpretations.

Summary

This study aimed to better understand the perspectives of middle level mathematics teachers with respect to the use of WCD as well as determine the extent to
which these perspectives mirror the practices of teachers within a classroom setting. A qualitative case study employing questionnaires, semi-structured interviews, and several classroom observations was used as each method contributed to creating a more precise and coherent theory that was aligned with the participants’ perspectives and understanding of their respective reality (Bogdan & Biklen, 2007).
CHAPTER 4 FINDINGS

Overview

This four phase qualitative study focused on middle level mathematics teachers, grades six to eight, and their perceptions of WCD as an instructional strategy used to support all students in the learning of mathematics. In the first phase I administered a four item survey to the 30 teachers which identified middle level mathematics teachers who valued and used WCD within their classrooms. I purposefully selected this sample based on the teachers’ employment at public schools that were solely middle level by design, only grades six to eight or seven to eight, which had similar demographics and academic performance, as determined by available public documents (See Figure 2).

The data for the second phase were collected from nine semi-structured interviews of purposefully selected teachers. These teachers were selected based on a comparison of their responses in the survey from Phase One and by a reputational case selection; administrators, academic coaches, or other mathematics educators recommended them based on the teachers’ perceived ability to facilitate WCD. Both Phase One and Phase Two focused on teachers’ perceptions of WCD and how it related to, and was implemented within, their daily praxis.

The third phase of this study sought to generate a more precise understanding of the teachers’ perceptions of WCD by examining how three teachers actually implemented and facilitated WCD within a typical class period. Each teacher was observed for at least five class periods. Purposeful sampling was again used to identify the three teachers from Phase Two who reported and described using more frequent and diverse
instructional and pedagogical strategies to facilitate WCD with adolescent students. Observational data was also used to better understand the extent to which teachers’ perceptions and beliefs coincided with their actual practice.

Finally, the fourth phase consisted of follow up semi-structured interviews with each teacher from the third phase. These interviews were based on emergent themes and additional questions that arose from both the second (initial semi-structured interviews) and third (observational) phases of this study. These final interviews were used to help generate a more accurate theory of WCD based on teachers’ perceptions and practice.

The following sections describe the results of the data analysis and are separated into the four phases of the study: 1) The initial questionnaire, 2) teachers’ semi-structured interviews, 3) classroom observations, and 4) follow-up semi-structured interviews. The first section provides the descriptive statistics from the initial questionnaire from which teachers were selected to participate in Phase Two. Since Phase Two sought to better understand teachers’ perceptions of WCD as well as create a teacher-generated framework (TGF) for facilitating equitable WCD, the second section consists of a descriptive narrative that includes the teacher’s perceptions of WCD as well as the strategies that they employ to create this type of learning experience for all students. The third section consists of the comparison of the (TGF) based on the responses from Phase Two with observed practices within the classroom of three teachers who were interviewed in Phase Two. The three teachers selected for Phase Three expressed having a high value for WCD, as reported in their survey and during their interviews, and also reported using several different strategies to facilitate WCD with respect to the unique
nature and needs found within many adolescent learners. Finally, the fourth section consists of the follow-up semi-structured interviews with each of the teachers observed in Phase Three.

Phase One: Questionnaire Data

For Phase One, I administered a four-item questionnaire which identified teachers who placed a high value on WCD as well those who typically planned to implement WCD at least once a week. The first three items were: 1) It is important for students to talk about mathematics as an entire class; 2) when the whole class has a discussion about mathematics, it can be more beneficial than in small groups; and 3) I feel that I can comfortably facilitate discussions with the entire class. Teachers indicated their response on a one-to-five scale with one meaning they strongly disagreed and a five meaning they strongly agreed; a three was listed as being neutral. The fourth item began, I plan for whole class discussions and gave four options: The four options were: A) nearly daily, B) about one to two times a week, C) about once every two weeks, and D) Once a month or less.

Thirty teachers from four middle schools were surveyed with the number of years these teachers have taught mathematics ranged from second year teachers to veterans of 25 years. The first item sought to determine if the teachers believed that it was important for students to talk about mathematics as an entire class. Ten teachers agreed strongly, 19 agreed, and one responded with a neutral response. For the second item, which sought to determine if the teachers believed that whole-class discussions could be more beneficial than small group discussions, only three teachers agreed strongly, 16 agreed,
ten responded with a neutral response, and one teacher disagreed. The third item sought to determine how comfortable the teachers felt in facilitating discussions with the entire class. Nine teachers agreed strongly, 16 teachers agreed, three responded with a neutral response, and two teachers disagreed. None of the 30 teachers indicated that they strongly disagreed with any of the first three items (See Table 1).

Table 1
*Phase One Questionnaire frequency of response by Item, n = 30.*

<table>
<thead>
<tr>
<th>Item</th>
<th>SA</th>
<th>AG</th>
<th>N</th>
<th>D</th>
<th>SD</th>
</tr>
</thead>
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<td>9</td>
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<td>3</td>
<td>2</td>
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</tr>
</tbody>
</table>

SA = Strongly Agree, AG = Agree, N = Neutral, D = Disagree, SD = Disagree Strongly

The final item sought to determine the frequency at which teachers planned for whole-class discussions. Special attention should be given to the word planned as; discourse is dynamic in nature and may occur spontaneously within any given lesson on any given day. Therefore, while teachers may not plan for WCD during a particular lesson, the unpredictability of classrooms means that moments may arise that are ideal for WCD, during which, the teacher may pursue this learning strategy. For this item, which only had four options, 20 of the 30 teachers indicated that they planned for a whole-class discussion at least one to two times per week. Five teachers indicated that they planned for WCD daily, 15 indicated that they planned for WCD once or twice a week, and ten indicated that they planned for WCD about once every two weeks (See Table two). None of the teachers reported planning for WCD once a month or less.
Phase One: Questionnaire

Item 4, n = 30

<table>
<thead>
<tr>
<th>Item</th>
<th>A</th>
<th>B</th>
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</tr>
</thead>
<tbody>
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<td>4</td>
<td>5</td>
<td>15</td>
<td>10</td>
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</tr>
</tbody>
</table>

A = Nearly daily, B = Once or twice weekly, C = Once every two weeks, D = Once a month

Phase Two: Semi-Structured Interviews

Nine teachers were chosen to be interviewed based on their responses from the questionnaire as well as by reputational case selection. School leaders such as administrators, department heads, mathematics coaches, and fellow teachers provided the names of teachers who they believed were strong and effective facilitators of WCD. These names were then crossed referenced with the survey data to determine those teachers who most likely placed a high value on the use of WCD in helping all students learn mathematics. I selected nine teachers for this phase of the study (See Table 3).

Table 3

Interviewed teacher questionnaire data sorted by years teaching mathematics. *Veteran teachers 10 or more years teaching

<table>
<thead>
<tr>
<th>Teacher</th>
<th>School</th>
<th>Years teaching mathematics</th>
<th>Question 1</th>
<th>Question 2</th>
<th>Question 3</th>
<th>Question 4</th>
</tr>
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<td>Ocean</td>
<td>13</td>
<td>AG</td>
<td>AG</td>
<td>AG</td>
<td>B</td>
</tr>
<tr>
<td>Sarah*</td>
<td>Island</td>
<td>11</td>
<td>AG</td>
<td>AG</td>
<td>AG</td>
<td>B</td>
</tr>
<tr>
<td>Carrie*</td>
<td>Mountain</td>
<td>10</td>
<td>AG</td>
<td>AG</td>
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</tr>
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<td>AG</td>
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<td>A</td>
</tr>
<tr>
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<td>AG</td>
<td>AG</td>
<td>SA</td>
<td>B</td>
</tr>
<tr>
<td>Samantha</td>
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<td>5</td>
<td>SA</td>
<td>AG</td>
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<tr>
<td>Traci</td>
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<td>4</td>
<td>AG</td>
<td>AG</td>
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<td>B</td>
</tr>
<tr>
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<td>New Town</td>
<td>3</td>
<td>AG</td>
<td>SA</td>
<td>SA</td>
<td>C</td>
</tr>
</tbody>
</table>

SA = Strongly Agree, AG = Agree, N = Neutral, D = Disagree, SD = Disagree Strongly, A = Nearly daily, B = Once or twice weekly, C = Once every two weeks, D = Once a month
I categorized the teachers into two groups based on years of experience; those with less than ten years and those with ten or more years experience teaching mathematics. The teachers with less than ten years experience are referred to as the novice teachers and the teachers with ten years or more teaching experience are referred to as the veteran teachers (Rowley, 1999). Of the nine teachers interviewed, six taught mathematics for less than ten years; three years being the fewest number of years teaching mathematics. Of the veteran teachers, three had taught mathematics for ten years or more with thirteen years being the maximum number of years teaching mathematics.

I examined the differences in the frequencies of their responses to the survey (See Table 4 and 5). For the first item (see Appendix A), three of the novice teachers responded with a Strongly Agree and the other three novice teachers responded with an Agree. All three veteran teachers, for item one, responded with an Agree. For the second item, two of the novice teachers responded with a Strongly Agree and four of the teachers responded with an Agree whereas all of the veteran teachers responded with an Agree. The third item had the greatest difference in responses with five of the novice teachers responding with a Strongly Agree while the other novice teacher responded with an Agree. For the veteran teachers, two responded with an Agree but one indicated that they had neutral feelings towards the prompt.

For the final item, dealing with the frequency for which the teachers planned for whole-class discussions during a given lesson, two of the novice teachers indicated that they planned for whole-class discussions daily, three indicated that they planned for
whole-class discussions once to twice a week, and one teacher indicated that they planned for whole-class discussions once every two weeks; all three veteran teachers indicated that they planned for whole-class discussions once or twice a week. The response for the last question indicated that the majority of the teachers, from both groups, planned for whole-class discussions about one to two times a week (See Table 4).

Table 4
*Phase Two teachers’ responses to Phase One Questionnaire Items 1-3, n = 9.*

<table>
<thead>
<tr>
<th>Item</th>
<th>SA</th>
<th>AG</th>
<th>N</th>
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<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>Vet</td>
<td>Nov</td>
<td>Vet</td>
<td>Nov</td>
</tr>
<tr>
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<td>5</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

Nov = Novice (<10 yrs teaching), Vet = Veteran (10 or more years teaching)

Table 5
*Phase Two teachers’ responses to Phase One Questionnaire Item 4, n = 9.*

<table>
<thead>
<tr>
<th>Item</th>
<th>A</th>
<th>B</th>
<th>C</th>
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<tbody>
<tr>
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<td>Nov</td>
<td>Vet</td>
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</tbody>
</table>

A = Nearly daily, B = Once or twice weekly, C = Once every two weeks, D = Once a month

**Questions on Perspective**

In order to better understand teachers’ perspectives towards WCD there were five primary questions that guided the semi-structured interviews. These questions focused on the teachers’ perspective, interpretation, and understanding of the characteristics,
benefits, and strategies of WCD and how they manifest within the respective classroom of each teacher. These questions were:

(1) How do teachers define discourse?

(2) How do teachers perceive the utility and benefits of WCD to help increase student understanding?

(3) How do teachers perceive and define their role in engaging all students in WCD?

(4) How do teachers describe meaningful discourse in their classroom?

(5) What instructional strategies do teachers utilize to engage students in discourse?

Since each question represents one element that shaped teachers’ perspective on WCD, a discussion on each is included below. These discussions include quotes from the interviewed teachers to create as precise of an understanding as possible; their words to represent their interpretations and understandings.

Teachers’ Definition of Discourse

While Question 1 is a more technical question, it was the first question for each interview as it sought to establish a definition or understanding of a specific term used throughout the interviews. It was important for the participants and me to have the same working definition for this term at the beginning of the interview so that discrepancies or misunderstandings could be avoided. Discourse, as a concept and instructional strategy, has existed since antiquity and has also been prevalent in the professional literature as a beneficial strategy for helping students learn mathematics for several decades (Griffin, 1970).
The teachers responded in one of two ways when they were asked to define discourse; one having positive connotations and the other having negative connotations. Many of the teachers were openly unsure of the definition, they said they did not know what the term meant, but provided a definition that they thought might be accurate. For example, Warren (Personal interview, May 13, 2010) said, “Discourse to me...I’m not really sure of the definition but to me it sounds like things not working out.” Of these responses, the majority had more negative connotations and could further be described as either having a negative affect or as being irrelevant. Carol (personal interview, May 28, 2010) stated, “Discourse to me sounds bad; disagreements, discussions of different topics. Discourse to me would mean something is not going very well or varying opinions on a topic, I guess.” Several other teachers also thought of discourse as being related to something other than the topic being discussed. Jasmine referred to discourse as being “off track or off tangent” whereas Traci related it to random statements that students would make because they were not engaged in the learning.

I would think that discourse, to me, would be if a kid who was to say something random, just anything and the whole class would run with that. I guess in middle school, period, they are just kind of like just looking around because they don’t want to pay attention and they just kind of run with that. It has nothing to do with what we are doing in class (Traci, personal interview, May 27, 2010).

Since it was important for the teachers and me to have the same understanding of the term discourse, I asked the teachers to instead define whole-class discussion if they
were either unfamiliar with the term discourse or if the definition they provided was erroneous. While discourse does not necessarily mean or equate to whole class discussions, I felt that this term would be one that they might be more familiar with and one which could provide a common working definition for the remainder of the interview. Teachers’ viewed whole-class discussion as being a teacher initiated and controlled phenomenon that relied on input from students. Carol stated that, “a whole classroom discussion, it would be, a discussion where I would put a topic out there and I got input from various students in the class. As many as possible, and then we talked about their inputs (Personal Interview, May 28, 2010),” whereas Warren viewed whole-class discussions as being highly structured and organized with students sitting with their desks in a circle and participating in an orderly turn-taking fashion, “it is just not craziness going on (personal interview, May 13, 2010).” Samantha thought of whole-class discussion as an interactive back and forth process that helped students think deeper about the mathematics being learned. Jasmine and Traci also supported this structure of teacher initiated discussions but supported by student input; although, for them, input from students was on a volunteer basis. By framing discourse as a whole-class discussion I found differences that separated the teachers into two groups. One group held the perspective that it should be teachers that held the central in this strategy while the other group thought it should be the students who took a more dominant role.

Those teachers who were familiar with the term discourse expressed it as a student-centered activity that required several facets of participation, was inclusive of all students, and was intended to engage the learner in the understanding of mathematics.
Initially Sarah stated that discourse was a “whole group class discussion” but went on to add that discourse should try to get “everyone involved and participating and talk on the topic that is being discussed (personal interview, April 22, 2010).” Carrie supported Sarah’s definition of discourse when she stated that discourse is a form of conversation but added that it does not just involve words. Specifically, students had a role besides just sharing in the conversation, they should also be “listening intently” as this is an element of an inclusive conversation.

Erin viewed discourse as a means of engaging students in the learning of mathematics but added that discourse is not limited to teachers directing a discussion based on teacher initiated prompts. She believed that discourse could be an opportunity for students to openly share understandings of a topic without teacher influence. However, Erin also stated that discourse can be used as an informal formative assessment to better understand students’ prior knowledge and misconceptions as this allows the teacher an opportunity to contribute to the topic under study.

These three teachers who were familiar with the concept of discourse viewed it as an interactive and inclusive whole-class discussion, a definition more aligned to Piccolo et al.’s (2008) definition. While the first group of teachers also defined whole-class discussions as involving both the teacher and the students, the first group also viewed discourse as having more positive connotations with structural elements that placed an emphasis on the student.
Summary

Most teachers believed that they were familiar with the term discourse but the majority of the teachers viewed it as being a phenomenon with more negative connotations until it was rephrased in terms of a whole-class discussion. Then discourse was viewed as a teacher-initiated activity to get students to talk about mathematics. The few teachers who viewed discourse as having positive qualities also described it as an inclusive activity to engage students, wherein students had roles besides simply talking about mathematics; students would also need to be active listeners and leaders of the discussion.

Benefits of Whole-Class Discourses

The teachers chosen for these interviews all expressed a value for WCD based on their responses from the initial survey. They all believed that WCD in the mathematics classroom was beneficial for several reasons; some of which were more beneficial to the teacher while others were of more benefit to the students. The following section describes these perceived benefits as they relate to the teachers and the students.

Benefits for the Teacher

The interviewed teachers strongly believed that WCD had specific benefits in supporting the learning of mathematics. However, their responses all related to three specific areas within the locus of their praxis: 1) Checking for understanding, 2) classroom management, and 3) discourse as an instructional technique. Each of these elements distinctly benefits teachers in their efforts to help students learn mathematics. A detailed narrative describing each of these areas follows.
Checking for understanding.

While the teachers’ responses aligned with one of these categories, every teacher reported that one of the benefits of WCD was that misconceptions were made more apparent during such a learning experience and could thus be addressed in a timelier manner. Carrie, as did several other teachers, indicated that she often used small group discourse to support student learning but that small group discourse can have drawbacks, one of which is the difficulty in identifying and correcting more widespread misconceptions.

I like small [group] discussion. But sometimes in smaller group discussions I cannot monitor certain students. If there is a child who keeps getting the same answer wrong it helps to clear those misconceptions up because they can see what the other kids did. (Carrie, personal interview, May 13, 2010)

Warren reinforced this belief that small groups could be beneficial but added that teachers needed to be aware that misconceptions could be generated and perpetuated within small group discussions. “A whole class discussion would be good if students are totally off base on their ideas. Yet they are sitting on a table that everyone agrees with their off ideas (Warren, personal interview, May 13, 2010).” Traci stated that identifying these misconceptions was of particular importance when students were either learning a new topic or when a topic was particularly confusing to them. She indicated that such topics could be computational but that they could have also been derived from more abstract concepts like the slope of a line.
Managing the classroom.

While the identification and correction of misconceptions was the most reported benefit of WCD, these teachers also believed that there were important managerial issues that were supported by WCD. For these situations, and based on teachers' understandings, classroom management referred to a process by which teachers made managerial decisions that had an impact or influence on the remainder of the lesson. It does not specifically mean a process or system by which student conduct, behavior, and/or engagement was monitored although this could be a secondary by-product of their managerial decisions. For these teachers, managerial meant performing, preparing, or gauging tasks that related to the next, or subsequent, portion of the lesson. For Carol, as many of the teachers also indicated, WCD was used as a means for either preparing students for work in small groups or for checking the effectiveness of their small group work. If students had a task to complete in small groups, Carol believed that she could determine the extent to which the groups were successful based on the type of response they provided. “The benefits are that you can see if the small groups are working. You know if everyone is discussing what they should be discussing and they are getting the ideas they should be getting (Carol, personal interview, May 28, 2010).”

Carrie, Warren, and Erin reported having often used small group interactions first as a means of leading into WCD. However, Warren believed that the students needed to be passionate about the topic of discussion first; one way in which this passion can be created is if the students have a common experience within small groups first.
Actually come to think of it, big classroom discussion would be really good if kids are passionate about something. Some kind of solution or way that they are doing it. I think maybe, and I’m just thinking about this now as we are talking about it; a small group might start getting them to that point where they feel passionate about the answer where they have tried it enough times where they go “I know this is the way to do it.” And once they are passionate about it, bringing it to the classroom discussion then; that will make for a richer discussion. (Warren, personal interview, May 13, 2010)

WCD was also used prior to small group work as the teachers believed that it would better prepare students for work in these groups. Jasmine stated that she used WCD as a means for identifying students for various grouping strategies. That is, based on the responses provided she determined which students might support each other’s learning the best. Carrie indicated that WCD provided her with an opportunity to model for students how to talk and work within their smaller groups as well as establish the expectations she had for the students while they were working in small groups.

When I want them to practice how to speak, or how to practice how to have a discussion, I want a bigger discussion group because I want to show them an example of what to do in their smaller groups. So before I let them go into their smaller groups, I would want to have a bigger group discussion so that they can model or take away; so they can talk about
what they need to talk about in their small groups. (Carrie, personal interview, May 13, 2010)

Thus, WCD was used to prepare students to work in small groups; at times it was used to identify students who might best support each other with the mathematics being learned as well as a means of modeling discourse for use in small group work. Regardless, WCD and small group work were reported as being intricately linked in the day to day lesson plans the teachers created.

*Utilizing WCD as an instructional technique.*

A few of the teachers also talked about the use of WCD as one of the methods they used to teach new content. Samantha (Personal interview, June 29, 2010) believed that WCD was “the gel for the whole lesson” meaning that it helped the students make the connection between the learning experiences and the desired mathematical learning outcomes. Jasmine was one of these teachers that believed WCD was an efficient instructional method for the delivery of mathematical content and said, “I can get my point across. It’s like shooting a pellet gun; the more pellets that shoot out the more you are going to hit something. It’s more like getting my message out faster (Jasmine, personal interview, April 20, 2010).” Traci also indicated that WCD was an appropriate opportunity for her to explain the content to help students learn more computational or problem solving strategies.

So, the way I teach, I like to do things step by step and so I list steps down that the kids can follow, like break it down. I guess more specifically, so the kids can follow easier; “Ok I have done this, I have done this, oh wait.
I have to go back because I forgot this step.” And they understand it better I find. And they are fine with that. So after we did that on the board as a whole class, [the students are] like “oh! I get it now.” they can go back to their regular math class and do it this way rather than the other way. Because I think that kids that are in this class need a little bit more strategies than other kids. So giving them different strategies they can use; that teacher strategy if they find it easier or they can use the strategies in here if they find it easier. So it is just an option that they have. They just have more options. (Traci, personal interview, May 27, 2010)

Thus, for Jasmine and Traci, WCD was beneficial as it provided a convenient opportunity for the teacher to try and impart mathematical knowledge. Erin stated that there were times when she wanted students to also learn a specific piece of content or information but in contrast to Jasmine and Traci’s perspective, Erin thought of WCD as an opportunity for her to improve her ability to craft meaningful questions and to help students arrive at this information on their own.

It also helps me realize that I can’t ask a question this way if I want this answer because there’s an ambiguity to it and you could get different answers, which is not where I’m going. So, which I never would have realized if I just stood up there and talked at them (Erin, personal interview, April 29, 2010).
Summary

WCD was primarily used by the teachers as a technique to recapitulate, summarize, and/or revisit previous learning. This technique also served as a formative assessment wherein the teachers could determine the degree to which students understood the mathematics being discussed. The teacher could then use this information to highlight and correct any misconceptions that existed in the students’ reasoning. Thus far the benefits of WCD have been benefits for the teachers. Specifically, the ways in which the teachers utilized WCD to determine students’ levels of engagement, as a strategy for preparing students for small group work, and as an instructional method for teaching new content.

Benefits for the Students

The majority of the responses from the interviewed teachers indicated that WCD positively benefited the students in their learning of mathematics. While all of these benefits were aimed at developing mathematical understanding, they can be categorized into one of three supportive areas: 1) Student understanding as classified by Wiggins and McTighe’s (2005) Six Facets of Understanding, 2) creating situations that meet students’ flexible and varied learning styles, and 3) in establishing and ensuring student accountability.

Student understanding: The Six Facets of Understanding.

Wiggins and McTighe (2005) suggest that there are six facets that support understanding of a given concept. These facets are: 1) Explain, the ability to offer complex and rich accounts; 2) Interpret, the ability to make a situation or experience
personal; 3) Apply, the ability to use information in novel or unique scenarios; 4) Perspective; the ability to see how others view a situation; 5) Self-knowledge, the awareness ones bias or lack of information; and 6) Empathize, the ability to relate to and/or feel what another person experiences. The six facets of understanding should not be thought of as hierarchical or dependent up on each other in order for a student to understand a topic or concept though the more facets that a student “has” with respect to a concept, process, or situation the deeper their understanding will be.

Of these six facets, the teachers reported the facet of Perspective most often and usually in reference to students’ opportunity to hear new or other ideas from other students. However, the benefits reported were often not listed separately. That is, the teachers would often combine several benefits together into one explanation. An example of this is when Carrie talked about students’ hearing other students’ strategies to solving a problem (Perspective) and how that helped them remember previously learned content that was needed for success in the current lesson (supporting various learning styles), which lead to different student generated ideas being shared, and thus generated greater participation and engagement (student accountability). For example, Carrie stated,

I like the overlapping; building upon each other’s ideas. When one person speaks someone never thought of that before or maybe they didn’t think of it that way but they have thought of it before and they are like “oh yeah I remember that.” And those build upon, and the conversation grows to more and we start talking about things more in depth, not just so
superficial. It builds and builds and builds and that is what I think is the best part; is when everyone gets involved (Carrie, personal interview, May 13, 2010).

Carol (Personal interview, May 27, 2010) also believed that part of the learning process is “for the kids just to hear other people talking about it in front of everybody” so that they can also understand how others viewed the mathematics being learned. Traci supported this statement because she believed that sometimes students were reluctant to raise their hands yet they had valid and legitimate questions that needed to be addressed. Through the use of WCD, more ideas could be shared and, perhaps, questions that may have gone unasked could be answered. Traci alludes to this when she said,

Sometimes, you know those quiet kids, they kind of fall through the cracks because you don’t; they don’t want to say anything. They are not making trouble in your class so they just kind of sit back and they just kind of like; I don’t think they want the attention on them so that is why they don’t want to say anything. But for those kids who are more verbal they may voice something that the quieter kids may have questions about. So in that way I think it benefits the whole class. And that is the most beneficial thing that the whole class discussion can do. (Traci, personal interview, May 27, 2010)

Ben and Samantha both commented that WCD allowed students to make personal connections to the mathematics being learned. Samantha stated that it was important for
students to use WCD to make connections because then they would begin to “own” the mathematics and understand the purpose for learning it.

Otherwise they don’t own it; it is not their problem. They don’t really care about solving it because it is just words in a book to them. You’ve got to connect it to something to get them to buy into it. Now there is a purpose, it has a purpose and then it has more meaning for them.

(Samantha, personal interview, June 29, 2010).

Another facet that the teachers talked about was that of *Explain*. Sarah believed that getting students to talk about mathematics promoted higher order thinking skills that extended to not only the student doing the explaining, but also to those students who were listening to the speaker, processing the new information, and then trying to make contributions based on the explanation.

It’s good for them to talk about [mathematics] because being able to talk about the math shows a higher level, I think. Definitely for the kids saying but then I think the other kids around who are listening and trying to take it all in and contribute. I guess I feel if you are getting them all to talk about math then you are getting them to think about it. (Sarah, personal interview, April 22, 2010)

Carol also commented that when students began to explain the mathematics more, then they were more likely to remember it. Carrie and Traci stated that this was of particular importance when the mathematics being discussed was either new information or was a “confusing” topic for the students. Sarah and Erin further suggested that student
explanations were beneficial because they framed student understandings in the language of their peers. That is, they believed that sometimes when students expressed their understandings it made more sense to the other students in the classroom instead of the language used by the teacher. Sarah said,

We might be on something that they are struggling with but one might get it so I will ask them to come up and explain their thinking because sometimes they explain it to each other when I feel like they are saying almost the same thing; it makes more sense to them (personal interview, May 22, 2010).

Erin gave an account of her first year teaching in which she was teaching the distributive property and was becoming frustrated that one of her “average” students did not understand this property. She tried to explain it in different ways but with no success until another student asked if they could try to explain it. Erin said she was shocked because the second student repeated, verbatim, her last explanation. At this time the confused student exclaimed that they now understood. “That taught me that there is something that I am not gleaming [sic] onto that is of value; of having students work together and students explain things (personal interview, April 29, 2010).” This account leads into the next major theme for the benefits students have with respect to WCD; student accountability.

*Student accountability.*

For this study student accountability is understood as a means of holding the students responsible for contributing to and partaking in the creation of mathematical
meaning as it relates to the lesson at hand. In doing so, students are placed in a central role that requires them to assume some of the roles traditionally associated with the teacher. These roles include, but are not limited to, providing feedback to individual classmates via verbal responses or questions, asking questions to the entire class, interjecting with comments or counter examples, identifying and commenting on errors in reasoning or computations, and verbally extending or expanding upon current understandings based on the WCD.

As previously stated, Carrie talked about how student questions or responses build upon each other; one student would begin with a statement or question and others would reply with additional comments or questions. Warren felt it was important for students to hear each other’s ideas because it created learning opportunities wherein the students were supporting each other’s learning by providing feedback, interjecting with additional or supportive comments; or students would question the methods, validity of the statement, or the solution presented. Sarah also believed that the students benefited when they were engaged in WCD not only because they became central to the generation of mathematical meaning, but because their conversations promoted higher order thinking. Sarah was the only teacher to suggest that WCD supported higher order thinking skills.

Sometimes the kids come up with things that I hadn’t thought about, you know what I mean? And so something that I am teaching, a certain way, someone might see differently…so they come up with unique ideas. So I think it’s good to be able to, well one, it’s good for them to talk about
[mathematics] because being able to talk about the math shows a higher level [of thinking] I think. (Sarah, personal interview, May 22, 2010)

Warren and Erin further confirmed this perspective of WCD as a method by which students support each other in their learning. Warren (personal interview, May 13, 2010) commented that he often allowed the class to “help steer the direction of the problem” as students then became the ones to clarify misconceptions or suggest alternative problem solving strategies. Erin noted that when students take the lead for their learning they also became more engaged with the content. Erin said that she knew when such levels of engagement occurred because students would make surprised comments about class being finished already; the time passed quickly for them. She added that this type of engagement cannot occur if the teacher assumes the role of a lecturer.

We don’t want to sit and listen to a professor talk for any length of time. So if students are saying class is over already that means that they were totally engaged and they are not going to say that if you are talking at them (Erin, personal interview, April 29, 2010).

Summary

The teachers believed that WCD benefited the students because the students became engaged in generating and supporting mathematical ideas related to the topic at hand. Furthermore, the teachers felt that the students assumed more responsibility for leading the discussions and thus benefited as they became more accountable for their own learning.
Teacher’s Role in Facilitating WCD

The teachers reported that when students take the lead in providing mathematical prompts that generate WCD the teachers took on a more peripheral role in the discussion. Every teacher interviewed described their role in these types of situations as a facilitator. By facilitator, or by facilitating a discussion, the teachers described their role as being more of a guide that was responsible for providing prompts or questions to stimulate a discussion. However, the teachers stated that as a facilitator, there were other duties or responsibilities subsumed in this role. The teachers included maintaining a positive and organized learning environment; shifting the responsibilities, duties, and roles of WCD to the students; and questioning students’ thinking to assess understanding while being cognizant of the unique nature and needs of adolescent learners. These aspects will be discussed in greater detail after a description of how the teachers guide as a facilitator.

Facilitator as Guide

When the teachers were asked what their role was during WCD, every one of them stated that they were to serve as a facilitator. Several teachers believed that students needed to take control of their learning and actively lead whole-class discussions but they also believed it was important for the teacher to guide the students through this learning process; to make sure the students understand the mathematics being taught through guided questions. Warren expressed that it was important to guide the discussion but that the teacher needed to be cautious in not controlling the conversation such that student generated ideas were stymied. “I don’t want to limit. I do want to lead them in a certain
direction but I don’t want it to be so strict that it only is one way of them seeing it (Warren, personal interview, May 13, 2010).”

Many teachers thought that it was the teacher’s role to initiate the conversation but then to assume a more peripheral role in the WCD; “I just like to sit back and watch. Sit back and sort of know where the conversation is going (Jasmine, personal interview, April 20, 2010).” Carrie also talked about removing herself as the foci of the discourse. “I literally sit back and just let them, not argue, but debate themselves. And that is, what I think is, what we should be doing; just facilitating (Carrie, personal interview, May 13, 2010).” Carrie continued by stating that she also needed to be able to steer the conversation but not in a dominating manner wherein she became a “back seat driver.” Carol, Warren, Ben, and Sarah support Carrie’s perspective of needing to be a guide that can “steer” the conversation and keep it going if students are stuck or at an impasse. Sarah commented that even though she may remove herself from the conversation to a degree, she still needed to be ready to guide the conversation or support student responses during the conversation; she referred to this as cueing. Cueing included such things as providing hints, introducing new vocabulary, or asking students to clarify a thought.

Carrie added that while she may initiate the WCD, she purposefully holds back in participating in the discussion and sees herself no longer as a facilitator but as a cheerleader; “I’m more the cheerleader at that point; ‘Oh good job. Oh wow! I never thought of that. I am loving this discussion guys.’ But I am not the center of attention at all. Not at all (Carrie, personal interview, May 13, 2010).” Even though Carrie tried to withhold opinions at times, she noted that students ultimately seek her opinion either by
asking her outright or by glancing in her direction trying to determine her perspective based on body language and facial expressions.

Supportive and Organized Classrooms

The teachers also believed that as the facilitator of the WCD they were also responsible for maintaining a learning environment that ensured all students had an opportunity to participate, that students participated in an orderly fashion, and that members of the class respected the person speaking. In essence, establishing, implementing, and maintaining their classroom management. Erin said that she found herself having to exert some level of control but yet being open and supportive of the students’ ideas; too many students talking at once could lead to a confusing discussion. For example,

What I have to, again going back to my experiences, I have to keep a balance between encouraging the students to do that and yet not having it get so chaotic that seven different people are talking at once and nobody is hearing anyone else. ‘Ok, that is a good thought. Let’s let you respond first and then [someone else will] follow up on that,’ as opposed to everyone yelling out at once. (Erin, personal interview, April 29, 2010).

Jasmine believed that her primary duty as a facilitator was to make sure that the students behaved properly. When asked, as a facilitator, what she thought was her most important duty, she said,

Initially it is more classroom management. If it gets too loud in this corner I try to get the noise level down, and I look to the whole class. And
ok, maybe they are not really engaged but they are not fooling around.

(Personal interview, April 20, 2010)

Carrie supported Jasmine’s perspective that classroom management was essential for WCD to be successful; it could be a decisive factor in deciding if she used WCD in a particular class. If the class was too large or if she felt as though she was unable to keep the students’ attention focused on the topic of discussion, then utilizing WCD became a greater challenge.

Sometimes they are off task because we are having a whole class discussion. Trying to regulate class management, trying to regulate their behavior while we are having a class discussion, if everyone wants to speak you got to make sure that they are not talking or that so-and-so is not talking. Are they listening? Managing that, I, that to me is kind of hard especially in a really big class. (Carrie, personal interview, May 13, 2010).

Warren believed that it was important to establish a classroom culture that promoted learning from the beginning and incorporated this belief into his classroom management plan. “I think I established the atmosphere in the classroom that they know that they can talk and that is something that is important early on for me (personal interview, May 13, 2010).”

As a relatively new teacher, Traci stated that she was reluctant to partake in WCD because, to her, middle level students became more off task during learning situations that emphasized WCD and maintaining an orderly classroom was important so that she
could present the lesson. She explained that WCD was easier with kindergarten students because the mathematics was less abstract and because the students found the mathematics more enjoyable.

It was easier to facilitate and monitor the kindergarten kids because…they were having so much fun whereas middle school, since it is so abstract and they don’t get to do as much hands on things, it is kind of, well, boring for them I would say. So it is harder for them to stay on task. (Traci, personal interview, May 27, 2010)

However, Traci believed that students’ engagement in WCD would likely change if she could use more manipulatives with them, as she previously did with her kindergarten students. But because the mathematics taught in the middle grades is so abstract, she believed that this level of engagement and relevance would be difficult to create.

**Shift in Responsibilities**

All of the teachers interviewed believed that it was important for them to turn over the control of the class, and the discussion, to the students. Sarah summed this up by saying, “I don’t want them to have my thoughts; I want them to have their thoughts (personal interview, April 22, 2010). Erin described the exchange of control as allowing, and actually promoting, “chaos in the classroom.”

I feel that I’m giving more control to my students; I’m allowing the students to have more a part in their classroom. And I’m allowing, and this is thinking all the way back to when I was in school sitting with my hands folded at my desk; I’m allowing chaos in the classroom. Yesterday
I did an activity, a typical algebra scavenger hunt that I’m sure you have done where you have the problems up and you have to find the answers up; terribly chaotic, terribly noisy, terribly meaningful because every student is engaged (Erin, personal interview, April 29, 2010).

While Erin’s example dealt with small group explorations, her focus was on providing engaging learning situations. However, Erin stated previously that one of the primary and natural benefits of WCD was in the way it engaged students. As a result of the students’ engagement she recognized that the classroom may not conform to other’s perceptions of an ideal classroom environment, because of the perceived level of noise. Several other teachers commented that their ability to facilitate WCD had improved since they first began teaching because their classroom management had also improved. For Erin, she recognized the need for her students to be a part of a classroom environment where the sounds of students conversing about mathematics were considered an acceptable norm rather than poor classroom management. She explained that, “These children grew up on Sesame Street and other things where there was a lot of interaction and that is what they are use to; and they are not able to sit and listen for a period (Personal interview, April 29, 2010).”

Warren related to Erin’s perception of controlled chaos in terms of good and bad noise. He said that during his first couple of years his instructional techniques were entirely teacher-centered. And while he occasionally incorporated various problem solving strategies to address the needs of various learners, these methods “didn’t help to facilitate the group discussion whatsoever (personal interview, May 13, 2010).”
However, one of the biggest lessons he learned over the last five years had been a shift from a teacher-centered instructional approach, wherein he was in front of the students doing the majority of the speaking, to a student-centered approach which provided the students more opportunities to discuss the mathematics amongst and between themselves.

Yeah, I realized that the kids needed to talk and I just needed to give them the chance to talk. I think that before, one of the big things; before I thought that all noise is bad noise. I had to learn the difference between good noise and bad noise. That was a big thing (Warren, personal interview, May 13, 2010).

Erin warned that while it was necessary for students to take control of and lead WCD, too many students talking at once can detract from the purpose and the benefits of WCD. She believed that when such situations occurred then she needed to split the whole class into smaller groups so that several separate conversations could continue. Once the small groups have had opportunities to discuss the topic, she restructured the class so that the discussion was amongst the entire class again.

Traci also expressed the importance for her students to take control of the discussion, or “let them have the floor,” as this demonstrated to her that the students were actively thinking about the mathematics being learned. Yet, Traci was cautious to not let just a few students dominate the conversation because then there would be fewer ideas being generated.

I guess I like that kids share their ideas with each other and they are actually talking about math because then they are actually thinking.
[Since] they are thinking about it, they can justify their answers when they say it. (Traci, personal interview, May 27, 2010)

Being able to learn what students know, don’t know, or any of the misconceptions that they may have was one of the benefits of WCD, as stated by the interviewed teachers. However, sometimes it was not clear to what extent the students understood the mathematics based on the comments or questions that stemmed from student-led WCD. So, teachers needed to know when to probe deeper to determine student understanding. All the teachers commented that this knowledge of student understanding could be achieved through the use of various questioning strategies, which leads to the next role; using questions as a means to learn what students know.

*Question Understanding*

Many teachers believed that it was their role to push the students in their thinking so that the students could clarify their thoughts and so that the teacher can better understand the extent to which students understood the mathematics. Warren expressed a need for students to justify their thinking with concrete examples and details as this provided him with a formative assessment of the mathematics. “To me, personally, it shows that they are defending their ideas, and I need to hear that from them; the ‘whys.’ Why are your ideas good? That is what I want to hear, not just because (Warren, personal interview, May 13, 2010).” The teachers frequently conveyed that the use of questions and different questioning strategies were essential in accomplishing this goal. Carol, Erin, and Warren believed this to be one of their primary roles during WCD; to ask questions, challenge students’ responses, and thus better determine what the students
know. These teachers would ask questions like, “How is your proof valid?,” “Can you add on to that?,” “Tell us how it works. Oh, why did you think that?” and “Can you say that it in your own words?” Carol referred to this as playing devil’s advocate; challenging students’ thinking regardless of the accuracy of their statement or solution. Carrie held a similar belief. She mentioned that while she does not ask her students to justify their responses every time, she may ask her students to defend their responses even if the student is correct; she tries to do this without indicating the accuracy of the response.

But yeah there are lots of times where I’m like oh my goodness but then I am like “Really? Ok, can you prove that for me? You got the answer can you prove that to me?” And when they do that that is the point when the kids always think that it is wrong; if I ask that but then they come up with the same answer. “Miss, it is right?” and I am like “I didn’t say anything.”

(Carrie, personal interview, May 13, 2010)

Traci also stated that when she was able to question students on their responses it provided them with an opportunity to clarify their thinking and were thus better able to understand and articulate the mathematics. As a result of needing students to articulate, defend, or justify their solutions Traci also believed that the students learned how to better express their reasoning in writing; a skill she felt needed to be fostered and modeled through WCD. Traci also believed that this increase in understanding, articulation, and written responses extended to those students who were not active speakers but were active listeners.
Sarah described an experience from when she was completing her undergraduate degree in education that required extensive use of questions. In one of her classes she had to create a lesson based solely on the use of questions to help students understand the learning objectives.

When I was in my undergraduate we had to do a whole lesson where all we could do was ask questions. We couldn’t tell anything so it was like a questioning technique to get students where you wanted them all through a series of questions which is very hard to do. (Sarah, personal interview, April 22, 2010)

Sarah believed that she is now better able to craft more meaningful questions that further probe students’ understandings or misconceptions. She stated that in order to be successful with this type of teaching technique, the types of question asked matter depending upon the depth or complexity of the intended discussion. Sarah commented that in order to get more students thinking about and engaged in the mathematics during WCD, the questions she asks needed to be more open-ended and allow for creative solutions and not just “traditional step-by-step” questions that require only factual or procedural knowledge to answer them.

*Affective Awareness during WCD*

All of the teachers believed it was important to challenge students’ thinking during WCD, to play “devil’s advocate,” but several of the teachers stated that they needed to be cautious when challenging students’ thinking because it could lead to embarrassment or shame if they were not able to provide a response to the question or
prompt. In essence, teachers needed to be aware of the affective development
adolescents undergo and that these students might feel that their responses, correct or
incorrect, were being critically scrutinized by their peers.

During the interview with Sarah, she described discourse as a phenomenon where
“everyone would be able to contribute to the discussion at a level that... I can see that
they are understanding or know what’s going on. And it would be different people being
able to answer at different times (Personal interview, April 22, 2010).” Essentially,
discourse was an inclusive and dynamic phenomenon that allowed her to assess students’
understanding. And while she believed that all students should be participating, Sarah
later stated that she was aware that some students did not wish to participate and that she
needed to be sensitive to these situations. “It’s hard, yeah? You have to remember, too,
that kids are people, too; teen problems and whatever. And a lot of kids, like today, I had
a girl crying about her family (Sarah, personal interview, April 22, 2010).” Jasmine and
Erin both indicated that adolescents can be acutely self-conscious and do not want to be
put in situations that could compromise their social standing or emotional security. For
these “shy” students, the teachers believed it was best to not to “put them on the spot” or
press the student for a response but rather leave them be.

You know the ones who are really shy, to me, it is not healthy to try and
get them to say anything. I guess I get this sense that they are not
comfortable, they are not able to speak; they are not, maybe, not sure
about themselves. They need another year, maybe to build up their
confidence. I just need to sense when to back off. Not try to force things, yeah? (Jasmine, personal interview, April 20, 2010)

Erin stated that she changed her questioning techniques because she wanted to create less intimidating situations for the students. Erin used the TI-Navigator, a response system that receives instantaneous and simultaneous data and responses from students’ calculators that is viewable by the teacher but not necessarily by the students. Erin said that she frequently used this system for initiating WCD as she can quickly see if there was a common error or possible misconception within the class. However, when she asked questions to probe student thinking she did so in a manner that allowed students to not claim responsibility for the response, even if the student she asked was one of the ones who provided the incorrect response. So instead of asking the student “what do you think?” she asks, “What do you think this student was thinking?” By stating the question in this manner, Erin felt that it took some of the pressure off of the student. If the student responded with an incorrect justification it did not matter to the student as much because “it’s just like trying to follow [someone else’s] line of thinking and not their own line of thinking;” it decreased some of the pressure the student may have felt towards providing a correct response in front of their peers.

Carol, aware that some students were reluctant to participate in WCD, utilized small groups to overcome the students’ fear or shyness, “I don’t force them. I just won’t. Because those are the kids that they’ll be there and they’ll listen and they’ll do it, but ho! Make them answer a question and they just freeze up.” She believed that by moving the topic first to a small group the students not only began to discuss the mathematics with
their peers but also increased their confidence and were thus better prepared to speak during WCD.

When you go from small to large [groups] they feel a little more confident in talking about it...because they have already talked about it in their little groups. To me, it seems that most of them are comfortable having a discussion with four or five kids and then sharing with thirty, than they are just giving their opinion. (Carol, personal interview, May 28, 2010)

In this statement Carol mentioned that students were more comfortable because they were only providing an opinion to a few of their friends rather than feeling that they were the center of attention in the whole class. Such beliefs also align with Erin’s modified questioning strategies.

Erin, Carrie, Jasmine, Sarah, and Carol commented that teachers needed to be sensitive to those students who tended not to talk as often in a whole-class setting; students they referred to as being quiet, shy, or scared to talk. Jasmine was the most adamant that students should not be required to respond to a question or contribute if she saw or felt that a student was apprehensive to speak.

You know the ones who are really shy, to me, it is not healthy to try and get them to say anything. I guess I get this sense that they are not comfortable, they are not able to speak; they are not, maybe, not sure about themselves. They need another year, maybe to build up their confidence. I just need to sense when to back off. Not try to force things, yeah? (Jasmine, personal interview, April 20, 2010)
Sarah stated that because she was reluctant to speak in WCD as an adolescent, she will not push students to participate. Carrie agreed with Sarah but also stated that a balance needs to exist between requiring students to participate and the option of not participating. Carrie believed that if she always gave students the option to participate or not then some students would “never have to participate;” an arrangement that she felt should not be an option.

In summary, the interviewed teachers thought of a facilitator as a person who was responsible for initiating the conversation but then assumed a less active role in the WCD unless they needed to ask clarifying questions, provide additional prompts to keep the students engaged in the discourse, or redirect the WCD so that it more closely aligned with the learning objectives. However, many of the teachers also stated that they needed to be cognizant of situations that may be perceived as being shameful or embarrassing to the students. In essence, teachers need to be mindful of adolescents’ affective development and promote a supportive learning environment for all learners.

*Meaningful Discourse in Practice*

Discourse can take many forms (Truxaw & Defranco, 2009) but the interviewed teachers tended to describe WCD in similar ways. Synthesizing the teachers’ definition of WCD and/or whole class discussions, as a discussion that included all students in talking about mathematics and required them to be actively engaged and contributing to the discussion, helped to establish a TGF around which meaningful discourse was analyzed. To these teachers “meaningful” meant that WCD also consisted of at least one of the following criteria: 1) increased student participation, 2) students displayed
observable physical cues, and 3) student responses became more sophisticated or of a higher quality. Each of these three criteria will be elaborated upon further below.

*Increased Participation*

Another common response dealt with the increase in students’ participation or an active engagement in WCD. Sarah described meaningful WCD as a discussion that is shared by many different people in the classroom or one that “ping-pongs from person to person.” Many of the teachers viewed an increase in observable physical cues, such as students being more vocal in their responses or when more students show their desire to contribute by raising their hands, as an indicator of participation. However, Jasmine and Traci suggested that an increase in participation could also mean that students were not saying anything; the person speaking would have the classes “undivided attention…without a lot of interruptions or random kids walking up and sharpening their pencils (Traci, personal interview, May 27, 2010).” Instead of students “blurting out” responses they would be so intensely focused on what was being said that they withheld comments until the presenter was finished speaking.

Warren stated that he knew when meaningful WCD was happening because the students were more “argumentative” and began to debate possible solutions amongst each other. Carrie elaborated on this belief and said that the questions the students ask were more complex or advanced. She felt that when students became more vocal, when they began to ask more questions of each other and provide various solution strategies, they assumed the role and responsibilities that a teacher initially had with respect to leading the WCD.
Erin and Carrie, however, stated that there were usually one or two students who might be shy, reluctant to participate in WCD, or who were disenfranchised with mathematics who serve as their indicators. Erin believed that if these students were verbally participating in the mathematical exchange of ideas then meaningful WCD was occurring.

You are engaging, you’re getting response from students who typically, who comes in without paper or pencil and sit back and [are] putting in his time; is straining to see what is for lunch and what time the period is over. I know when I call them they are going to say “I have no idea, huh, what is the question.” I don’t get an answer from them. Occasionally, not often enough, when I have that whole class discussion he is engaged, and if I have got him then it has been a success. (Erin, personal interview, April 29, 2010)

Carrie provided support to Erin’s comments. Carrie believed that when meaningful WCD was occurring then there was a change in the types of students engaging in WCD. She commented that even the kids who expressed a dislike for mathematics, with lower achievement levels, or the students who infrequently participated in WCD became more absorbed in the discourse; they became actively involved. “When they get involved that is when I am like that is awesome. Then I feel good (Carrie, personal interview, May 20, 2010).”
**Observable Physical Cues**

All of the teachers related to various types of physical cues as indicators of meaningful discourse. The two most frequent responses included an increase in the number of students sharing thoughts and/or when more students raised their hands. Jasmine (personal interview, April 20, 2010) said “kids raise their hands and they want to give input. They want to blurt out an answer, their hands go up and their eyes get big” whereas Carrie and Carol commented that all the students will raise their hands and will want to debate solutions and ideas amongst each other. Erin added that the noise level in the classroom may actually increases as students are “anxious” to share their thoughts and perspectives with the whole class.

However, teachers reported that there were other physical indicators for meaningful WCD such as excited facial expressions or a lack of “bored” facial expressions, “you don’t have that glazed look in some of the students’ eyes (Erin, personal interview, April 29, 2010).” Another response from the teachers was that students are actively engaged in listening to the person speaking; “Everybody is listening to everybody. There is nobody flipping through their book, there is nobody staring off into space, there is no one with that inattentive behavior that we see so much of (Carol, personal interview, May 28, 2010).” Traci referred to this as having the students’ undivided attention. The students all wanted to better understand the mathematics involved, either because the topic was confusing or because of some errors they encountered during previous assessments.
While not an observable physical cue in and of itself, Carrie and Erin both commented that, as a result of the increased participation, and as indicated by observable physical cues, there was a change in the “energy” within the classroom. “There is a certain energy that, you know, there are 24 students and you don’t feel like they’re getting up and leaving (Erin, personal interview, April 29, 2010).” Carrie described this energy as an audible and physical excitement. In essence, the manifestation of this “energy” was evident in the students’ vocal responses as well as in their body language.

*Higher Quality Responses*

Another indicator of meaningful WCD, though one that was only mentioned sparingly, was the presences of higher quality responses from all students. Sarah (personal interview, April 22, 2010) indicated that there would be an increase in participation but that “everyone would be able to contribute to the discussion at a level that…I can see that they are understanding or know what’s going on.” Warren explained this as hearing the “why’s” and not just the “because” in student responses whereas Carrie identified this change as being evident in the types of questions that students asked of each other in response to a provided solution.

*Summary*

The majority of the indicators for meaningful WCD provided by the interviewed teachers dealt with an increase in participation or more observable physical cues within the classroom. Some of these changes included indicators such as a shift in the types of students responding, those students who were considered to be more shy or quiet, as well as those from whom the teachers typically anticipated a response; an increase in the
number of hands being raised indicating that more students wished to speak; an increase in the degree to which students were focused on the mathematics being discussed; and a feeling that a more exciting “energy” was created as a result of greater participation rates. However, only a couple of teachers commented that there was also a qualitative change in the level of sophistication in student responses. That is, the quality of students’ responses increased due to their engagement in WCD.

*Instructional Strategies that Engage All Students*

Understanding teacher perspectives towards WCD assisted in creating a TGF from which WCD can be examined. Thus far, teachers’ perspective on the definition and utility of WCD, as well as their role in and their description of meaningful WCD, within the classroom has been described. The final question sought to better understand the various instructional strategies teachers utilized to engage all students in WCD.

The teachers provided a vast range of examples and scenarios that depicted and described the types of strategies that they used to facilitate and engage students in WCD. After the responses were analyzed, coded for common themes, and analyzed again it was determined that the strategies that the teachers used could be identified as belonging to one of the following four categories: 1) Questioning strategies, 2) small group interactions, 3) incorporation of technology, and 4) teacher modifications based on the presence, or lack of, students’ reactions, interactions, or affective needs. Each of these categories is elaborated upon and described in further detail below.
Questioning Strategies

Of the various and detailed responses provided by the interviewed teachers, the use of questions and different questioning strategies to elicit more student responses as well as more verbal interactions and exchanges between students, was the most frequently cited. For this study, “questioning strategies” refers to the types of questions teachers may ask their students, the process by which teachers selected students to address those questions, and other instructional “tools” used to facilitate or initiate the use of questions.

Even though the teachers stated that they needed to use various questioning strategies to either initiate or facilitate WCD, the primary discursive exchange followed the traditional Initiate-Response-Evaluation (IRE) process (Cazden, 2001). That is, the teachers overwhelmingly and routinely described and explained discourse as a process initiated by them through the use of a “general” question, “I ask a whole lot of questions (Warren, personal interview, May 13, 2010),” which was then followed up with a response by a student. Only occasional did they describe instances of “piggy-backing” responses, wherein students responded to each other before they referenced the teacher again. The final element of the IRE process was a follow-up evaluation of the response by the teachers; be it a summary, retelling, or judgment of the responses worth. Thus a contradiction arose between teachers’ given definition of WCD and their perception of how it was manifest within the classroom.

The interviewed teachers also talked about several different types of questions they would ask to facilitate or initiate WCD. While the responses varied from teacher to
teacher, the most common type of question were opinion questions. Carrie referred to open-ended questions as “general” questions but in her description of these types of questions they were more aligned with opinion questions. Opinion and open-ended questions vary in both design and intent. Open-ended questions often have several different answers, appear to have no immediate solution, or there could be several methods used to arrive at a solution whereas an opinion question may, or may not, require a solution at all or require that students use mathematics in support of their response.

The one example of an open-ended question that was provided came from Sarah. She had asked her students to make connections between numbers and people; “how are numbers and people alike?” Furthermore, the response to such a question might only be based on inconsequential or superficial mathematics—mathematics that is elementary in nature and unrelated to the grade level content—but it could provide students the opportunity to generate responses and connections that were relevant to the students. The nature of such a prompt, being open-ended, could help students in their thinking about mathematics especially if it was introduced early in the year and elaborated upon as the year progressed. However, Sarah used this prompt with only a few weeks remaining in the school year and it was unclear what were her learning objectives for this specific prompt.

Questions seeking an opinion formed another typed formed by teachers. Opinion questions were described as questions that did not have a correct answer or that did not require computations to be performed in order for a student to respond. They were
frequently described as questions that were less intimidating or less stressful in nature. The teachers stated that opinion questions were useful in two ways: 1) they provided a low stress means by which to initiate WCD and 2) they were a way in which to include students who were typically considered to be low achievers in mathematics, and/or reluctant participants in mathematical discourse.

There is [sic] those kids that want to go first so if there is a group that wants to volunteer a lot of the time I will let that group go first. (Sarah, personal interview, April 22, 2010)

Erin further supported the use of opinion questions as she believed students were more likely to participate if the perceived shame of providing an incorrect answer was removed and replaced with a less intimidating opportunity to contribute. Erin stated (Personal interview, April 29, 2010), “Again, I think it’s if I’m trying to point out your way of thinking about it, [then it is] taking some of the burden off of me as opposed to ‘I was thinking this.’” In essence, if the students had to claim responsibility for the rationale behind a response then they could feel more pressure and stress to be correct whereas trying determine what another person was thinking was far less intimidating because the student really did not know what the person who provided the response was thinking. Warren commented that he also used opinion questions, or “informal votes,” but that student responses would be non-verbal. If a solution or a solution process were presented to the class he might ask the students to raise their hand if they agreed. In doing so he could quickly assess student understanding, at least on a superficial level.
In addition, of the nine teachers interviewed only two teachers stated that they used questions to probe for students understanding beyond just an agree or disagree, one dimensional dichotomy. Jasmine, one of these two teachers, believed that it was important to understand student thinking. Her vision of probing for deeper understanding meant continuously asking “why” until the students could no longer provide a response. “Keep asking why. ‘Why did you do that?’ Keep prodding. ‘Take it to the nth degree guys,’ you know. I think that is the key; keep pushing. Get them to go until they can’t answer any more (Jasmine, personal interview, April 20, 2010).”

Erin, however, used different means to generate higher levels of thinking and justification from students. She commented that sometimes she would have students justify their own response but at other times the students would need to justify the responses of other students. While the type of question would be a direct question, one asked directly to a particular student requiring a specific response, Erin stated that she would ask an initiating question but when students’ hands rose, she would ask one student to provide the answer and another to provide the justification. After both responses, Erin stated that she did not tell the students the correct answer but instead asked if there were any other possible solutions even if the original solution and justification were correct. She said that the reason for asking for additional responses instead of confirming an answer was to push students to re-evaluate their responses and to hopefully help them better understand the mathematics under study.
Participation Strategies

When it came to increasing participation in WCD, the teachers provided several strategies that they currently used or may have seen other teachers use. Some of these strategies the teachers said they used on a more regular basis and some were only occasionally used, but each of the strategies could be categorized in one of two ways. The strategies were either based on teacher preferences, that is, the teachers chose who participated and when; or they would use a method to randomly select which student participated first.

Teacher selected strategies.

Closely linked with questioning strategies is the process by which students were selected to respond to a question that was presented by the teacher. While the reported strategies varied during the interviews to some degree, the strategies the teachers shared were still relatively similar. Only three teachers stated that they used techniques besides just waiting for a voluntary response or directly calling on a student. The teachers all stated that they preferred to ask questions to the whole-class with responses coming from those that wished to volunteer first. Erin, in fact, said that she only asked questions of the whole-class and Traci believed that asking for volunteers was the only way that she could ask questions because if she tried to include students who did not wish to participate it would incite “chaos” in the classroom. As previously stated by Jasmine, Erin, Sarah, and Carrie; there was strong belief and a deep concern that they needed to protect students from embarrassment, shame, or psychological discomfort when participating and responding to questions during WCD. Warren even commented that he would “start
them out with a really easy problem just to boost their self-esteem.” Erin believed that she could get a wide variety of response without having to call on particular students; she just had to “open up” the question to the whole-class again and usually a student would provide a different solution.

Ok, the smart one has already talked. The one who always wants to talk has already talked. I understand that there isn’t only one of each of those, but now the pool is getting diluted. “You mean no one has a different answer? Everyone agrees with these two?” or “These are the only two answers?” They are a little more comfortable to say, “Maybe I am right.” (Erin, personal interview, April 29, 2010).

Nearly every teacher stated that sometimes they needed to directly call on a particular student. A couple teachers commented that students who were directly called upon were called on in a random manner but there was no random process reported by which a name was generated; the teacher said that they just called on whichever student they felt like choosing at that time. Warren said that sometimes he even yelled at the students because, “sometimes that works…they are not saying stuff they know.” Thus, voluntary responses or teacher selection were the primary methods for identifying and selecting who would participate in WCD and only one teacher, Sarah, described techniques that involved students in the selection process. This will be discussed in greater detail shortly.

*Random selection.*
Besides the teacher-centered approaches in the selection of students to participate or respond to a question, three teachers described ways in which students were selected to participate in WCD. Sarah and Carrie reported that they used cards with the students’ names on them. These cards would be resting face down so that the next card with the students’ name on it is not visible. When the teacher wished to determine who would next respond to a given question, they would draw a card and read the students name that was listed on the card. Sarah said that she used this technique when she felt that she was not getting the number of students volunteering to participate as she would have liked. Sarah commented that the cards were shuffled regularly and that she used this technique at least once a week with great success; “I find that it keeps them more alert and ready and into the discussion because they don’t know when they are going to be called on (personal interview, April 22, 2010).” Ben thought of this as creating a “shared fear” amongst students because he believed many students do not wish to participate but the students did not know who would be asked to participate. Sarah also commented that she used the cards to get students to comment on each other’s responses. Student A may make a comment and then Sarah would draw a card to see who, Student B, would provide comments in support, or against, of Student A’s initial comment. However, she cautioned that this “piggy-back” technique, as Traci referred to it, is only really useful when the questions were more open-ended in nature and if they did not rely heavily on procedural or algorithmically based questions.

Carrie stated that students often had ideas or insightful questions that were not shared unless they were asked to do so. She felt the name cards were beneficial because
ideas and questions that may not have been stated became more evident; “there is always another, someone pointed out something that no else thought of…I want to build upon that (personal interview, May, 13, 2010).” Carrie commented that even though some students may have had their hands raised and wanted to provide a response to a question, she still wanted greater participation from all students; not just the ones that tend to participate on a regular basis. To begin with, Carrie would ask a question and then draw a card with a student’s name on it and ask this student for a response to the question. She said that sometimes the next student chosen, based on the cards, would be asked to reply to the first student’s response with the intent that the discussion will build more on the students’ ideas than her ideas. The cards could continue to be used throughout the WCD, if responses were not forthcoming, for the entire class period with the cards being placed at the bottom of the deck to be re-entered into the rotation after the student had shared their thoughts.

I rotate it until it is one time over and then I will do it all over again. I want to make sure that all the kids have something to say. “Oh, what did you think about her [response]?” “Oh” you know, “can you say what she said in another way? What do you feel? Can you say that in your own words?” And then someone will come over to their ideas and I will be like, “wow. That is interesting, and I will say, “comment on that.” And then we are on to the next question and before you know it all of them, at least most of them, will be done. (Carrie, personal interview, May 13, 2010)
While Carrie stated that she usually did not get through all the cards in one class period, she commented that she was able to increase participation and was able to hear what more students understood, or misunderstood, about the mathematics for that day. If she was unable to get through all the names in one day, then the deck of name cards remained the same until the next class period. Sarah, however, stated that she would constantly shuffle the cards during the class period so it was possible that any given student could be called upon to share more than once during a class period.

Both Carrie and Sarah stated that using the name cards was effective in including more students in WCD because of the random nature. They felt that the students were more attentive during WCD because they needed to be prepared and ready to contribute; they were unsure when they would be called upon to share their ideas or provide a solution.

I find that it keeps them more alert and ready and into the discussion because they don’t know when they are going to be called on…and I think the kids respond to that, too, because the person that is always raising their hands isn’t always giving out the answer and they know that. (Sarah, Personal interview, April 22, 2010)

However, both of these teachers commented that there were times when they would call on a student whose name was not shown on a drawn card, but they would act as though the said name was the one indicated on the card. The stated reason being that sometimes students, who are frequently reluctant to participate, might indicate that they
have something to share and the teachers did not want to miss the opportunity for these students to contribute to the WCD.

Sometimes I am not paying attention to the card. I know that they didn’t speak but I am going to make up the name because I know that they knew the answer; right then. I knew that they wanted to share something and that is the one time they raised their hand. I am not going to not pick them because they are finally doing it and after you do that a couple of times they find that it is not that bad. (Carrie, personal interview, May 13, 2010).

While both Sarah and Carrie stated that the name cards were effective in initiating and facilitating WCD and that they used the cards on a regular basis to increase participation, they also stated that they did not use them for a particular or prescribed situation. That is, the name cards were not merely used to generate more participation because participation rates were low, but rather were used at any given time. Neither were the cards reported as the primary strategy that Sarah and Carrie used to initiate or facilitate WCD. Name cards were just one more strategy they implemented and they did not come across as anything uniquely beneficial or impactful in helping all students learn and discuss mathematics in a meaningful manner.

Sarah also talked about other random selection process that she had heard of or had attempted to use but abandoned because these strategies did not match her “style.” One of these strategies involved using a ball wherein one student, who was holding a ball, would provide a response and would then throw the ball to another person so that they could offer the next comment. This process would continue until everyone had a
chance to contribute. Sarah did not make clear the exact process she took when she attempted this strategy but some possibilities might be that the teacher would need to monitor who had contributed to ensure that everyone had a chance to contribute to the WCD. Also, the teacher would need to consider procedures for participation; does everyone need to contribute once first and then repeat this process or could students participate several times before others have had a chance to contribute? The second strategy that Sarah said she had heard other teachers use, though she had not tried it herself, was a physical web of string. A ball of string would be given to the first student who responded to an initial prompt and once they were finished, they would hold onto the end of the string and throw the ball of string to another person. This next person would share their thoughts, hold onto the string that connected back to the first person, and then throw the ball onto the next person. This process would continue until everyone had a chance to add to the discussion and the ball of string had created a web throughout the class.

Summary.

The interviewed teachers used questions and questioning strategies to initiate and facilitate WCD although the most common type of questioning techniques used were questions directed and open to the entire class. Occasionally, teachers would use non-verbal techniques or less intimidating opinion based questions to increase participation for all students, but rarely did the teachers report asking questions that probed students’ thinking; questions that asked students to justify their responses. The teachers preferred to accept voluntary responses first and while some teachers only asked for volunteers,
two teachers stated that they would use other strategies to identify or select which students would participate; student name cards being the method most commonly used in this scenario.

Small Groups

While the primary concern of this study was on teachers’ perceptions towards WCD, every teacher reported that they used small group interactions in conjunction with WCD. In essence, small groups were viewed as a learning experience to prepare students for WCD or as a technique to provide necessary background knowledge for students so that they could be better prepared to participate during WCD.

Out of the nine teachers interviewed, Carol was the strongest advocate for small group interactions. She even commented, “I try so hard not to do [WCD]” because she felt that she was usually the one doing the majority of the talking. This was in spite of the fact that she also felt that WCD was extremely important; students needed to talk about mathematics so she could better understand what they knew. Therefore, she preferred that her students worked in small groups most of the time with only a small portion of any given lesson devoted to WCD. However, Sarah cautioned that, even though she is a proponent of small group discourse, “it is so hard to make sure that they are on task. Especially at this age they want to talk about Friday night or Saturday instead of the stuff they are doing (personal interview, April 22, 2010).”

The other eight teachers held common beliefs that discourse within small groups served as a spring board to WCD; students were more knowledgeable and were better able to contribute ideas as a result of small group discourse. Carrie commented, “Once
they are done with the smaller class discussion they have more meat to talk about when we have bigger class discussion.” When asked to clarify what “meat” meant she replied that students’ ideas were more detailed and unambiguous.

So now they have other opinions and while they are talking in the group they have more in depth things to say whereas, maybe before when they are writing or when I told them to think individually for five minutes they might have come up with more general things. It wasn’t very specific.

(Carrie, personal interview, May 13, 2010).

Warren and Sarah believed that discourse within small groups helped students feel comfortable talking in front of their peers are thus more confident when it came time to contribute during WCD, especially for the students who were believed to be shy. Sarah stated that “shy” students were able to hear others’ ideas. Carol and Jasmine also commented that small group discourse generated more participation from the quieter students in the class and it was during this type of interaction that the teachers provided encouragement to these students to share their thoughts once the class came back to WCD.

Erin had a different view of using small group discourse to support WCD. Erin recognized that, at times, several students would try to contribute to the discussion at the same time. During such instances she believed that it became too difficult for the class to follow the discussion or for her to effectively facilitate the WCD; she felt she was “sort of losing control.” Therefore, Erin would split the class into smaller groups so that the students could share their thoughts. After a few moments, she would then bring them
back together as a whole class and ask individuals from the groups to summarize the small group discourse. To ensure that all students within the group were held accountable, she reminded the groups that “just because you raise your hand, all I’m taking that to mean is that your group is ready to answer. You have to make sure that everyone understands and that means you don’t know who I am going to call (personal interview, April 29, 2010).”

**Discourse Support Tools**

While the use of small groups was a unanimous strategy for facilitating WCD, several of the teachers also believed that the use of certain technologies and manipulatives were also effective in increasing participation.

Even though not every teacher used these tools, the teachers that did use them believed these tools to be highly effective in increasing student accountability and participation during WCD. These tools were classified in two categories; technologies and manipulatives. Of these tools, the most commonly mentioned was the use of technologies. In this section, technologies are referred to as electronic devices that aid in the distribution and dissemination of students’ ideas. Some of these technologies included hand-held responders that allowed students to input solutions with the results being displayed, to the teacher or the entire class, for analysis; document cameras that projected student work on to a viewable surface or transfer images to a television screen; and/or “smartboards” that could incorporate mathematical learning software and the manipulation of information on the board via human touch. Manipulatives are understood as objects that can be physically modified or adjusted to create mathematical
representations. Examples of manipulatives, as provided by the teachers, included such things as algebra tiles and also individual mini-white boards.

_Incorporating technologies._

The one technology that the teachers seemed to find the most beneficial was the hand-held responders. Teachers could post questions on the television or project them onto a screen and then have each student input their solution into each of their responders so that the results could be analyzed and discussed as a whole class. Carol and Sarah stated that one of the benefits of using the responders is that all students participate and provide a response to a question and they are able to check all of their answers at once. Erin said that one of her biggest concerns when facilitating WCD is when some of the higher achieving students want to frequently share their thoughts, which means many other students assume a peripheral role in the WCD. Furthermore, by using the responders, every student is required to provide input, from which WCD can be initiated. “What I love about it is that I have the ability to see who has answered, everyone has to answer, everyone is answering anonymously (Erin, personal interview, April 29, 2010).” Erin said that she can then ask specific questions to get students to justify the provided responses. However, as previously stated, Erin is cognizant of the shame and embarrassment adolescent learners can feel if they are openly asked to answer a question or provide justification. This is when she would ask a low stress question such as, “What do you think they were thinking?” By asking questions in this manner students are offered an opportunity to respond without having to be correct. The student does not have to take responsibility for knowing what others are thinking, even if the student
asked was the one who provided the incorrect answer; “It allows the person to correct the mistake anonymously or at least allows the person to see their mistake without being embarrassed.”

The teachers also believed that document cameras would facilitate WCD. Sarah commented that she used the document cameras often but believed that they were particularly useful when students are having a difficult time conveying their understandings verbally. Warren said that he liked to use the document cameras to show a piece of student work and then have the class comment on the work shown. It is likely that these document cameras could be used in other ways to facilitate WCD but nothing else was reported at this time.

Warren also commented that he used a “smartboard” to facilitate WCD. Just as with the document cameras, students were able to demonstrate their work or convey their understandings of the mathematics being discussed even if they did not verbally contribute much to the WCD.

What helps in the classroom is the technology; kids like goofing around on the smartboard. So they can, even if they don’t talk trough their problem they are writing it up there and they are sharing their ideas with the class.

(Warren, personal Interview, May 13, 2010)

Thus, using hand-held responders, document cameras, or “smartboards,” the teachers were able to display student work to the whole class, within the moment, which in turn acted as a stimulus for WCD. Furthermore, these support tools, as reported by the teachers, are focused on student participation. Students were the ones responsible for
presenting their work and, when they felt comfortable, defending their work to the class; the teacher assumed a less dominant role by not providing the content to be discussed.

Utilizing manipulatives.

Manipulatives are tools that allow students to explore and represent mathematical concepts with the ease of easily adjusting the model they create (Van de Walle, 2010). Manipulatives can be important tools when teaching and learning various levels of mathematics. However, only one teacher actually talked about using manipulatives as a means of engaging students in WCD. Traci said that she had used manipulatives extensively when teaching in the primary grades but found it difficult to use them in the middle grades because the mathematics was more complex and abstract. None the less, she did say that when she feels there is an appropriate use for manipulatives she will use them in a whole class setting wherein WCD is an element of the learning process.

Another type of instructional tool that supported student explorations were individualized mini-whiteboards as they allowed students to create non-permanent models or representations of their mathematical understanding that was easily modifiable. The interviewed teachers believed that mini-whiteboards were valuable tools in supporting and facilitating WCD for a couple reasons. First, students could begin to explore an idea individually, or in a small group, and then use these representations as a platform from which to begin WCD. Warren commented, “So they will display it on their board with their little group discussion; that is what their group agrees on. So guys can look at it around the room and then we can have a discussion about it.” Warren also stated that by using the whiteboards students are “more engaged,” partially because he
recognized that some students do not wish to talk in front of the whole class and partially because each student has their own white board to use, which increases individual student accountability. Sarah and Carol stated that they preferred to use the mini-whiteboards because more students are involved. “I try to do the board stuff but I have thirty kids, I hate having…six people at the board and the rest just sitting there watching.” Thus, by using mini-whiteboards students are provided with a medium on which ideas can be formulated and modified and ultimately used as a catalyst for WCD.

Modifying lessons.

Teachers can plan for WCD and decide ahead of time which instructional strategies they may use but teaching is a dynamic endeavor. At times, teachers need to be ready to adjust their lesson plans or the instructional strategies that they are using at the moment in favor of strategies that may be more effective. This seems to also be the case when facilitating WCD. When the teachers were asked to describe the instructional strategies that they used to engage more students in the learning of mathematics, their responses aligned into two common themes: 1) Strategies that increase student participation and 2) strategies that assist students in formulating their ideas.

The interviewed teachers frequently talked about how they would have to adjust their questioning techniques to try and include more students in WCD. Carol commented that once she asks a question, she will wait until a predetermined number of hands are raised before she will select a student to reply. The number participants she wishes to see willing to volunteer changes frequently and sometimes is dependent on the type of question she asks.
If it is an opinion it will be a lower number of students. If it is a question where they need a longer response time to think about it, it is a higher number of students. It is my wait time thing so that I remember to wait.

(Carol, personal interview, May 28, 2010)

Carol also stated that sometimes students are still reluctant to raise their hand even after she waits. When this happens then she tells the students, “Ok, I am waiting for eight people to raise their hands.” Because Carol does not call on students until she sees the specified number of hands raised, she said that students begin to get agitated at others in the class because they are not raising their hands. Carrie commented that she also waits until a student provides a response and when they do not, other students become uncomfortable with the silence and will participate.

[One minute] is the longest that I will wait. I cannot, even that minute is killing me. That minute takes so long. I look at the clock and I’m like, I can’t believe this. Usually by half a minute they are trying to say something already. (Carrie, personal interview, May 13, 2010)

In the end Carol believes that it is worth waiting because, eventually, several students will want to participate. “They learn that pretty fast. If they know that you expect them to participate, more often than not, they will” (Carol, personal interview, May 28, 2010).

Carrie also supported using wait time though she did not mention if she waited until a specific number of students raised their hands. She did say that it was important to wait after asking the question because that way more students have a chance to
participate in the WCD. Carrie did warn that it is easy for teachers to answer their own questions if a student just sits there and does not provide a response.

So, that’s when they go “I better know what I am doing” so they look at the board or ask their friend. That way they are like not super afraid to speak but when, with them a lot of times, when I call them they are the ones that just sit there and I hear crickets. But I won’t call on anyone else; I will just sit there. I will wait for a minute. Sometimes they will answer; they will eventually answer. (Carrie, personal interview, May 13, 2010)

If it occurs that a student will not provide a response then Carrie “tables” the questions which means that she skips the question until a later time and nobody else gets to answer that specific question. She then has the student remain after class so that they can talk with the student about the question, not about the student refusing to participate. In doing so, Carrie said that the students learn that it is not so frightening to participate because she values every student’s response. Carrie provided other reasons why she used wait time but these will be discussed in the next section.

Another unplanned modification involved the teachers selecting students who did not have their hands raised. Every teacher said that they have used this technique though some of the teachers provided a rationale for this decision. Erin stated that part of her classroom expectations is that students will participate when they are in small groups. However, once they bring the discussion in the small group back to the classroom, she expects all students to be ready to participate and contribute to the WCD. A reminder of these expectations are evident in a prompt that she might give a group; “Damien better
not have that deer in the head lights look in his eyes because you had make sure that he understood what you were trying to say (Erin, personal interview, April 29, 2010).”

Carrie, Carol, and Sarah also commented that they select students who do not have their hand raised because they also have classroom expectations that everyone should be attentive to the WCD and thus be ready to participate.

Finally, Warren said that he offered incentives as a means to promote greater participation. He felt that using prizes, or by giving out tickets which can be placed in a jar for a larger “package” drawing at a later date, could increase the participation rates initially, but he warns that the effects of the incentives tend to be “short lived.” He noticed that after a while students just do not seem to care about getting erasers or pencils in exchange for contributing to the WCD.

The interviewed teachers also commented that they modify their strategies to help student formulate their ideas and understandings of the mathematics being discussed. Some of these modifications were as simple as restating or rewording the original question or asking a different question, but a few others provided opportunities and the time for students to internalize the question.

Carrie, who previously stated that she waits one minute for students to respond to a question, had other reasons why it was important for a teacher to wait for a student response. She elaborated that, “if you ask them a question they don’t know the answer to it they need time to, you know, internalize the question; really think it through and then they will have something to say (personal interview, May 13, 2010).” Another way in which Carrie said she provides opportunities for students to internalize a question is
through a writing prompt. If the class is having a WCD and they seem to come to an impasse or are unsure how to respond in the moment, Carrie asks them to write about what they think might be the correct solution or process.

So then I say “ok I will give the entire class five minutes,” and they sit there, and sit there and I tell them I don’t even care if you don’t know. Sometimes I will have them write and even if they don’t know, keep writing “I don’t know what to write, I don’t know what to write, I don’t know what to write.” Then eventually they will have something down.

Then after the five minutes are up then they will have more to say because they had time to think about it. (Carrie, personal interview, May 13, 2010)

Carrie sometimes provides a student with a prompt prior to asking the question. For example, students may be working in small groups and Carrie may over hear the small group discourse and ask a particular student to share a comment once they rejoin as a whole class or she may see something in a student’s work that she would like them to share with the class at a later time; a strategy also shared by Carol. In this situation, just as with the writing prompt, students have an opportunity to formulate their ideas in a coherent manner prior to being asked to contribute in front of the entire class.

Therefore, the interviewed teachers were aware of moments within the flow of WCD that required them to modify their intended plans. Some of these modifications included techniques that promoted greater participation, or at least a willingness in students to contribute, and others sought to provide time for students to process the
question being asked and methods to help them express their ideas so that they could better articulate their thinking.

Summary

The semi-structured interviews helped clarify the perceptions teachers’ have towards WCD and all teachers believed that it was a useful instructional strategy in some manner even though many of the teachers misunderstood or were unaware of the term discourse. When the term discussion was used in place of discourse, the teachers seemed to have a similar understanding of WCD as the teachers who conveyed understanding of the term WCD.

The interviewed teachers also believed that there were specific benefits for teachers and students alike and that the teachers had specific responsibilities when facilitating WCD; namely guiding the discursive exchange, creating supportive and organized classrooms, questioning students to gauge their understanding, and gradually shifting the leadership responsibilities of a facilitator to the students. However, the teachers were also quite aware of the specific social, physical, and cognitive needs of adolescents and tried to create learning environments that were sensitive to their needs.

Finally, the teachers described meaningful WCD in terms of increased participation, clear and observable physical cues, and higher quality responses from the students. In addition, the teachers discussed the various techniques and strategies that they have used to include more students in the WCD. Some of these included the use of questions and questioning strategies, teacher selected and random selected participation strategies, the use of small groups, and different technologies.
While the teachers provided examples and descriptions of the strategies used within their respective classrooms to facilitate WCD, the descriptions provided are still based on their perceptions of their praxis. That is, the teachers’ responses are internalized reflections of their practice and may not mirror what they actually do in the classroom. Therefore, I believed that there was a need to observe teachers facilitate WCD to determine the extent to which their perceptions of their praxis coincide with their actual practice.

Phase Three: Teacher Observations

In order to understand the context of the findings, a teacher-generated framework for WCD will first be discussed based on the nine interviews of teachers who believed WCD is useful in helping all students learn mathematics. This framework represents the compilation and synthesis of beliefs and strategies used by the interviewed teachers and thus does not represent any one teacher, specifically. With that said, this framework does assist in analyzing the actual practices of teachers as the teachers’ overall perspective of WCD was nearly identical.

Teacher Generated Framework of WCD

After analysis of the semi-structured interviews, an initial theoretical framework of how teachers perceived WCD was created. This teacher-generated framework (TGF) is composed of two separate facets: 1) Required roles and duties of the teacher and instructional strategies frequently used by teachers to facilitate WCD and 2) the desired student traits that would be evident as a result of implementing WCD. The first facet would be apparent in the teachers practice as they relate to the teachers role in WCD and
the second facet would be apparent in the students’ responses and behaviors during WCD.

*Facet One: Instructional Strategies*

The instructional strategies supported by teachers that create the first aspect of the TGF consisted of three primary elements. The first was the need to keep the discussion moving and on topic through the use of questions so that the intended learning objectives could be met. Teachers believed that their primary duty was to facilitate WCD and this meant to keep the discourse flowing and on topic by asking the class guiding questions; occasionally open-ended questions might be used. The second element was based on the need to create engagement and participation from all, or nearly all, students. Student participation is fundamental to WCD but voluntary responses were considered the norm. However, other techniques might be employed to increase engagement and participation in WCD. These techniques included the use of technologies and/or methods for randomly selecting students to share their ideas like name cards. The third element involved the use of small group interactions to prepare students to participate in WCD. Small group interactions were also perceived as a key element in promoting WCD. The small groups were used to create shared experiences prior to WCD so that students were better prepared to participate in a whole-class setting or because so many students wanted to participate, small groups could be used to engage more students in discursive interactions after WCD. In the latter situation, the teachers would often bring students back together to continue WCD.
Facet Two: Desired Student Traits

For the second facet, teachers perceived that there would be specific and observable traits demonstrated by the students. These teachers believed that through their efforts in facilitating WCD (facet one) there would be at least two traits that would aid in promoting the learning of mathematics. First, participation would increase because all students would be actively engaged and would have contributed to the WCD. Next, student responses would become more sophisticated or of a higher quality; an indication that they understand the mathematics being learned.

WCD Analysis

The TGF was used to analyze the discursive interactions of three teachers—Erin, Carrie, and Samantha—who stated that they believed WCD was a valuable instructional strategy in helping all students learn mathematics. The following sections include a discussion of the findings from the fifteen observations with three different teachers and how their perspectives match the TGF and ultimately correspond with their actual teaching practice. Each teacher was observed during five different class periods, over several days, consisting of at least two different lessons for each teacher. These observations were all conducted during the third and sixth weeks of the beginning of the school year and thus it should be noted the teachers were still building relationships with their students in each of their respective classes; the ideal situations described by each teacher from the previous section may not be evident to the extent reported as a result of it being the beginning of the school year rather than the middle or the end.
Observations of Erin

Erin has had thirteen years of teaching, all of which have been in middle level mathematics. After a few years of teaching Erin pursued another career for several years only to return because of the personal value teaching added to her life. She has been at Ocean Middle school since her return to teaching seven years ago. Within the last two years she completed her master’s degree in curriculum and instruction with an emphasis in middle level education; students in grades four to nine and between the ages of eleven and sixteen. Her teaching assignment for the current school year is seventh grade with three classes of honors mathematics and two classes of “regular” mathematics. The largest of these classes had 24 students and the smallest class size consisted of 19 students. In every class there were more girls than boys; for a couple of classes the girl to boy ratio was nearly three to one. Each of these classes was observed at least once over a two day period.

Erin’s classroom is open and organized; the desks are clustered into groups of four with three to four students sitting at each cluster. The desks are positioned in such a way that students do not necessarily face the front of the room. When the students came in at the beginning of the class there were clear expectations for what they should do; namely open their student planners and copy down the day’s agenda and retrieve any other classroom supplies like calculators. This classroom is equipped with a “Smartboard,” a document camera with a projector, and TI-73 graphing calculators that can be linked to TI-Navigators, a wireless networking device that displays each student’s work in real time on the teacher’s computer whose displayed can also be projected onto
the front board. Erin said that she has not yet used the TI-Navigators though she considered the lesson from the first observation to be an ideal situation for their use. The reason that Erin provided for not using the TI-Navigators was because she did not have enough time to get them set up though she planned to do so in the near future. During each lesson observed, Erin greeted the students as they came in and made a point to remind students to read the board so that the lesson could start promptly.

*Relating Observations of Erin to the TGF*

In having the desks set up in groups it initially appeared that small group work would be encouraged; this assessment proved to be accurate for each observation. The first couple of lessons were on using the graphing calculators and during one of these lessons students were asked to determine how to create a scatter plot for a given set of data, though students were given no direction on how to accomplish this task. Only one student indicated that they knew how to do this though later the student expressed that they had forgotten how to create one. Erin asked the students to try and figure this out on their own. While these directions could be interpreted to mean that the students were to work independently, and though every student was trying to figure this out on their own, several students began conferring with each other or when they had a question.

After several minutes Erin asked if anyone had determined how to enter a scatter plot and the first opportunity during the lesson for WCD arose. However, the discursive exchange was limited to mostly one student and the procedures that student did. As a result, it is unclear if the other students in the class understood the discussion between the teacher and Student 4. Student 4 seemed to think that he was on the right path because he
provided rebuttals to each of Erin’s comments but the procedures Student 4 used were not the ones being sought and were thus negated by Erin. This may be part of Erin’s desire to keep the conversation and the exploration moving along so that the intended learning goals could be addressed, but it is unclear if other students in the class understand why Student 4’s method is unacceptable other than by having the teacher ask for other methods. For example, in the following exchange Student 4 and Student 20 offered suggestions but neither of them were explored. Erin simply moved on.

1. Erin (E) → Class: anyone making any progress besides [Student3] who said he already knows how?
2. Student 4 raises hand.
3. E → Student 4: Did you figure it out or did you know from previous experience?
4. Student 4 → E: I figured it out. I just pressed graph.
5. E → Student 4: You pressed graph and what happened?
6. Student 4 → E: A trend line comes up.
7. E → Student 4: A trend line comes up but we didn’t put any data in this.
8. Student 4 → E: Oh. You can find out what is in it by pressing draw or lines.
9. E → Class: Any other ideas maybe?
10. Student 20 → E: You can press second and y-equals and then, it comes up and you can put enter on one of them and press type and one of them is a scatter plot.
11. E⇒Class: ok. Anything else?

After this exchange, Erin restated the student’s response and reminded the class that they found how to graph the scatter plot but not how to enter the data in to make the scatter plot. She then proceeded with the next part of the lesson; passing out the papers with the data set and analyzing the data set to understand what elements were needed to make a scatter plot. Even though this initial opportunity for WCD was based on a procedural task, learning how to use technologies effectively can help make the learning of mathematics more meaningful. During this portion of the lesson, Erin is seeking any ideas students may have about how to enter data into the graphing calculator to create a scatter plot. Student ideas are accepted to an extent, or rather, they are not overtly rejected. That is, in lines 8 and 9, she could have asked for others to voice their opinion about the process Student 4 was using, or even have asked others to try this process out individually or possibly even in small groups, as small groups is part of the TGF for WCD, and report back to the class. Instead, she asks for other ideas thereby rejecting the student’s response without directly stating that the student’s response is not the desired answer. It is possible that Erin is also accepting any response and trying not to place judgment on any one method. But, in the next exchange, it becomes clear that she is actually looking for a particular answer; a particular method for entering in the data. Erin does accept other possibilities and encourages students in their efforts to try and figure out how to enter data but she also makes it very clear to the class when the student has the right answer by exclaiming “list,” the button needed to enter the data, and then actively pursuing Student 21’s methods.
12. E→Class: Is there any button that, we saw graph and we thought that makes sense but it didn’t.

13. Student 20→E: Insert.

14. E→Student 20: Insert. Does that seem to do anything?

15. Student 20 shakes their head no.

16. E→Student 20: Not really. Good thought; you are trying to insert things.

17. Student 21→E: You could press list.

18. E→Class: List! Sounds like a possibility. Ok, where is list?

   Describe it.

19. Student 21→E: Um, underneath draw and next to the arrows.

20. E→Student 21: Ah, here! Do we press the yellow button first?

21. Student 21→E: No because that will give us stats.

22. E→Class: Yeah. Because if you press the one in yellow that is just giving you the one above it in yellow. So, press list. See what happens. Show the person next to you that you have list up. Check with a partner.

23. E→Student 5: [Student 5], how you doing? You got list?

Erin was an adamant believer in only calling on individuals who voluntarily wished to participate, and thus those students who did participate all raised their hands indicating that they wanted to share; if more than one student raised their hand then Erin chose the person to participate. Thus, in this initial opportunity only two students
participated and each exchange was only between the individual student and the teacher. Other students were asked to participate, through a voluntary request to the entire class, but no one else raised their hand at this time. Later in the exploration students were asked to make a prediction of what they thought their scatter plot might look like based on the data set the teacher provided. While the excerpt from the observation is lengthy, it is included in its entirety to help clarify another pattern that seems to be emerging; the habit to have discursive interactions funnel through the teacher.

24. E→ Class: So what would you expect? Would you expect that the higher the price the more shirts that would be sole that the lower the price the more that shirts that sold? Or would you expect that there is no correlation? What do you think? Not looking at their data what would you expect?

25. Student 5 raises their hand


27. Student 5→E: Negative correlation.

28. E→Student 5: Negative correlation meaning what?

29. Student 5→E: That the higher the price the less amount of shirts sold.

30. E→Student 5: Why?

31. Student 5→E: Because you see one shirt that is 50 dollars but if you sell more shirts then it is 41 dollars.

32. E→Student 5: Ok, yes.
33. Student 22ÆE: I think the more shirts you buy the higher the price will be, like for every, when more…

34. EÆStudent 22: Ok. I think what it is saying, and I understand what you are saying and that is a good point, but I don’t think that it is saying that if you but 40 shirts it is $15.95 but if you buy 100 shirts it drops down to $12.95. I think it is saying that if you buy, or if the price is 50 dollars, then 200 shirts were sold.

35. Student 22ÆE: Oh.

36. EÆStudent 22: Ok. But that is a good point. Maybe I am misinterpreting. What do you think [Student 8]?

37. Student 8 provides no response.

38. EÆClass: There is a key that gives it away.

39. Student 22ÆE: It says that the more expensive the shirt is the less people will buy it.

40. EÆStudent 22: Because it says sold at that price.

During this exchange questions or comments, initially, passed through the teacher first even if all the teacher does is restate the previous student’s comments. On only two occasions during the five observations with Erin did students directly comment to another student. For one of these two, Erin politely asked the student to be quiet and raise their hand if they wanted to participate. For the other occurrence, the student’s comment was not accepted or addressed. It is unclear if Erin even heard the comment or why she may
have not encouraged this response. Erin’s personal perception of WCD, and one that supported the TGF for WCD, is based on voluntary responses from students.

Erin does attempt to include Student 8 in the conversation but when he does not respond, she asks another question to the whole class. Such decisions and actions are in alignment with Erin’s own perspective and framework of WCD as well as that shared by other teachers; if a student does not wish to participate then they do not have to. However, in reviewing the lapsed time during the recording, only four seconds were allocated for this student to respond. It is possible that Erin sensed that Student 8 did not wish to participate. Perhaps because this was only the fourth week of school, Student 8 may have been reluctant to participate. Since Student 8 only had four seconds to formulate a response, it is also possible that he could have had a response and would have provided one if allowed more time or encouraged to do so.

In the next excerpt, more students contributed to the discussion on divisibility rules for numbers. It appears that Erin makes an attempt to challenge students’ thinking; wanting the students to be more precise in their reasoning, justification and in the mathematical language that they use. Erin was one of only a couple of teachers who reported during the semi-structured interviews that challenging students’ thinking, probing their responses further, was one of the roles the teacher has during WCD. Yet, an ideal opportunity for WCD was passed up because Erin ultimately provided the response that she was looking for when it was not forthcoming.

41. E ➔ Class: Think back, if you still have [notes] in front of you. What is probably the easiest divisibility test? If you can justify your answer
I will take it. What do you think is the easiest? There were others but I just picked those. Student 5, what do you think?

42. Student 5: The numbers are divisible by something.

43. E → Student 5: No, not what it said but what actual numbers, what was the easiest one?

44. Student 8: Ten.

45. E → Class: Ten. Why is ten the easiest one?

46. Student 10: Because it if it ends in zero then it is divisible by ten.

47. E → Class: All you have to do is look at the last number to see if it is zero. What else?

48. Student 6: I thought two was the easiest because if it ends in an even number.

49. E → Class: Ok, so what is an even number?

50. Student 6: Two, four, six, eight, ten.

51. E → Student 6: Ok, so what is an even number? You can’t possibly name every even number. Why not? Give me an even number?

52. Student 8: Two.

53. E → Student 8: Ok, but that is not all of them.

54. Student 4: I could [name all of them] but it will take a while.

55. E → Student 4: If I gave you a day or two. Why can’t you?

56. Student 2: Because numbers go on.

57. E → Class: Why?
58. Student 8 → E: Because numbers keep going.

59. E → Class: Why?

60. Student 10 → E: Numbers never end.

61. E → Class: We are on the right track but what makes them endless?

62. Student 8 → E: A googol?

63. E → Student 8: Shhhhh.

64. E → Class: Why are numbers endless? Prove to me just don’t say because.

65. Student 6 → E: Because you could just keep adding zeros and zeros and zeros.

66. E → Class: Or any even number he gives me. I can just add two more to it and I have another even number.

67. Student 6 → E: Oh. Yeah.

68. E → Student 6: Well, that is what you were thinking but that is not what you said.

In this exchange, student participation was still based on a voluntary process. Students participated of their own accord and the teacher did not have to select anyone to participate, though she attempted to initially invite Student 5 to participate. Responses were always coming forth, albeit by the same two students, 6 and 8, who provided eight of the thirteen student responses. Again, the discursive patterns indicate that responses are first funneled through the teacher prior to another comment being made by a student.
Erin also kept the conversation moving, using one of the components of the teacher-generated framework, by asking “why?” or directing the students towards a desired response, “we are on the right track but what makes them endless?” However, in doing so opportunities for meaningful WCD that could have provided greater understanding of the topic at hand were missed. In line 25, Student 6 provided a “proof” that numbers are endless because they could keep adding a zero to the end of a number and generate a new number. That is, one could add ten to any number to get another unique number, though this may not have been what the student was thinking. If this was the intent of Student 6, then the response is a perfectly valid explanation but Erin decides to provide her own solution even though it is, in essence, identical. If it was not the intent of the student, then an ideal opportunity for meaningful WCD was passed up that could help students understand this aspect of number theory. After Erin responds with her own definition, Student 6 replies “Oh. Yeah.” seeming to indicate that they had not originally understood the question in this way. Yet, Erin follows up (line 26) by telling the student that her definition was, in fact, what the student was thinking, though this is not apparent at all. According to the TGF, the students could have been asked to discuss Student 6’s definition and then report back, or the teacher could have asked for others to respond to Student 6.

Culture of Responsibility

In order to have meaningful WCD students must also be comfortable being leaders within the class. That is, a transfer of responsibility must happen. The teacher, at some point, needs to allow students to assume more roles and responsibilities during
learning experiences so that they can create more meaningful connections to the content. On several occasions, though not directly related to WCD, Erin does not ask students to assume greater responsibility but expects it to happen; she acts and speaks as though being responsible to each other is simply part of her classroom norms. Before the lesson began for the day she informed students that the next time the class met they would be testing in one of the computer labs. Erin asked if anyone did not know where the lab was and during each class one to two students indicated that they did not know the location of the lab. Instead of telling the student where the lab is located, she asked, “who also has period three with [Student X]?” When one of the other students in the class raised their hand, Erin said, “make sure that they get to the lab, ok?” At other times, like when one of the classes was working on the calculator exploration, a student had discovered how to do the intended task correctly, Erin told the class, "[Student Y] and [Student Z] can help you out if you are stuck. They are not going to tell you how to do it, you won’t learn that way, but they can offer advice.” During another class period that was working on the same exploration, a student was stuck entering her data on the calculator, specifically in setting up her List 1 and List 2. The student raised her hand and told Erin where she was stuck and Erin then said out loud to the class, “You need L1 and L2. She needs help setting up L1 and L2. Can anyone come help her set up L1 and L2?” At which point, two students got up from their desks in different areas of the classroom to come over; one of them returned to her desk after she saw another student going to help. Erin could have told the student how to set up her lists in the calculator but instead asked the class to assist. In keeping with her habits of asking for voluntary help, she did not ask a specific
student to assist even though she knew who had accomplished setting up their lists; two
minutes prior to this interaction she had asked for students to raise their hands if they had
completed this task.

All of these actions established a culture of responsibility in which the students
were expected to become leaders within the classroom. Furthermore, these types of
interactions were evident multiple times in every class period. Erin expected students to
help each other out and contribute to each other’s learning; elements necessary for
meaningful WCD.

Summary of Observations of Erin

Erin planned for students to engage in WCD for each of these five observations.
The examples of discursive exchanges listed above are representative of how Erin
conducted WCD; relying on voluntary responses to her questions with all responses being
routed through her. Erin had students clustered in small groups and made it clear that
students within these small groups should ask each other for help when needed.
Additionally, it seems as though ensuring that the discussion progress in a timely manner
in order to meet learning objectives was of critical importance to Erin as there were
several occasions where student responses were not explored in great detail until a
“correct” response was provided. As previously stated, there are clear patterns of
teacher-student discourse in which ideas, comments, and questions are funneled through
the teacher. Such patterns are consistent with IRE questioning strategies and by
following such a pattern, student-to-student interactions are limited. Finally, Erin
established a clear and encouraging culture of responsibility in which students are
expected to become classroom leaders and support each other in their learning. It is unclear if such expectations were ever discussed openly with the students or if they were part of the unintended curriculum. Regardless, this classroom culture was prevalent in each of the observed classes and seemed to be fully accepted by the students as they did not exhibit behaviors that showed frustration towards these expectations.

Observation of Carrie

Carrie has been teaching for the past twelve years, all of which have been in the seventh and eighth grades. Her current school has a strong culture of supporting science and mathematics education and is a frequent participant in extra-curricular mathematics and robotics competitions. This is Carrie’s fourth year at Mountain Middle School and her current teaching assignment consists of six seventh grade mathematics classes. One of these classes is a special education inclusive class during which the special education teacher co-teaches with Carrie. Carrie’s largest class was 29 students while her smallest class size was only 17.

Carrie’s classroom had only tables that can accommodate up to four students per table though she never had more than three students at a table and usually only two. A couple of students were the only ones at their table though these tables were located near the front of the class and were adjacent to another table of two or three students. While these tables were connected to the adjacent tables, students could converse easily with each other when needed. All tables were in rows positioned perpendicular to the front board. Also, this school did not have air conditioning but because the average day time temperature can reach nearly 90 degrees, there were several fans running to keep the
inside temperature more comfortable. During these observations there were four ceiling fans and seven floor fans all running at the same time. This classroom was also equipped with a document camera and a projector to display work on the front board and calculators were readily available whenever students needed them; the use of calculators was, in fact, encouraged.

*Relating Observations of Carrie to the TGF*

Carrie also supported the use of small groups and this was evident throughout her lessons. Even though students were typically working in pairs the collaboration between these pairs was encouraged. When students came into the classroom, the expectation was for them to begin their “bell work,” a handful of questions based on the previous day’s lesson; which were on using and applying the order of operations. Even though this was individual work and students needed to show their work, Carrie never said anything to the students when they would ask each other for assistance. After about five minutes, Carrie informed the class that she would need five people, one for each question, to go up to the front to show and explain their work. Four students raised their hands indicating that they wanted to be the ones chosen but Carrie only called on two of these students, Student 5 and Student 12. For the other three Carrie selected one, Student 18, and used name cards to randomly select the other two, Student 16 and Student 13. For the student that Carrie chose, she later commented that this student was someone who usually doesn’t participate but Carrie noticed that this student had the correct work and answer for one of the questions.
Ok anyone want to go to the board? [Student 5], who else? Anyone else? (Using name cards to select a student name) [Student 16] you are doing number 3, [Student 13] you are doing number 2. (Student 12 raising their hand) [Student 12], you want number 6? Alright. It looks like [Student 18] really wants number 4. (Observation, August 19, 2010)

Her method of selecting students included volunteers, teacher-selected, and random-selected participants. None of the students verbally, or nonverbally, objected to these selection methods. This was true even for the students who indicated that they wanted to share but were not chosen to do so. During a subsequent interview Carrie stated that this day was not the first day that she had used the cards but that sometimes she was unsure as to the response she would get from the students as it is still early in the year and students are not use to being selected in this fashion. During these observations, all the students acted as though the name cards were just part of the regular classroom norms. There were not any observable sighs, comments, or other verbal or nonverbal expressions that would indicate that this selection process was disliked or unacceptable to the students.

When it came for the students to present their work, Carrie would ask who was ready and that student would go up to the document camera with his work and begin to explain how he arrived at his solution. Student 16 was the first student called up to present. He went up to the document camera, showed the initial problem but without any accompanying work, and explained the steps he took to arrive at his solution. Carrie asked Student 16 to show the work because it was hard for the class to follow his ideas
without seeing them in writing and then asked the next person to come up and present but
informed Student 16 that he would be coming up later to finish their presentation. In the
exchange that follows, two patterns become apparent. First, when students present,
Carrie attempts to include several other students in the discussion and second, student
responses are also funneled through her first before other students have an opportunity to
contribute.

1. Carrie (C) \( \rightarrow \) Student 16: That is ok, why don’t you go back to your
table and do that, it is ok, I didn’t know that was how you were going
to do it and I didn’t tell you to have it ready. So go work on it and
we’ll come back to you. Ok let’s move up to number three who was
[Student 13] and you (Student 16) can go after, ok?

2. Student 16 nods in agreement.

3. C \( \rightarrow \) Student 16: Ok, thank you.

4. Student 13 goes up to the document camera.

5. Student 13 \( \rightarrow \) Class: So, first I did 4 to the second power which is 16
and then I did 16 divided by 8 to get 2. Then I did 25 minus 2 equals
23.

6. C \( \rightarrow \) Student 13: That’s a 2?

7. Student 13 \( \rightarrow \) C: It’s supposed to be a 2.

8. C \( \rightarrow \) Student 13: Ok, you can make it a two if you want. Ok [Student
11], can you, in your own words say what she did so that we can hear
it again?
9. Student 11→Class: She simplified 4 squared and then 16 divided by 8 to equal 2 and then subtracted 25 minus 2 to get 23

10. C→Class: Does anyone know why she did those things? (4 hands go up) What we talked about last time. What these, what is the reason she did 16 divided by 8, she could did 25 -16 or she could have, you know, why do that? There is a reason she is doing these things.

(Student 5 has their hand up) [Student 5]?

11. Student 5→C: She followed G.E.M.D.A.S.


13. Student 5→C: It’s the way that, it’s the way that you do things. Like, I forgot the word.

14. C→Student 5: You forgot the word?

15. C→Class: Can anyone help him? (No time allowed for a response)

16. C→Student 5: Is it the order of operations?

17. Student 5→C: Yeah.

18. C→Class: So G.E.M.D.A.S. But what is the order? [Student 7], thank you. (Carrie used name cards to select students).

19. Student 7→C: Grouping.

20. C→Class: Grouping, G for grouping symbols. Um, [Student 2].

(Used name cards)

21. Student 2→C: E is for exponents.
22. C→Class: E is for exponents. [Student 14], what about the rest?

(Used name cards)

23. Student 14→C: Multiply and divide and then add and subtracting.

24. C→Student 13: Ok thank you my dear. Let’s give them a round of applause.

25. C→Student 16: [Student 16], do you need more time?

26. Student 16→C: Yeah.

27. C→Student 16: ok, oh are you ready now?

28. Student 16 indicating that he was actually ready now; only five seconds elapsed.

29. Students16→C: Yeah.

This discursive interaction lasted four minutes and sixteen seconds but during this time six different students and the teacher were included in the conversation and one additional student, Student 16, was prepared to continue the discussion on a different problem. Furthermore, Carrie utilizes the WCD as a means to check what other students understand about using the order of operations. On line 8 Carrie asks Student 11 to restate what the student presenting said. Even though Student 11 repeated back the procedure, and it is unclear if Student 11 understands the reasons why the given steps were used, Carrie addresses this concern in line 10 when she asks the class why Student 13 applied the operations in the order presented. Student 5 replies that they used “G.E.M.D.A.S.” but Carrie used this opportunity to check student understanding of the order of operations by asking what that meant. Student 5 provides an explanation but states that they could
not remember the term that defines the process. Even though Carrie asks the whole class for assistance, she immediately provides the response to her own question. This would be the only time that she did answer her own question.

Next, Carrie uses this opportunity to have students call out the mathematical operation associated with each letter in the acronym. Although, the students seemed to understand the procedure, Carrie seemed to be using repetition as an instructional strategy to reinforce their understanding. Several times later in the lesson Carrie asked students the order in which the operations were implemented or if certain operations could be switched.

30. C→Class: Ok, so let’s go back to the order of operations.
31. C→Student 20: What is the first thing [Student 20]?
32. Student 20→C: I don’t remember.
33. C→Student 20: Ok take a look at your notes. I will come back to you for the letter G.
34. C→Student 12: [Student 12], what does E stand for?
35. Student 12→C: Exponents.
36. C→Student 12: Do we have any exponents?
37. Student 12→C: No.
38. C→Class: No.
39. C→Student 7: [Student 7], what comes after that?
40. Student 7→C: Multiplying and dividing.
41. C→Class: Multiplying and dividing; whatever comes first.
42. C→Student 11: Can you change that one, [Student 11], and do the multiplying first?

43. Student 11→C: Can I erase it?

44. C→Student 11: Yeah, there are a whole bunch of pencils up there.

45. C→Student 12: So while he is doing that, [Student 12], what does G stand for again?

46. Student 12→C: Grouping symbols.

47. C→Class: Yeah, grouping symbols. There is no grouping.

48. C→Class: (Seated in the back of the room looking at the student work projected on the board) So he did 4 times 3 and got 12. So what is he doing [Student 9]?

49. Student 9→C: He is dividing by 6.

50. C→Class: So he is dividing by 6 ok.

51. C→Student 21: Does he do the 28 minus 2 or the does he do the 2 plus 4 next? (Used name cards to select student) Um, [Student 21].

52. Student 21→C: He does the 28 minus 2.

During this exchange, Carrie reinforced the order in which mathematical operations were performed even though she asked the students this same question earlier in the lesson. However, this time she embedded the questions within the context of an actual computational problem. This excerpt is just under five minutes long, but again Carrie included six different students in the WCD.
On three occasions, Carrie would probe a student’s response for further justification. For each of these instances, the students initially retracted their response as if they believed their response was incorrect because the teacher was asking them to clarify or justify their response. Carrie often replied by telling the student, “I’m not saying you are wrong. I just want to know why you think that.” Three of the times students would then provide a justification for their response but on one occasion the student replied that they did not know how to explain their thinking. Carrie then opened the question up to the class and another student voluntarily provided the justification for the original student’s response.

Culture of Responsibility and Participation

When examining the last two excerpts above, a pattern becomes evident in Carrie’s expectations for participation. In each case Carrie asked a student to participate; that student was either not prepared to participate or did not know the answer to her question. Regardless, she does not let another student answer the question asks the first student to either find the answer to the question or be prepared to present when called on later. More importantly, she follows up on her statements and actually comes back to the students to hear their responses; it appeared as though Carrie’s students have learned that, in only a few short weeks, she expects their participation.

Carrie also elicited participation in ways that include nonverbal responses and whole class choral responses. During two of the observations, Carrie would ask a question to the class, pause for a few seconds and then ask the class to give her the
answer out loud and in unison. For one of these choral responses, she asked for a nonverbal response to a question prior to the choral response.

53. Students are working on a problem using the order of operations.

54. C→Class: As soon as you are done raise your hand.

55. Students begin to raise their hands. Three do not have their hands raised; 32 seconds elapse.

56. C→Class: So on the count of three, tell me your answer. One, two, three!

57. Class→C: 79!

58. C→Class: Ok. So we all got 79.

Three students did not raise their hands when asked. One was next to Carrie so she probably noticed that this student did not have his hand up; her response back to the students was “So we all got 79?” By stating that all the students got the correct answer she allowed those students who did not have their hand up feel as though they were included; she did not single them out. Carrie’s methods helped her students feel like they were still valued members of the classroom.

During Carrie’s initial semi-structured interview she stated that she expects her students to participate. It seemed that her students understood these expectations because similar interactions occurred during two other class periods with the same results; students who were not prepared to participate or students who did not know an answer to her question when asked, took the necessary steps to prepare a comment and/or found answers to the questions so that they could participate and contribute when called on
again by the teacher. As a result, Carrie created a classroom culture of responsibility and participation. Students were expected to contribute to the WCD when called upon, and all who were called upon did not express, verbally or nonverbally, any reservations in doing so.

Summary of Observations of Carrie

Carrie’s perceptions of WCD were similar to the TGF in that small group work was utilized and encouraged, she used technologies as a means to facilitate WCD, and she relied voluntary responses. However, her personal perceptions differed from most of the other teachers interviewed in two ways; first, she was one of only two teachers who reported using name cards to call on students and secondly, she expressed during her initial semi-structured interview that she expected students to participate. Both of these differences were also evident in her practice.

However, few student-to-student interactions occurred during these observations. Carrie would ask a question, and regardless if the student was prepared to participate or if they needed to come back to the student at a later time, the student’s response was directed back to Carrie, at which time she would typically restate the student’s response or personally comment on the response. This type of interaction also follows the traditional IRE method of discourse.

Even with few student-to-student discursive interactions, there was a prevalent culture of participation and responsibility within the classroom. Carrie utilized name cards to select and include several different students in the WCD and the students responded without frustration or offence when their name was chosen. Students who
were not ready to respond or did not have an answer for a particular question were given more time to formulate a response and Carrie always came back to the given student to hear what they had to say; she always followed through with her promise. Furthermore, Carrie utilized WCD as an opportunity to check for relational understanding. She often called on students to explain various steps of a computational task to determine the extent of their understanding. Revisiting the rationale behind a procedure throughout a computational process also allowed more students opportunities to contribute to the WCD.

**Observations of Samantha**

Samantha is in her sixth year of teaching mathematics though she has been involved in education for ten years prior to being a mathematics teacher. During this ten year period she spent seven years as a paraprofessional teacher and then three years as a Special Education teacher all within the same high school. It was during this same ten year period that she completed her Master’s in Teaching and received her teaching license. Samantha reported that she has always been good at mathematics which influenced her decision to become a mathematics teacher. Samantha currently holds licensure in secondary mathematics which would allow her to teach mathematics from seventh to the twelfth grade. While her current assignment is seventh grade, she has taught both seventh and eighth grades within the last five years but has also considered transferring from teaching in the middle grades to teaching in a high school setting.

Samantha has the desks in the classroom arranged in groups of threes and fours with each cluster of desks facing the wall mounted television in the front corner of the
classroom next to the board. This television is connected to a document camera and can also be interfaced with her laptop computer. Having the desks arranged in this fashion aids in small group interactions and Samantha utilized such interactions several times throughout each of the observed class period. When students were working on a problem, they would often consult with each other and she never asked to refrain from this behavior; students were also encouraged to use calculators whenever they may need them.

Samantha recently transferred to a new middle school this year and feels as though she is having difficulty settling into the new teaching assignment. She reported that she feels as though the new school culture is not as open, welcoming, or supportive as her last school was and as a result she reported that it has had an impact on her teaching. “I feel like I am being ignored; that I don’t matter at this school. And, I don’t get help with anything unless I make the effort to find out. This just doesn’t seem right, that a new teacher to a school should be left to figure things out on their own (Personal Interview, June 29, 2010).” At this new school she teaches four classes of seventh grade mathematics, one of which is an honors mathematics class addressing eighth grade standards, and one exploratory class which changes each quarter and is designed to expose adolescents to diverse curricula beyond the traditional core content areas of mathematics, language arts, science and social studies. At the time of the observations Samantha’s exploratory class was physical education. In addition, a couple of her mathematics classes are inclusion classes wherein students identified as receiving Special
Education services are placed in regular education students; one special education teacher is also present during these class periods.

Finally, it should be noted that for each of the five observations with Samantha, she reported that her lesson plans were not as developed as she would have liked. For one observation, for which she had previously indicated that she had planned for a portion of the lesson that would utilize WCD, she informed me that she was “just going to have to wing it.” Thus, it was unclear at the time of the observation as to the extent to which she had actually planned for WCD and what “winging it” meant to her. This question was included in the Phase Four follow up interviews.

Relating Observations of Samantha to the TGF

There were three initial observations with Samantha each of which were 80 minutes in length. During these first three observations there were few interactions that included a discursive exchange. The majority of the interactions consisted of the teacher presenting to the class and students having independent work time during which the teacher would assist individual students if they had any questions. The discursive interactions that did take place all relied upon voluntary responses and frequently only a few students would provide a response as is evident in the following interaction.

1. Samantha (T) ➔ Class: So this is standard notation. Ok help me out here, what number is going to be less than ten?

2. S6 ➔ T: One

3. T ➔ Class: Just one?

5. T→Class: So one and eight.

6. T→Class: So my number is at the end. Where am I going to move my decimal?

7. S6→T: By the eight.

8. S8→T: After the one.

9. T→Class: After the one and before the eight. Ok.

10. T→Class: This is less than ten?

11. SS→T: (Choral response by three students) Yes.

12. T→Class: It has to be less than ten, because. Ok now we need to find the exponent.

13. T→Class: So how do I do that?

14. S6→ You slide the decimal.

15. T→Class: Ok, I put the decimal over here so I need to count it.


17. T→S11: That is right.

18. T→Class: So how much is that? (No time for response)

19. T→Class: Ten, right?

20. SS→T: (Choral response by three students) Yes.

21. T→Class: You moved it ten spaces so now you know the exponent is ten and you indicate it with a small ten because it was that many places.

22. T→Class: Anyone not understand?
23. No response from students.

In the excerpt above, which comes from the first observation (July 12, 2010) and lasted just three minutes and twelve seconds, only three individual students provided responses and when there were choral replies to Samantha’s questions, again, only a few students would contribute. These types of interactions were typical for the first three observations and were rarely as lengthy as the one above. Also, during the initial observations there were few interactions for students to communicate their understandings or to ask questions. During the third observation (July 14, 2010) there was only one interaction wherein the students initiated a question.

24. T→Class: So to find the median you start by crossing out your numbers until you get to the ones in the middle. Since we have two numbers left, you add them up and divide by two and that is your median.

25. S7→T: What happens if you have an even number for your data?

26. T→S7: Ok, this happens to have had an uneven number; that has only one number in the middle. But say I had one more number then I would have two numbers in the middle. I would add it up and divide by two.

27. S7→T: But if there is only one number for the median?

28. T→S7: Oh I know what you are saying now. If you only have one number then that is your median.
29. S9→T: I have a question. Say you have 83 and 85 couldn’t you just say that because there is only one number in between then it would have to be 84?

30. T→S9: Yes you could do that if there is only one number in between. But that is if you understand what you are doing; it is the middle number. Ok? Ok.

This interaction would seem like a perfect opportunity to engage the rest of the class so other students could be included in the learning and so that other students’ ideas could be heard; hearing other students’ ideas, or having students phrase understandings in their own language, was one of the components of the TGF. The interaction listed in lines 24 to 30 was also one of the few observed opportunities for WCD that would have been initiated by the students. During Samantha’s semi-structured interview in Phase Two she commented that it was important to be aware of these types of situations and that a teacher should capitalize on them to help students understand the mathematics being learned.

After these initial observations, it seemed as though WCD was not implemented in Samantha’s classroom as she had described during her Phase Two interview. The discourse did not appear to be interactive, back and forth exchange of ideas between the students and the teacher; grounded in students’ interests to help them make meaningful connections, which Samantha believed adamantly was critical for students to learn mathematics; probing students’ thinking through the use of higher order and more complex questions; nor did there appear to be any use of small group interactions with
respect to WCD to help prepare students to contribute to WCD. After nearly three
weeks, I approached Samantha again and asked if I could come back to observe a few
more lessons during which she had planned for WCD. Samantha openly agreed and
stated that she would inform me of the days that would be the best to observe, but also
wanted to know how long the WCD should be. I informed her that the amount of time
spent on WCD was entirely up to her; I just wanted to see what it looked like during a
typical class period. A few days later, Samantha invited me back to observe a lesson
which would include WCD.

Upon arriving to the classroom that day, Samantha stated that she was not as
prepared as she would have liked. This lesson included more opportunities for students
to contribute vocally, but the discursive interaction between Samantha and her students
consisted of an IRE pattern; the teacher would ask a question, a student would respond,
and the teacher would evaluate the response before moving on to the next question. The
excerpt below exemplifies this type of discursive interaction, which seemed to be the
only type of discursive interaction used by Samantha. Furthermore, voluntary responses
were again the norm and when responses were provided they tended to be from the same
students. Only twice did Samantha call on individual students and then it was to provide
a factual response to a computational question. No further probing for understanding was
done. In fact, Samantha frequently asked if “everyone got it” but relied upon the
students’ voluntary responses to be the indicator of the understanding.

31. T→Class: Ready or not we are starting, do your corrections if it is

wrong.
32. Teacher writing problem on the board; \(3(2 – 15)^2 + 9^3 – 125\).

33. T → Class: What is inside the parentheses?

34. SS → T: (Choral response) Two minus fifteen.

35. T → Class: And that equals?

36. SS → T: (Choral response) Negative thirteen.

37. T → Class: Ok. If you did parentheses, what are we doing next?

38. S19 → T: Exponents.

39. T → Class: So we do the first exponents and then we do it left to right.

40. T → Class: Ok, negative thirteen squared is how much?

41. S7 → T: Negative 169.

42. T → S7: Thank you.

43. S7 → T: Oh, no. Since you are timesing [sic] it by itself it should be positive; positive 169.

44. T → S7: Sure?

45. S7 → T: Yeah.

46. T → Class: Negative times a negative is a positive. So for the exponents, 169.

47. T → Class: Plus, next exponent to the power of three. Nine to the power of three?

48. S3 → T: 729.

49. T → Class: 729. Did everyone get 729?

50. SS → T: (Choral response from about five students) Yes.
51. T→Class: Negative 125. What is?

52. S15→T: 159.

53. T→S15: [Student 15], what is the answer to three times 159?

54. S15→T: 477.

55. T→Class: Did everyone get that?

56. SS→T: (Varied choral response, most were yes) Yes. No.

57. T→Class: What is 507, ok, what do I do next. I’m sorry, [Student 1]?

58. S1→T: 1236.

59. T→S1: Ok, exactly.

60. T→Class: Ok, is that what everyone got?

61. SS→T: (Choral response of about five students) Yes.

62. T→Class: Ok, my last step. There is only one more step.

63. S15→T: 1111.

64. T→S15: Wait, I didn’t call on you yet.

65. T→S10: [Student 10], what did you get?

66. S10→T: 1111.

67. T→Class: 1111. Did everyone get that?

68. SS→T: (Choral response) Yes.

69. T→Class: Ok.

This exchange represented the best discursive interaction that I witnessed over the five observations conducted. What this exemplified is that, based on the TGF,
Samantha’s perceptions of her practice did not coincide with her actual practice. The only elements that might seem to coincide are the acceptance of voluntary responses and small groups. However, the use of voluntary responses appeared to be used as a means of moving on to the next part of the lesson. The type of discourse that Samantha used was an even more limited version of IRE. It existed between only a handful of students; never more than five during any discursive interaction. Secondly, small groups were to serve as a method to prepare students for WCD. It was believed that when students have opportunities to participate in small group discourse they have gained deeper understandings into the mathematics being learned. Yet, small groups only seemed to work together when the students were practicing computational skills.

Summary of Observations of Samantha

Initially Samantha’s perception of WCD seemed to be different than what she had reported during her semi-structured interview, thus additional observations were requested. However, after all five observations, it became clear that her perception of WCD did not match her own practice nor did it correspond with the TGF. Students’ responses were almost entirely voluntary and Samantha did not use any strategies to include other students in the conversation. Even in allowing only voluntary responses, it is likely that other students would have contributed if given the opportunity to do so; this may have meant that Samantha would need to ask those that frequently contribute to refrain from responding. Furthermore, Samantha stated that it was critical that students make personal connections to the mathematics being learned and that WCD was an ideal way in which this could happen, but attempts to help students make these connections
were not observed. Even though Samantha was having a difficult time assimilating into the culture of the new school, lesson planning and the use of various instructional strategies were still within the locus of her control. This means that some aspects of her practice with respect to WCD should still be evident if her perception matched her practice. However, there seemed to be no correspondence between Samantha’s perception and her actual practice.

Summary

Based on the TGF, not all teachers’ perceptions of WCD corresponded with their actual practice, though two of the teachers, Erin and Carrie, had utilized several of the strategies identified in the TGF and thus had perceptions that closely mirrored their practice. Carrie’s perception of WCD seemed to be identical to her practice though there were few student to student discursive interactions because all student responses were first funneled through her. Erin’s perceptions were also relatively close to her practice but because she relied upon voluntary responses, even though this was considered the norm and part of the TGF, often the same students provided responses and some students were never selected to participate. Carrie did not include every student in the WCD each class period either, but she utilized name cards that created a situation where in any student could have been called upon to participate. Furthermore, Erin also had limited student to student discursive interactions because she, too, utilized the same funneling effect used by Carrie. This technique more closely aligns with a traditional IRE form of communication. Finally, Samantha’s perception of WCD did not appear to reflect her practice at all. Even though students were in groups, these groups were not used to
promote meaningful WCD. Furthermore, her use of voluntary responses limited the responses to the same few students in nearly every discursive interaction and also followed an IRE pattern more than an inclusive WCD that aimed to include more student to student communication.

Phase Four: Follow-up Semi-Structured Interviews

As a result of the analysis from the observations, three questions arose that I believed would help clarify the TGF and provide a more precise understanding of the teachers’ perceptions towards the use of WCD in their classrooms. Specifically, these questions were: what did teachers believe to be the most beneficial component of the lessons that were observed with respect to WCD, how did the teachers come to their understanding of WCD, and to what extent did the teachers believe that WCD can aid in the affective development of adolescents? Therefore, additional semi-structured interviews were conducted and became the basis for Phase Four.

Each of the three questions for this section added to the TGF and thus the theory of teachers’ perceptions towards WCD as an instructional strategy that supports all middle level students learning of mathematics. This first question sought to further clarify what each of the three teachers believed were the most beneficial aspects for the students during the observed WCD interactions. Since these perceptions are based on observations unique to each teacher, and are influenced by their personal understandings of WCD, a section is included for each teacher with a summary of their responses from the first two questions. The responses to the last question were coded and analyzed for
themes and thus the findings consist of a single construct based on the emergent themes from all three teachers.

*Teachers’ Reflections and Related Understandings*

The observations for each teacher were completed over several days and thus the lessons were slightly different, yet they were nearly all from the same unit of study for each respective teacher. With that said, the teachers were asked to reflect on the lessons that corresponded with observations and were asked to determine what they believed were the most beneficial aspects for their students with respect to their planned WCD. Since this question is based on specific observations with each teacher, a section will be included for each teacher with a comparison of the teachers’ responses with my interpretations based on the observations.

*Erin’s Reflection*

Erin’s classroom was arranged so that students were seated in groups of three or four and she believed this arrangement was the most beneficial aspect in her facilitation of WCD. She believed that because students could first share ideas in small groups that they would then be better prepared and possibly more comfortable to participate in a whole-class setting.

I really like the idea of my students interacting in their small table groups. Saying something in front of two or three people has to be far less intimidating than biting the bullet and being brave enough to say it in front of the whole class. (Personal interview, August 22, 2010)
During the observed lessons the students frequently interacted with each other and even sought help from students at other tables. This level of interaction existed even though there were other factors that could have limited or impeded student interactions of this nature. Specifically, these interactions occurred during the third week of school during which time the students have only had limited opportunities to get to know one another; Ocean Middle School receives students from nine elementary schools from several different communities and has a substantial military population, which, to Erin, meant that the students “were literally talking to strangers.”

Erin also believed that as a result of the students’ small group discourse which was then followed up with WCD, students were able to make connections to the mathematics that they would not have been able to make with just the teacher talking. When the students talked amongst themselves about how to use the divisibility rules, you could hear others say, ‘Oh yeah, I remember that.’ I really like the idea of students discovering things for themselves, understandably with some guidance, rather than talking at them for 44 minutes. (Erin, Personal interview, August 22, 2010)

From the first interview with Erin to this follow-up interview, she clearly expressed her perceived importance of using small groups to help student communicate their understandings of mathematics as well as develop deeper understandings based on the students’ exchange of ideas. For this reason it seems that small-group interactions are critical in supporting students learning during WCD, and is likely incorporated in other learning strategies, too.
Erin’s Understanding of WCD

Small groups certainly seemed important to Erin in her facilitation of WCD as she often referred the students to their groups for assistance during the lesson. However, this reflection of her facilitation of WCD was also deeply rooted in her understanding of WCD.

Erin talked about her personal experiences from when she was in elementary school through college and how she had always been comfortable allowing others to speak up in class. In fact, she preferred to not have to contribute in front of everyone else; “I went through most of my education as ‘the quiet one’ and was more than willing to let the dominate students take over (Erin, personal interview, August 22, 2010).” However, she also stated that based on the initial semi-structured interview, she had come to see WCD in a slightly different perspective; one that required more students to be involved. “Although I have used it to some extent in the past, after our talk last summer, I made a conscious effort to make it a regular part of my lesson plan (Erin, personal interview, August 22, 2010).”

When asked to share her current perception of WCD, Erin stated that the teacher needs to be cautious in only accepting responses from those who tend to be the most vocal students in the class; this statement is certainly different than her personal habits and preferences as a student. It also demonstrates a shift in her perspective as a teacher. Erin originally stated that teachers should not call on students if they do not raise their hand to participate as this could lead to embarrassment, but during the second interview
she believed that all students could add to the WCD because they all have ideas; albeit some students wish to share their ideas more often than others.

Every student has something to contribute and every class has a few students who are more than willing to dominate the discussion. It is ever so tempting for the teacher to buy into this since it helps move the discussion along in the predetermined direction. (Personal interview, August 22, 2010).

The necessity to “move along” a discussion was frequently expressed by other teachers who were interviewed and was also apparent during Erin’s observations. Even though she is aware that all students can contribute ideas to the WCD and to the class’ understandings a belief still seemed to exist that the understandings derived from the WCD must come from “predetermined” plans as established by the teacher. Therefore, the conflict between the dynamic nature of WCD, which means that student generated ideas and questions might divert the teacher’s original plans, and the need for the teacher to make sure that the discussion proceeded to meet specific learning objectives resurfaced again.

Summary of Erin’s Interview

Erin believed that small group interactions were the most beneficial to supporting and sustaining WCD but she also expressed that her perspectives have changed from the beginning of this study. Even though, as student she was reluctant to participate in WCD, she seemed to believe that all students have ideas that could benefit the whole class if they were shared. Furthermore, she believed that her students were still reluctant to
interact with each other as they were like “strangers” to each other even though, to me, this did not seem to be the case.

_Carrie’s Reflection_

When I asked Carrie what aspect of her planned WCD was most beneficial to students, she had a difficult time responding. Carrie, thought about the questions but then stated that classroom discussions do not rely on just one instructional component but depend on a complex mixture of several techniques; “I think the strategies used all work together. The sum is larger than the parts (personal interview, August 23, 2010).” However, when pressed to identify one of the many that she utilizes, Carrie stated that having students present their work to the whole class was the most important.

I really think that having students present to their peers is very beneficial. Sure it does have to do with my questioning the class, but the students ask each other questions, and give alternate ways of completing the same exercises. Many new things come up from those discussions. (Personal interview, August 23, 2010)

Carrie also added that she benefited from WCD that is based on student work as it allowed her an opportunity to make formative assessments on students’ understandings. Carrie believed that as a direct result of her students’ WCD she could determine what they knew, what misconceptions they may have had, and make adjustments to her planned instruction. This assessment could still be considered a direct benefit to students as the students receive feedback in real time on the mathematics being learned and thus strengthen their understanding of it as well.
In her response Carrie actually alluded to a second important element; the need to effectively question students. During Carrie’s observations, she used name cards to select which students would participate in the WCD; sometimes this was to present work and other times it was to comment on an idea presented by another student. She would start by asking a question and would then draw a name to choose which student would respond to that question. However, I noticed that she would sometimes shuffle through the cards, looking at them until she arrived at a particular name. When asked about what she was thinking during such occasions, Carrie replied that she wanted the selection process to seem random but there were often times when she wanted to hear from specific students, either because they had not participated yet, or because as she was walking around she noticed something in their work that she believed would help the other students in their learning of the mathematics as well.

Most of the time I am moving the cards around because the students I picked usually volunteer a lot and I want to give others a chance. And, I know that sometimes a student may be frustrated at that time, or is not prepared enough, and I don’t want to embarrass him or her. (Carrie, personal interview, August 23, 2010)

Carrie’s use of name cards worked well in her class in that students seemed to respond without any animosity, frustration, or objections. The use of these cards promoted participation from a variety of students but this could be a result of her purposeful selection of students. Name cards can be a random technique for choosing which students will participate but because Carrie used them judiciously, she seemed to

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have garnered student acceptance of a technique that could otherwise lead to students’
disdain if it lead to students’ feeling shamed or embarrassed.

Carrie’s Understanding of WCD

Carrie commented that she has learned about WCD through several different
means; professional literature, professional development and/or university classes,
observations of other teachers, and her own personal experience in trying to refine her
own praxis through thoughtful reflection. Of these four means for learning about WCD,
Carrie believed that the two most beneficial was through the observation of other teachers
and her own personal reflection.

By observing other teachers and how they facilitate WCD, she realized that the
positive effects of WCD are far from realized when there is a “teacher-centered”
approach. That is, when the teacher does most of the talking and only accepts volunteer
responses to limited yes or no questions, she believed it was difficult to know how to help
students or to know what they understand. Furthermore, Carrie believed that it is easy for
teachers to accept responses from those students who tend to volunteer frequently, but
she has come to understand that all students need to be involved.

Too many times, including I, will take the fist answer from the first person
with their hand up. I remember reading, and it was evident when I
observed other teachers, that the quiet students won’t answer because we
always pick the same students or we don’t get them involved. But, I feel
that everyone will benefit from classroom discussions, especially ones
with the whole class. (Carrie, personal interview, August 23, 2010)
Carrie went on to comment that by including all students in the WCD, more connections can be made to the content. That is, because several different students participate at different times, then different students hear multiple ideas from multiple perspectives and these varied interpretations allow students to build upon their prior understandings of the mathematics under study; “students can build their understanding based on what their peers say. It gives them time to connect various ideas and make sense of it all (Carrie, personal interview, August 23, 2010).”

In addition to building connections within the content, Carrie stated that students also strengthen their relationships with each other; building trust and respect. Furthermore, students begin to “feel part of a group” and even those students who typically do not participate in WCD begin to “break out of their shell” and feel more comfortable sharing during WCD.

Summary of Carrie’s Interview

Thus, Carrie’s understanding of WCD is based in her belief that it is important for all students to participate because students are able to make more meaningful connections to the content but also become a valued member of the learning community. These understandings stem from various sources including professional literature and professional development classes or university course work, but she believed that the sources that have provided her with the best understanding has been through observations of other teachers and careful reflections and modifications of her own practice. As a result of her observations and reflection she believed that having students present and
defend their own work is likely the most beneficial aspect of WCD followed by her questions and questioning techniques that aimed to include all students.

_Samantha's Reflection_

When asked what the most beneficial aspect of the WCD was for the students, based on the lessons observed, Samantha stated that it was the fact that students were able to make a connection to the mathematics learned. She believed her students were able to further develop their skills by building upon their previous skills. However, based on the observational data, it is unclear how Samantha came to this understanding as only a few students ever participated in discursive interactions during class time and these tended to be the same students. Thus, it may have been evident that these particular students made connections because they were the ones who were the most vocal, but it seems that the perceived connections for other students is unclear. When asked how she knew students were making these connections, Samantha stated that the students were speaking in the local vernacular, which is more familiar to them, and thus could understand better.

Students used the words of their own generation; slang. When they speak this way during class discussions, they discover more relationships. Discourse makes students and teachers think about what they are doing. It is like drawing a picture with words. (Samantha, personal interview, August 20, 2010)

Helping students make connections certainly is one of the benefits of WCD, and while utilizing the local vernacular to help make connections should be supported, one
cannot be certain that WCD assisted in helping students make the connections to the content unless more students become involved in the process.

Perhaps the most interesting finding from this interview was that Samantha claimed that she does not plan for WCD, even though I asked to observe on days during which it was planned and several conversations were had about which days would work best and how long the planned WCD should be. “To be honest, I really don’t plan for discussions. It just comes naturally with the responses that I get from students” (Samantha, personal interview, August 20, 2010).” This professed lack of planning was also reported by Samantha when she informed me that she was just going to “wing-it” that day and this might account for the IRE type of interactions. This is not to say that IRE is the result of a lack of planning, but rather that it seems to be a type of WCD that is easily adaptable and implementable if the teacher has not planned for a discursive interaction with the entire class.

Samantha’s Understanding of WCD

Samantha indicated that her understandings of WCD were based on her belief that all relationships are social. Samantha told of time when she was in high school and her mathematics teacher left on maternity leave which resulted, in her view, an unprepared and unqualified long term substitute being the mathematics teacher. Samantha said that the substitute teacher openly confessed that they did not know mathematics well at all and thus only assigned work from the textbook without any accompanying instruction. Samantha and her classmates knew that they would have to teach themselves
mathematics, trying to deconstruct the examples given in the text to learn trigonometry. This experience has greatly impacted Samantha’s perception of WCD and seemed to also have influenced the learning experiences she expects for her students.

I believe that from the very beginning of our lives, we learn things socially through discourse. Problem solving becomes much easier with different points of view. Through my experiences in high school, I discovered that the only way we would be able to pass the class was if we taught ourselves. I believe that my reason for using whole group discourse is grounded in that experience. (Samantha, personal interview, August 20, 2010)

Samantha’s claim that WCD was a social endeavor that supports mathematical learning is certainly congruent with current research (Van De Walle, 2010) but there continues to be a discrepancy in her perceptions and her actual practice. She stated that her understandings have come to her as a result of taking classes in educational psychology and interpersonal communication and not so much as to the content of these classes but that they were conducted in such a way as to promote discursive interactions between the students of the class. As a result, she claimed to have come away from these classes believing that the “participation in discussions was a big part of learning (Samantha, personal interview, August 20, 2010).” Samantha seemed to hold a strong belief in the use of WCD and the influence it can have on student learning but did not seem to recognize that only a few of her students were benefiting in the manner that she was conducting her classes.
Summary of Samantha’s Interview

Samantha believed that her students engagement in WCD was evidence of the connections the students were making in mathematics, yet only a few students participated in WCD during the observed lessons. Furthermore, Samantha stated that WCD was a naturally occurring event in her classroom and thus there is not a need to plan for it. Her beliefs in WCD as an instructional tool, which promotes learning was also evident and these beliefs were grounded in her past experiences in learning mathematics as well as through university courses dealing with the social nature of learning. While these beliefs are genuine and heartfelt, the observational data does not seem to correspond with these beliefs.

Affective Development through WCD

Erin, Carrie, and Samantha all believed that WCD supported adolescents as they grow and develop affectively; socially and emotionally. After the analysis of their interviews, it became evident that each of the benefits the teachers discussed were all related to one common and underlying theme from which they believed WCD supported adolescent students in their affective development. This theme centered on the ways in which WCD promoted belonging in the classroom.

WCD Promotes a Sense of Belonging

Several previous studies have confirmed that adolescent students need to feel a personal connection to their school and to at least one adult on their school campus (Jackson and Davis, 2001; NMSA, 2000; Van Hoose, et al., 2001). For some students feeling that personal connection may come easily as they are more outgoing students who
actively sought out opportunities to participate. However, and as stated by several teachers throughout this study, there are those students who frequently avoid participation especially if it is within a whole-class setting. Yet, according to Erin, Carrie, and Samantha, if teachers are able to include these students in situations that require their participation then these “quieter” students will feel a connection to the class that they are in. Samantha (personal interview, August 20, 2010) stated that, “emotional stability comes from belonging to a group, so discourse would be important in a student’s well-being from that perspective.” When asked if WCD can promote adolescents’ affective development, Erin was adamant that it would and that this is of particular importance during this stage of human development as many adolescents are seeking acceptance from their peers and experiences that might make them feel shamed are strongly avoided.

[WCD] definitely helps. This is a scary time for most of my students and they certainly don’t want to lose face in front of their peers. Once they learn that all views, while not necessarily on track, are okay, it encourages them to participate more. (Erin, personal interview, August 22, 2010)

Samantha believed that WCD provided an avenue through which students receive encouragement and reinforcement that their thoughts and ideas are legitimate and worthwhile. Adolescents feel supported in their learning from some of the people who matter most in their lives, their peers. The students also learn social skills that help them relate to their other classmates; skills that span curricula.

Students also need validation that their ideas count for something.

Validation is a basic human need that is met through whole-class
discussions. Students enjoy hearing things like, “that’s right!” or “that’s a good idea!” Students who contribute to a discussion develop social skills that enable them to communicate with other people in their lives.

(Samantha, personal interview, August 20, 2010)

One interesting nuance in Samantha’s response was the phrase, “students who contribute” as this implied that the inclusive, supportive, and nurturing benefits that stem from belonging to a group is only manifest when one contributes. This means, based on Samantha’s own acknowledgement, students’ contributions through active participation in WCD was imperative in the affective development of adolescent students. Therefore, all adolescents should be included in learning experiences, such as WCD, that offer this type of support in school.

Carrie stated that students often feel that they do not have anything to contribute but sometimes their contributions help others understand in a way that the teacher has not been able to provide; “they may think that what they have is not important, but sometimes, it is exactly what someone else needs to hear.” And this is precisely why student participation is necessary; nobody knows what a student is thinking, or how their thinking can benefit the overall learning objectives unless that student shares their thoughts. Creating a sense of community, or belonging within the class, can be done in many ways but one of the ways indicted in these interviews was to elicit participation and responses from the students if they are not forth coming. Involving more students in the WCD was one of the primary roles of the teacher as indicated in the initial semi-structured interviews which means that throughout this study, teachers seem to be aware
of their responsibilities during a WCD. Although they were aware of their role some
either had difficulty implementing strategies to create inclusive WCD, were unaware of
what strategies could be used to increase more inclusive WCD, or did not realize that
their practice did not match their perceptions and beliefs toward WCD.

Summary

The previous chapter included the findings from this four phase study which
explored middle level mathematics teachers’ perceptions of WCD as an instructional tool
to help adolescents in learning mathematics. The data collection methods included in this
study, as they were implemented, included a questionnaire, initial semi-structured
interviews, classroom observations, and then follow-up semi-structured interviews with
the teachers whose lessons were observed. Each of the four methods were conducted
during four separate phases and the results for each of these will be summarized in the in
the four parts below.

Phase One: Questionnaire

The first phase of the study utilized a four question questionnaire, and involved 30
teachers from four different middle level schools to formulate an initial understanding of
teachers’ perspectives towards WCD and also to identify teachers who valued WCD as
an instructional tool to support the learning of mathematics for all adolescent learners.
The results of the questionnaire indicated that teachers tend to support the use of WCD.
Half of the teachers reported that they implemented WCD as an instructional technique at
least once every two weeks and ten other teachers indicated that they used WCD nearly
daily.

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Phase Two: Semi-Structured Interviews

From the sample of 30 teachers, nine teachers were identified to be interviewed to further understand their perceptions of WCD. Part 2 focused on providing insight into the five research questions. These questions were: 1) How do teachers define discourse, 2) how do teachers perceive the utility and benefits of WCD in supporting all learners, 3) what is the teacher’s role in facilitating WCD, 4) how do teachers describe meaningful WCD, and 5) what instructional strategies do teachers use to engage all students in WCD? A summary for each questions follows.

Six of the nine teachers misunderstood the definition of discourse or reported that they did not know the definition of discourse at all; these six teachers had all been teaching less than ten years. All of the teachers from this group that did provide a definition, interpreted the term as having more negative connotations. When this same group of six was asked to then provide a definition for whole-class discussions, they all provided similar definitions. These teachers viewed whole-class discussions as being a more teacher centered and teacher initiated phenomenon that required the teacher to control the input from the students and tended to include only voluntary responses from students.

Three of the teachers interviewed, all of whom had taught for ten years or more, described WCD in a manner that was more aligned to the current literature on WCD. These teachers also perceived WCD to be a student-centered, inclusive phenomenon wherein the students openly share in the responsibility of discussing mathematics and in exchanging ideas related to the topic at hand; students became active listeners and leaders.
of the discussions. These three teachers also thought that WCD would likely be teacher initiated, but believed that students were also capable of initiating the dialogue, and would include several facets of participation; voluntary, random teacher selection, student selected, and/or non-verbal interactions.

Teachers reported that there were two categories of benefits when utilizing WCD. These two categories were classified as benefits that supported the teacher or benefits that supported the students.

The teacher benefits from using WCD included such things as the ability to check for student understanding and address any misconceptions that they may have; manage the classroom so that the teacher could check students’ progress in reaching the intended learning goals, this was often done through small group work; and the use of a supportive instructional technique (WCD) to aid in the presentation of new concepts or as a means to help teachers learn how to craft more meaningful and higher order questions.

The teachers also believed that the students benefited from WCD. Teachers believed that WCD supported student understanding as students were able to hear new ideas from other students, which the teachers believed translated into higher-order thinking skills, and because these comments were stated in student friendly language. WCD required that students be held accountable in the learning process because they became active leaders and contributors of understandings within the classroom.

The interviewed teachers all believed that their primary role in facilitating WCD was to be a guide. To these teachers, facilitating or guiding the WCD was understood as encompassing four separate duties.
The first duty within their role included the maintenance of a positive learning environment. This meant that the teachers needed to ensure that all students participated in a respectful manner while creating a culture of support and participation. Students were expected to participate, though only if they wished to, but responses would not be ridiculed or negatively criticized by anyone within the classroom.

The Second duty included the need to shift responsibilities from the teacher to the students for contributing ideas and understandings but the teacher needed to make sure that there were no dominating student(s) during WCD. The teachers also reported that when the students took the lead in contributing ideas and questions during WCD then there was also a change in the ambient environment; they believed that one could “feel” a change in the learning environment.

The third duty entailed teachers questioning students’ thinking. Teachers believed that student responses often needed to be challenged so that students could come to a better understanding of the mathematics. By challenging students to further defend their thoughts the teachers could further determine what students knew and identify previously hidden misconceptions.

The final duty was to be cognizant of students’ social and emotional development. Teachers needed to be aware that some students did not wish to participate and therefore they would not ask these students to do so. All of the teachers reported that the awareness of adolescence affective development was critical. Some of the teachers believed this aspect of the adolescent student to be so important that if the teacher...
believed a student did not want to participate, even by the smallest inclination, then they would not call on the student.

The nine interviewed teachers all described meaningful WCD in terms of observable physical characteristics from the students; one teacher also described meaningful WCD in terms of the quality of responses generated by the students. The primary indicator was an increase in students’ participation. This included students being focused on the person speaking, students wanting to contribute to the WCD, and the identification of certain students, who typically do not participate, as indicators of meaningful WCD when they are participating. Teachers also talked about observable behaviors such as an energetic change in facial expressions, more hands raised, little commotion, and a general feeling that students are energized and focused on the topic. One teacher believed that one indicator of meaningful WCD was a shift in the quality of responses from the students. They reported that students tended to provide more sophisticated responses and asked more insightful questions during meaningful WCD.

The analysis of the interviews indicated that teachers used strategies that could be classified into one of four categories. These categories included questions and questioning techniques, teacher selected strategies, small group interactions, and other support tools for WCD.

The use of questions and questioning strategies was the most reported type of strategy used. However, teachers preferred to ask opinion type questions as they believed these types of questions were more aligned with supporting students’ affective development. When students are asked their opinion on a topic, the accuracy and
The veracity of their response was of less importance than their actual participation. One teacher believed that open-ended questions, ones that allowed for creative interpretations and unique responses, were useful in strengthening student understanding of mathematics. However, all teachers described the process by which they question students in a typical IRE fashion; the teacher would ask a question, followed by a student’s response, and then the teacher would evaluate and comment on this response before asking another question.

The teacher selected strategies included methods by which teachers would select students to contribute to the WCD. The most reported and preferred method was to select only those students who voluntarily wished to participate. Teachers would ask a question and would only call on those students who raised their hands or the teachers would accept the first response that was shouted out. Occasionally the teachers would call on students who did not raise their hand to participate, though they concern of embarrassing students who did not wish to participate often trumped this selection method. Finally, a couple of teachers reported that they would use name cards to randomly select students to participate. The teachers had a stack of cards for each class period with each student’s name on a card. The teacher would draw one card to determine who would contribute; the student’s contribution was often in response to a teacher’s question though it could also be used to select who would share their work in front of the class. While other random selection methods were mentioned by one teacher, none of them were reported as having been used by this teacher.
All of the nine teachers reported using small groups as a means of increasing engagement for WCD. Sometimes small groups would be used prior to WCD to prepare students to contribute. The teachers believed that small groups allowed students to have an opportunity to talk together to hear ideas and perspectives and this would help them formulate their own thoughts. At other times, small groups would be used during a planned WCD because the teacher noticed that many students wanted to share their thoughts. This allowed students to break into smaller groups so that many more could share their thinking. When students had shared in small groups then the teacher would bring the entire class back together to recap what was discussed in their groups. Also, teachers reported that they would use small groups after WCD because the teacher had modeled how to interact in a discursive interaction and thus the students would also know how to conduct themselves when they were in small groups. However, a few teachers indicated that small group interactions were also problematic at times because it was difficult to know what students were discussing in each group; misconceptions could be perpetuated because the teacher was unaware of what students were talking about.

There were two primary types of support tools mentioned by all of the interviewed teachers and one additional tool that was discussed by one of the teachers. Technology tools were the most frequently reported tool. Technological tools included such things as document cameras and “smartboards” but also included individual student responders that were synched with the teacher’s computer and even calculators, some of which were graphing calculators. A second type of tool was the modification of the lesson. Modifications were made for one of two reasons; to increase participation or to
help students formulate their responses. The modifications that were used to increase student participation included waiting for a given number of students to raise their hand, increasing wait time between questions, choosing students without their hands raised, or offering incentives. The modifications that were used to assist in the formulation of students’ ideas also included increasing wait time but this was to allow students to internalize their thoughts. Another modification for aiding students in preparing their responses was asking students to write their responses as this allowed the students more time to internalize and make connections to the mathematics under study.

*Phase Three: Observations*

Three teachers were purposefully chosen from the nine teachers that were interviewed to be observed to determine the extent to which teachers’ beliefs and reported practice of WCD coincides with their praxis. These teachers were chosen based on the results from their initial questionnaire and their responses from their interviews; they seemed to place a significant value on the use of WCD as an instructional tool to support all learners. Each of the three teachers were observed for at least five class periods, over several days all of which occurred during the first three to six weeks of a new school year.

The analyses of the observations were grounded in the TGF based on the nine semi-structured interviews from the previous phase. The TGF consisted of two facets: 1) strategies and/or roles frequently implemented by teachers to facilitate and promote WCD and 2) desired student traits that support students’ learning of mathematics.
There were three strategies and/or roles that were reported as being frequently used to facilitate and WCD. The first two relate to specific roles that teachers believed they needed to fulfill in order to facilitate WCD and the last is a specific strategy. The first role was the need to keep the discourse moving. Teachers felt that students would talk about topics unrelated to the intended learning goals or might not make the desired connections to the mathematics so the teacher needed to keep the WCD moving so that the learning goals could be met. The second role related to the need for teachers to create student engagement and participation. Teachers thought that WCD was not a naturally occurring event and only a few students voluntarily participated thus excluding many students. In addition, the teachers believed that they were responsible for generating participation that included all students. The final component was a strategy that was reported by all of the interviewed teachers; the use of small groups. Small group interactions were thought to support WCD for several reasons. First, small group interactions provided opportunities for students to obtain necessary background information, it created environments in which more students felt comfortable participating, and it allowed for opportunities for many students to talk about a topic by which others could hear several other ideas and thus be better prepared to participate in WCD.

There were also desired student traits that supported all students’ learning of mathematics. First, it was believed that students would have participated more as a result of the teacher’s facilitation of WCD and increased student participation. Secondly, student responses would have been of a higher quality. As a result of engaging in WCD
and hearing from several other participants in class, students’ thoughts would have been better formulated. Finally, the interactions in the class would have been more inclusive. That is, all students would have had opportunities to contribute to the WCD because of the dynamic nature of WCD.

Three teachers were observed from three different middle level schools; all of the teachers were teaching seventh grade mathematics at the time of this study. The TGF was used to analyze each of the teacher’s lessons to better understand the degree to which their praxis corresponded to their perceived practice. These three teachers were Erin from Ocean Middle School who had 13 years teaching experience, Carrie from Mountain Middle School who had ten years teaching experience, and Samantha from New Town Middle School who had five years teaching experience.

Erin used small group interactions to promote discourse amongst students. Erin also asked questions to the whole class and accepted responses from any student who responded, but all of the discursive interactions followed a typical IRE process; student responses were funneled through the teacher first, with an evaluation, and then another question from the teacher. Furthermore, nearly every response was voluntarily, though she did ask a couple of students to participate on two separate occasions. Finally, Erin created a strong culture of responsibility wherein students were expected to assume, and willingly accepted, leadership roles. While Erin’s praxis coincided with some of the facets of the TGF, there were several areas in which her perceptions of her practice did not match her actual practice; specifically with respect to creating engagement and the desired student traits.
Carrie also utilized small group interactions wherein students supported each other in their learning through discursive interactions. Students were also responsible for presenting their work to the entire class and were chosen to do so through various methods; some students volunteered, some were selected by the teacher and some were randomly chosen using name cards. Carrie frequently probed student thinking by asking follow-up questions to specific students or by asking other students to defend another student’s response. Carrie created a strong classroom culture of participation, which included a culture of responsibility. Participation was created through the use of the name cards, which students seemed to openly accept, choral responses, volunteer responses, and responses from students that the teacher selected to participate. The WCD in Carrie’s class also followed the IRE process with Carrie commenting on or questioning student responses prior to other students being able to provide a response. Finally, Carrie’s perception of her praxis seemed to coincide with her actual practice and the observed lessons closely matched the TGF.

Samantha also had her students arranged in small groups, which promoted small group interactions. However, this was the only facet of the TGF that was evident during the observed lessons. Samantha also used the IRE process to facilitate WCD but few students participated in this type of discursive exchange and the few that did were volunteer responses. For the first three observations, interactions that could have supported WCD were few and far between. In subsequent observations, Samantha utilized a lecture style instructional approach but she did ask several questions that could have been used as opportunities to initiate WCD but these opportunities were not
capitalized upon. In addition, Samantha’s perception of her praxis did not match her actual practice; her use of small groups and her ability to keep the discussion moving were the only facets that matched the TGF. There did not appear to be a culture of responsibility or of participation that could support the facilitation of WCD.

**Phase Four: Follow-Up Semi-Structured Interviews**

In this final phase of the study I wanted to learn more about two emergent themes. These themes were framed in the following questions: 1) how did the observed teachers come to their understanding of WCD and 2) can WCD support adolescent students’ affective development? These two questions arose from the interviews and from the observations with each of the respective teachers.

Each teacher reported arriving at their understanding of WCD through different ways. Erin came to her understanding of WCD through her experiences in the classroom but also mentioned that her understandings had changed based on the initial semi-structured interview. As a result of this interview she decided to think about how she could implement WCD more often as she did not previously view WCD as an effective strategy for teaching and learning mathematics. Carrie stated that she came to her understanding of WCD through observations of other teachers along with frequent reflections on her own practice. These observations were important to her because she was able to witness various strategies and then incorporated or modified the strategies she felt were most effective to use in her own classroom. Whereas Samantha believed strongly that learning was a social endeavor and this was based on her previous college course work. During this interview Samantha also revealed that she believed that WCD
was a naturally occurring phenomenon in her classroom and thus she did not need to plan for, and, in fact, never planned for WCD during the observations.

Each of the three teachers talked about how WCD supported adolescence during this time of their life as they grow and develop socially and emotionally. The teachers said that WCD helped students gain a sense of belonging to the students and the teacher within the classroom and that this sense of belonging was critical to foster. The teachers were aware that adolescents constantly seek acceptance from their peers and thus WCD provided an avenue through which students gained recognition as being part of the classroom and validation of their ideas. Carrie believed that by selecting students that did not typically participate and asking them to contribute to the understandings of the class via WCD, students would feel more connected to the class; this was counter to many of the thoughts and beliefs of the other teachers interviewed.
CHAPTER 5 CONCLUSION

This study examined the perceptions of a small number of middle level mathematics teachers to better understand how they viewed WCD as an instructional strategy to support all students in the learning of mathematics. WCD can be an effective instructional technique to strengthen adolescent students’ understanding of mathematics through a shared, interactive, and inclusive exchange of mathematical ideas, concepts, and understandings if it is used appropriately.

The learning experiences that teachers plan for, create, or co-create with students are fundamental to the academic achievement and attainment of students (Marzano, 2004). With that in mind, the nature of these learning experiences should be focused on creating experiences that are more student-centered; the students should be actively engaged in learning of mathematics. WCD inherently is student-centered because there are more students than teachers in a classroom but this does not mean that teachers are less important during WCD. In fact, teachers play a vital role during WCD. Not only are teachers content experts, but they need to be the facilitator of WCD which means that they need to be able to interject with appropriate follow-up questions that probe students’ thinking and use methods that provide opportunities for all students to participate. Perhaps the most important responsibility that teachers must take on for WCD to be successfully implemented is the creation of a classroom culture that welcomes and expects participation from all students. This means that teachers need to employ methods that make adolescent students feel comfortable enough to participate, even if they are considered one of the quieter students in the class; hold students
accountable to participate; validate students’ ideas without placing judgments on their responses; and assess students’ understandings of the mathematical content to adjust their instruction to better meet the needs of the students.

By examining teachers’ perceptions of WCD, I was able to gain insights into the decisions teachers made in planning mathematical learning experiences, choosing teaching techniques, and determining methods for assessing student understanding. However, by the completion of this study I came to understand that the learning experiences the three observed teachers believed to be present in their classrooms with respect to WCD, were not present or were not present to the extent to which they thought they existed. In other words, the observed teachers’ perceptions of WCD were incongruent with their actual practice.

The implications for such discrepancies are tremendous for the teacher and the students alike, with respect to WCD. For the students, as I found in the observational data, many began to be unintentionally marginalized; they were not even invited to share their thoughts and ideas let alone have them considered as valid contributions to the classroom’s collective understandings. When teachers believe that they are implementing WCD, but the reality is that their enacted version of WCD is less inclusive, engaging, or aligned with the intended version of WCD; the effectiveness of their teaching and students’ learning can be negatively affected (Muir, 2008) Yet, there is a difference between intentionally altering the use of a particular learning strategy and believing that the strategy being used is being successfully implemented. The three
teachers I observed in Phase Three belonged to the latter case; the intended curriculum was different from the enacted curriculum and they were unaware of this difference.

There were four common areas in which teachers’ perceptions and practice conflicted with either their own beliefs or with the current literature dealing with effective pedagogical practices and adolescent development. These areas of concern focus on: 1) Connecting pedagogy to the nature and needs of adolescent learners, 2) creating cultures of participation that are inclusive of all students, 3) assessing for learning through collaborative and formative methods, and 4) shifting responsibilities from the teacher to the students to promote relational understanding. This final chapter examines the implications of the learning environments for each of the three observed teachers, with respect to four critical areas, as a result of the discrepancy between the teachers’ perceived reality and my observation of their practice.

However, before I discuss the discrepancies I found, I want to it to be made clear that the three teachers who were observed expressed a deep rooted interest in providing the best education possible for their students. Thus, the discussion that follows should not be viewed as a critical review of individual teachers. Rather, the following sections should be viewed as a critical reflection on how perceptions and beliefs can shape teachers’ praxis; some of which may be, at times, incongruent with their own philosophies and/or the previous findings from the current literature and the implications of these inaccurate perceptions.

Each of these four areas affect student learning and thus have specific ramifications within the day-to-day proceedings of the classroom and in the development
of student learning. The implications for the incongruities between teachers’ perceptions and their practice or reported practice practices are discussed in more detail in each of the following sections.

Connecting Pedagogy and Praxis

Implementing effective pedagogy in the classroom can be thought of as requiring relational understanding about teaching; teachers know what to teach and what manner to teach it in. In essence, teachers must merge their content knowledge with effective methodologies for teaching adolescents. Implementing effective pedagogy also means staying abreast of current understandings within the field of education through various means of professional development. However, for the three observed teachers it became evident that their understandings of discourse and the utilization of WCD within a middle level classroom were not always aligned to the understandings of current research. In particular, there was a noticeable difference in their understanding of the term discourse as well as the implications for using WCD to support adolescents’ social and emotional growth.

Confusing Terminology

One of the first substantial findings from this study was that there was a pervasive misunderstanding of the term discourse. Only three teachers expressed an understanding that aligned with Kuhn’s discourse model (see Figure 1) or Robert and Billings (2010) maieutic approach to WCD. Erin and Carrie were two of these teachers and it was expected that they would implement strategies to create a classroom setting that mirrored their beliefs yet this was not the case.
Samantha, however, was one of the teachers who confused the term discourse with a phenomenon with more negative connotations yet I selected to observe her because of the way in which she described the impact of whole-class discussion in helping all students develop a personal connection to the mathematics being learned. While most of the interviewed teachers all described various components of whole-class discussions, which were similar in some ways to the descriptions by the teachers who understood WCD, they were still either unaware of or misunderstood the term discourse. Most of the teachers believed that discourse had a negative connotation; it was something that should be avoided. In making this connection, it seemed that the teachers were confusing the term discourse with the word discord. Discourse in mathematics instruction, in and of itself, is not a novel, innovative, or original phenomenon. It has been a part of the fundamental framework of beliefs held by the NCTM for over twenty-years and has been instrumental in education for decades prior. There is ample research (Hmelo-Silver & Barrows, 2008; Hoffman et al., 2009; Huang et al., 2005; Moschovich, 2008; Nelson, 2009; Piccolo et al., 2008; Staples, 2007) indicating discursive norms, methods, strategies, and processes by which teachers can improve their use of meaningful WCD, yet teachers were unfamiliar with the term.

However, teachers were familiar with the term discussion and felt comfortable describing whole-class discussions. While it may seem like an inconsequential variation, discourse and discussions are inherently different. Recall that discourse is based on a shared and inclusive exchange of ideas upon which new understandings are created and
explored, whereas discussions are more of an exchange of views that do not intend to create new understandings.

The question that then arises is how can teachers develop and improve upon this aspect of their practice if they are unaware of the terminology used within the discipline? Beneficial professional development and access to professional instructional resources could be limited simply because teachers do not understand the vocabulary of their practice. Shifting teachers’ practice towards the inclusion of meaningful WCD can be a long and arduous process (Hoffman et al., 2009; McKeown & Beck, 1999), but it is seems unlikely that such shifts will ever occur if teachers are not even familiar with the professional vernacular. Furthermore, the shift in teachers’ praxis toward meaningful and inclusive WCD seems to be somewhat problematic for the teachers who did understand the term discourse as their perceptions did not match their practice.

When comparing the teachers who were familiar with the term discourse with those who were not familiar with the term, another difference became apparent. The reported beliefs of the veteran teachers and the novice teachers with respect to the effectiveness of WCD, as indicated on the questionnaire, were noticeably different. The veteran teachers, who rated their effectiveness and their ability to facilitate WCD lower than the novice teachers, described WCD in much more complex ways. The veteran teachers provided more strategies for facilitating WCD, reported more student and teacher benefits for WCD, and described in greater detail what meaningful WCD looked like. So while the veteran teachers were less likely to agree with the usefulness and
benefits of WCD when compared with the novice teachers, their understanding of the
facilitation of WCD was more substantially more detailed than the novice teachers.

Erin and Carrie, two of the veteran teachers, were part of this group of teachers
that seemed to express a greater understanding of WCD, yet there was an obvious
disconnect between their reported understanding of discourse and their implementation of
their understandings. This was most evident when in their follow-up interviews they
believed that there was substantial evidence supporting the existence of WCD during
their lessons, but the given evidence was typically only related to certain student
responses and not to the rich, inclusive exchanges that they described.

*Attentiveness to Adolescents’ Affective Development*

Another aspect of connecting pedagogical practices to adolescent students was
within the teachers’ attentiveness and responsiveness to the affective needs of adolescent
learners. These needs are often found within the social and emotional realms of
adolescents. Middle grade teachers need to be aware that their actions, or inactions, may
affect adolescent development negatively, and thus not support academic achievement.

While some of the teachers in this study had academic backgrounds with an
emphasis in middle level education, all of the teachers expressed an understanding that
they needed to be careful not to alienate students or otherwise make them appear
inadequate. In following practices that were sensitive to students’ affective development,
the teachers were also being protective of individual students who they believed were
more shy, quiet, or reluctant to participate. The teachers did not want to embarrass,
shame, or otherwise humiliate a student if they believed that including them in WCD
would create negative feelings or uneasiness. Such efforts and awareness should be commended to a degree as adolescence is certainly a time of significant social and emotional change. Building and sustaining strong personal relationships with students is critical and strengthening these relationships can trump other concerns in the classroom in certain circumstances. That is, sometimes a teacher may decide to not include a student in WCD because they are building trust and mutual respect.

With that said, the interviewed and observed teachers were so concerned with damaging students’ affective development that the teachers frequently opted to not include the students. Sometimes students were never included which means that the discursive exchange was not even WCD. The teachers talked about being attuned to the developmental needs of adolescent learners, specifically in that some students were not as comfortable as others talking in front of groups of people, but in doing so entire populations of students were being excluded. Okolo, Ferretti, and MacArthur (2007), in referencing the Santa Barbara Discourse Group (1992) state that WCD helps students establish and strengthen relationships with their peers and thus helps them feel more connected to, and valued within, the classroom. Van de Walle (1994) states that the teachers must provide time for students to talk about mathematics and ample time for students to generate responses as this helps the students learn to “trust and believe in one another. This attitude conveys support and confidence and is usually all that is necessary to get a quality response (p. 47).” Yet, nearly every teacher in this study felt it was unhealthy to include students in WCD and thus they should just let the student be; student contributions during WCD were at the students’ discretion. A troublesome reality begins
to take shape if one imagines these students having similar interactions in each of their classes, with all of their teachers, throughout their entire middle school experience. Fair, just, and democratic societies seek to include all members so that more sophisticated and advanced understandings are created. In essence, the sum is greater than the parts, yet only some of the “parts” were participating in WCD. What is perhaps most startling, is that this unintended exclusion existed in two of the three classrooms observed.

Erin and Samantha reported, along with many of their colleagues from the interviews, that they would not ask students to participate if they sensed that the student did not wish to participate and thus missed an important component in supporting affective development during adolescence. This was certainly the case during my observations in Erin and Samantha’s classroom even though Erin attempted to include a particular student when she asked him if he wanted to share his thoughts; “Are you sure? I know you know it. I know you know it (observation, August 17, 2010),” students did not have to contribute to WCD, only those who volunteered a response added to the WCD. These teachers held this conviction even though they all believed it was part of their responsibility to create engagement and increase student participation during WCD; an instructional strategy that they believed was valuable to the students.

Grennon, Brooks and Brooks (1999) state, “discourse with one’s peer group is a critical factor in learning and development. Schools need to create settings that foster such interactions (p. 111).” Jackson and Davis (2000) further encourage supportive and inclusive classroom environments for adolescents and state learning experiences within these types of classrooms should be frequent and prevalent throughout the school.
However, if the teacher is overly reluctant to call on students because the students wish to avoid social or emotional unpleasantness, then opportunities are withheld for students to affectively grow and develop as well. When students have opportunities to develop and improve in areas that they may perceive as being embarrassing or difficult, like contributing in WCD, then they will become more comfortable in these situations. By participating in inclusive interactions with their peers, such as those provided by WCD, students can develop greater self-esteem, raise their sense of personal value; and self-efficacy, confidence in what they can achieve; and ultimately achieve more success (Van Hoose et. al., 2001). Therefore, teachers need to be cautious in deciding not to include students. As Carrie stated, if the teacher perpetually allows students to not participate, then the classroom culture has been established that they will never have to. This could lead to future marginalization particularly for student groups who are perceived as being shy or “unable” to respond. What this means is that a balance must be struck between honoring student wishes and unintentionally creating marginalizing situations for adolescents. It is the teacher’s responsibility to challenge all students as well as make them feel welcomed, valued, and respected for their ideas as well as being an individual.

This strongly suggests that including all students in WCD should become a priority. Although the methods by which all students—quiet, shy, reluctant speakers, or otherwise—are invited or selected to participate should be closely examined so that these students experience success early on. Carrie talked of calling on such students early on in the WCD as this provided them opportunities to contribute when many of the more obvious ideas had yet to be discussed. In doing so, Carrie helped her students become
more comfortable interacting with their peers and be valued as an equal and respected member within the learning community; thus promoting affective development.

Creating Cultures of Participation

While the previous section discussed the implications for not including students in WCD, Carrie’s comment on the ramifications of constantly allowing students to not participate brings to light an important issue for equitable learning environments; the creation of a classroom culture that promotes participation. Classroom cultures of participation are inclusive, value all individuals’ comments and ideas, and maintain accountability for all members within the learning community for contributing to and shaping the understandings that arise through collaborative and shared discursive interactions. In this next section, Erin, Carrie, and Samantha’s practices, reported and observed, are discussed with specific emphasis on their overabundant use of voluntary responses. Furthermore, the need for implementing more random selection processes as well as instructional strategies that have an impact on creating inclusive classroom cultures of participation to promote mathematical learning will be discussed in greater detail to highlight the disparity that was reported.

Relying on Voluntary Responses

Every teacher interviewed supported the use of inclusive WCD that was similar to Kuhn’s discourse model but frequently described discursive interactions that began, and continued, with the teacher using a traditional IRE structure. Teachers would pose a question, wait for students to voluntary raise their hands, call on one of these students, evaluate the student’s response, and then repeat the process. However, voluntary
responses only include a voluntary and limited snapshot of what the majority of the students in the classroom understand, or do not understand.

Samantha and Erin were both proponents of voluntary response and Erin initially stated that she only used voluntary responses because she did not wish to shame a student who was not comfortable speaking in front of the whole class; her actions and beliefs were clearly evident during her observations. However, Larsen and Bartlo (2009) unequivocally state that in order “to support learning of all students, it is important that all students are active participants in the classroom discourse (p. 78).” By active participation, Larsen and Bartlo mean that students are at the forefront of the learning experiences by actively asking questions themselves, not just the teacher asking questions; justifying solutions and explanations; as well as challenging others’ ideas with the purpose generating a more rich and complex understanding of the mathematics.

Carrie, on the other hand, also used voluntary response but she was also able to incorporate techniques that ensured several different students contributed during any given WCD. One of her favorite, and frequently observed, methods was the use of name cards. What this demonstrated was that voluntary responses can be acceptable and incorporated in during WCD, but as the NCTM (1991) states, meaningful interactions are built upon cultures of collaboration. Teachers might wish to accept voluntary responses but should do so sparingly. Voluntary responses simply cannot be the only means by which teachers generate participation during WCD if inclusive collaboration is to develop. This means that those teachers who consistently rely on voluntary responses are leaving some, if not arguably the majority, of the students out of the learning experience.
and are thus promoting learning for only a few of the students. It should be noted that while Carrie successfully implemented strategies that promoted a culture of participation, she, too adhered to the IRE approach to WCD. Such actions significantly limited the student-to-student interactions that Kuhn (2009), Roberts and Billings (2010), and Carrie herself described as being indicators of meaningful WCD.

A comment heard in several of the interviews was that there are often some students who did not wish to talk. Carol stated that one of the main reasons she did not like to use WCD was because there were few discursive interactions; she believed most of the talking was done by her. Yet the teachers also believed that it was their responsibility to facilitate the conversation; wanting to make new or unique ideas and ways of thinking more apparent to all students through WCD. This created a substantial paradox in the teachers’ practice. The teachers recognized that some students did not want to talk and since the teachers did not want to make any students feel embarrassed or shamed for not responding, the teachers would not call on certain students. However, the teachers simultaneously believed that it was part of their responsibility, their role as the teacher, to include all students in the learning experiences; this included facilitating WCD. It is simply impossible to have inclusive WCD, wherein all students participating is central to the generation of understandings, while excluding certain students and only relying on a select voluntary responses.

Most teachers believed that students should not be pushed to respond as teachers need to be aware of their social and emotional needs, as previously discussed. And while acknowledging that, sometimes, students may not want to contribute, allowing students to
perpetually opt out of participating in the learning environment should not be part of the classroom culture as it may lead to disengagement just as Carol commented; “there is no one with that inattentive behavior that we see so much of.” Unfortunately, this is exactly what happened in Samantha’s classroom. Only a select few students ever contributed, which in turn caused Samantha to direct her questions to only these students, which resulted in many other students throughout the classroom having their own side conversations; they were no longer actively engaged with the content or their learning.

During the initial interview, Erin noted that even those students who tend to not want to participate are often actively engaged when meaningful WCD is taking place. Yet, she struggled to include others in the WCD. In fact, Erin believed that through her implementation of small group discussions, the WCD was effective. Erin’s perception of the small group discussions was accurate in that students were often talking amongst each other about the mathematics being learned but when she would bring the students back to a whole-class setting, inclusive participation became limited. Erin knew that her students would be intently focused on learning if she could facilitate meaningful WCD, but such interactions were not evident. If positive and pro-learning behaviors are the norm during meaningful WCD, then the question begs to be asked why not employ WCD if it means students who tend to disengage from learning mathematics become actively engaged with learning mathematics? There is an overwhelming amount of research that reveals when there is a lack of student engagement—the investment, attention, interest, and effort students put into their learning—student learning diminishes (Alvarez, 2002; Black, 2005; Bryson & Hand, 2007; Carini, Kuh, & Klein, 2006; Jackson & Davis, 2000; Klem
Erin believed that the small group interactions were effective in promoting and facilitating WCD but later she stated that it was difficult to facilitate meaningful and engaging WCD because it was simply too early in the year. However, Carrie and Erin began the school year on the same day and I conducted their observations within two days of each other. It seems unlikely that two additional days would make a significant difference in the classroom culture that was created, yet there was a noticeable difference between Erin’s creation of a classroom culture that promoted responsibility and Carrie’s creation of a classroom culture that promoted responsibility and participation.

It may be that not all students will participate in WCD all the time and some students will feel less confident responding to probing questions. Furthermore, adolescent students should not be expected to participate under any and all circumstances. But Rigelman (2010) found in a previous study that the norms and classroom culture are “highly critical” elements in establishing mathematical discourse amongst students. As evident in Carrie’s classroom, a classroom culture that expects participation can accommodate occasional opportunities to not participate whereas classroom cultures that depend on voluntary contributions, such as those I observed in Erin and Samantha’s classroom, had difficulty in simultaneously accommodating expectations for participation from all students and allowing students to not contribute to the learning experience indefinitely. Both paradigms cannot exist at the same time and thus, if one were to be chosen, it would seem to be more beneficial for the teacher to
operate under the paradigm that offers more flexibility; namely establishing and maintaining classroom cultures of participation.

Generating Random Participation

Carrie relied upon means other than just voluntary responses to generate participation from a greater range of students; not just those who tend to be more vocal in sharing responses. The method she used the most to create an inclusive participation was the use of name cards; each card contained the name of an individual student. Carrie would pull one card out of this set, usually randomly, though she would also read a different name if she deemed it necessary, and would then read the name of the person on the card; this would be the student asked to contribute. Carrie, as well as some of the other teachers interviewed, talked about creating an environment wherein students were unsure of whom would be asked to participate in order to increase students’ attention to the discourse at hand as well as increase participation rates. When teachers utilize such methods along with increased wait time, they also convey to the students that their ideas matter and when students feel that their ideas are valued, regardless of accuracy, they are more likely to take intellectual risks (Van Hoose, et al., 2001).

Intellectual risk taking is exactly the type of behavior that should be encouraged in the classroom in order for all students to become better learners of mathematics. Adolescent students need to feel that they can be successful in their endeavors especially since, as Canfield and Wells (1976) stated, if they feel deficient in their social capital, or their “chips,” they are less likely to participate. While it may seem contradictory to recommend methods that create a “shared fear,” as Ben called it, for students who believe
that they have fewer “chips” it must not be forgotten that the culture of the classroom is
important. Students who have fewer “chips” will participate, even though they are less
likely to participate because they wish to not be embarrassed through participation,
because the teacher established a classroom culture that values all students and their
ideas. I believe that this type of classroom culture was evident in Carrie’s classrooms
which likely had at least a few students with few “chips.”

Expectations of participation can and should be established early on in the year
and be reinforced. Students should be reminded of them during the school year but
providing such reminders does not mean that teachers are insensitive to students. Rather,
it conveys a message to adolescent learners that their ideas, thoughts, and perspectives
are valued. Students must be given the opportunity to participate and have their efforts
validated by their peers and the teacher if the class does not do so inherently. One way to
support and strengthen classroom cultures of participation is by developing or
implementing techniques that randomly select students. On a few different occasions,
Carrie would pull a card, ask a student a question, whose answer was unknown to the
student. At this time, Carrie would ask the student to find a possible solution and remind
them that she would come back to them shortly. After some time, usually five to ten
minutes, Carrie would ask the student to provide an answer to the question. Carrie
always remembered to come back to the student and in doing so conveyed a clear
message that each student is responsible for participating, contributing, and needs to be
ready to either provide a solution or be ready to find a solution if one was not
immediately available.
During the interviews, Sarah said that by using random selection methods students were more alert and engaged in the learning process; characteristics of effective learning. Based on the diversity of students participating, it was clear to me that Carrie’s students were more engaged with the mathematics because of her use of a random selection process. Erin and Samantha could have benefited, from employing some type of random selection method such as the name cards. When the name cards were used, the students were prepared to participate, this created learning experience in which the students became equally-contributing members of the classroom instead of classrooms that were more teacher-centered, as was observed in Erin’s classroom and extensively in Samantha’s classroom.

During the follow up interviews Carrie was very aware that she was calling on a variety of students to participate and she mentioned that it was important for her to do so even though she believed that she could improve upon her methods because she felt she was not generating the diversity of participation she desired. While Carrie could work on developing other strategies that would also promote a classroom culture of participation, I think it would be in her best interest to focus on generating WCD patterns that were more aligned to Kuhn’s discourse model rather than the “wagon wheel” patterns that were witnessed during my observations. In doing so, the classroom culture of participation is strengthened as the teacher shares more of the responsibility for generating questions, understandings, and thus meaningful mathematical explorations with the students. After all, it is the student learning that is the focus of teachers’ efforts.
WCD Instructional Methods

The teachers in this study reported using several different methods to elicit more frequent responses from students. Some of these included techniques for randomly selecting which students would participate, utilizing small groups before and/or in between times of WCD, and through the use of questions and questioning strategies. However, some of these techniques did not address certain aspects of adolescents’ cognitive development and some that were reported by these teachers were only sparsely evident. By overlooking, omitting, or otherwise neglecting methods of instruction that did not fully address the cognitive needs of adolescent students, which should not necessarily be confused with the students’ wishes, opportunities are missed that assist in creating rich and more complex mathematical understandings within a classroom culture of participation.

Using Questions

Questions, and the use of various questioning strategies, were frequently reported as a means to increase participation and to facilitate WCD. While questions were extensively used in nearly all of the observations, the simplistic nature and limited scope of the questions I observed lead me to be concerned with the overall effectiveness of the questions. Perhaps one of the most alarming discoveries was that only two of the nine teachers talked about using questions that would probe students’ thinking by asking them to justify a comment, even though they also reported that WCD was useful in identifying misconceptions. If all teachers do is ask questions that have obvious answers, or questions that can require a response of an agree/disagree, yes/no, or a nod of the head
then there is no way to determine what the students actually know. There needs to be more than just asking “a whole lot of questions” or a repetitious use of “why,” as Warren (personal interview, May 13, 2010) and Jasmine (personal interview, April 20, 2010) reported, to create more complex discursive interactions. Teachers need to know what kind of questions to ask along with when and how to follow up with additional questions that probe students thinking.

Freedman (1994) suggested using open-ended questions, or questions that allow for interpretation and creativity in generating a response, as a beneficial means of assessing student understanding through writing; these types of questions provide insight into what students know, how they know it, what they may misunderstand, and where students’ strengths and weaknesses may lie. Again, I believe that open-ended questions need not be limited to written response from students and should, in fact, be used frequently to promote relational understanding and more refined thinking skills when used during WCD.

With that said, there were few instances where this definition of open-ended questions was used to promote or facilitate WCD. Erin, when teaching divisibility rules, used an open-ended question to initiate the WCD. She asked, “What is probably the easiest divisibility test? If you can justify your answer I will take it. What do you think is the easiest?” Such a question allows for several different interpretations and Erin conveyed to the class that she expects them to be ready to justify their thinking. In the exchange that follows this (see page 123 from Chapter 4), a perfect opportunity arose for rich and meaningful WCD but Erin eventually answered her own question. The
questions were not used to promote thinking but were instead used to help the teacher move on to the next topic within the lesson. When I asked Erin during the follow up interviews what made her use of WCD effective, she reported that the students were talking about the mathematics. While Erin’s questions generated some discursive exchanges, she greatly limited the potential impact of the questions when she answered them herself. If questions allow teachers to support students’ understanding (Lobato, et al., 2005, Staples, 2007) through creative student interpretations (Freedman, 1994) then teachers should not be answering their own questions. Perhaps the most shocking aspect of Erin’s use of open-ended questions was that it was one of the best examples from the observations. Carrie and Samantha both reported that questions were important in facilitating WCD but their questions were generally simplistic and required little higher-level thinking skills. Again, the observed teachers beliefs, based on their interviews, did not coincide with their actual practice.

The next issue to consider is in learning how to probe students’ thinking through the use of questions. One should recall that while the teachers believed that it was important for them to share more of the leadership responsibilities of conducting and perpetuating WCD with the students, the teacher is still an integral member of the classroom. This means that, at times, the teacher cannot let some comments go unaddressed as they may provide opportunities to further develop deeper content knowledge. Teachers need to push student thinking via questions that ask for alternative justifications, non-examples, or ones that seem to challenge current understandings.
Such practices seemed to be all but non-existent in the interviews of all but two of the teachers.

Utilizing questions that probes students’ thinking is important for two reasons: one, it provides the teacher with a means to check for misconceptions, and two, it allows students to develop greater relational understanding as they make more complex connections to the content. The observed teachers, as well as the other interviewed teachers, were all advocates of WCD. Yet, most teachers did not report using questions as a means to challenge and probe student thinking; an important component in facilitating WCD (Bennett, In press). The teachers who were observed did, however, report that they could gain better insight into what students knew or misunderstood as a result of using questions.

Follow up questions were asked on a regular basis in both Erin and Carrie’s classrooms, but Carrie was the only one who would check with more than one student or probe several students’ thinking. That is, while Erin would ask a follow up question, it was open to whomever was the first to respond and then Erin would move on whereas Carrie would probe several students to try to understand the class as a whole more collectively. I am not implying that teachers need to probe students’ thinking, or several students’ thinking with every question, but they should be checking on a regular basis throughout the WCD to ensure that the intended curriculum is the curriculum that is being learned. Unfortunately, Samantha never used questions to probe students’ thinking; questions seemed to only be used to progress through the lesson quickly. In essence, questions and various questioning strategies, while reported as being effective
and a necessary component in facilitating WCD, were marginally used, at best, and were thus not as effective as they could have been in the observed classrooms.

*Utilizing Small Groups*

One of the strategies most commonly reported, and witnessed during the observations, was the use of small groups. When students were in small groups, the teachers believed that they were more likely to talk with one another; more students would participate in discourse because of their interactions within the small group. These teachers also stated that after students had an opportunity to talk within their groups then they would bring the discussion back into a whole-class setting. However, one of the issues with focusing on small groups for interactive student discourse is that small group discussions can only be summarized or synthesized, both of which can be valuable, but they cannot be recreated. As Larsen and Bartlo (2009) relate, for students, the reproduction of constructive and important small group discussion is “practically impossible for them. Students tend to focus on the results of their conversation, seldom on the process or pitfalls of those conversations (p118).” It is precisely these nuances, the process by which students generate and make mathematical meaning and the pitfalls that may lead them to incorrect assumptions, which are fundamental in creating relational understanding. This means that WCD can play an instrumental role in helping students construct relational understanding and should be capitalized upon. Small groups should not be the only means by which students interact with each other as valuable learning experiences are missed. Carrie (personal interview, May 13, 2010) stated that she could not always be sure that students were making the connections she had planned for them.
to make when the students were in small groups and thus she would use WCD in order to ascertain the connections they made.

Of the three teachers observed, Erin was the closest to utilizing small groups in a manner that supported WCD. At the beginning of each class period she would have several problems displayed for the entire class to see and each student was to work on solving these problems. Students could interact and discuss any of the problems with each other during this time and most of the students openly talked together. However, when Erin brought the class back together it was merely to go over the answers to the problems that they had just completed. There was no discursive exchange asking students to justify their solutions based on their work within the small groups. Furthermore, when small groups were used after an episode of WCD, Erin did not bring the class back together to review, summarize, or assess what had been shared during the small group discourse. In essence, small groups were not being used as reported.

As for Carrie, she also used small groups at the beginning of a lesson, just as Erin did, as an opportunity for students to talk together about the problems that the students were asked to complete. However, the students did not need to work together to come to a common understanding or to partake in a common experience to help them better understand the mathematics being learned and thus the effectiveness of the small group work was limited because student-to-student discourse within the small groups were again voluntary. Voluntary participation, as shown earlier, does not support the learning of all students; only those who wish to participate.
Samantha also used small group interactions in a similar fashion as Carrie; students were given problems to work on and the students were allowed talk to each other if they needed help. In doing so, I observed several of the same issues that were evident in Carrie’s classroom; only some students were talking about the mathematics. Furthermore, I witnessed many more students not talking about mathematics while they were in small groups but when I questioned Samantha about the effectiveness of the small groups in supporting WCD based on my observations she adamantly believed that the small groups were beneficial because the students were able to discuss the mathematics with others. What this means is that not only was Samantha’s implementation of small groups as a teaching strategy to facilitate and support WCD inaccurate with her practice, but her perception of how the small groups were interacting was also inaccurate.

It should not be construed that small group discourse is unimportant or less important. In fact, small group discourse can be an effective means of supporting WCD for the very reasons the teachers gave; students have opportunities to explore a concept and share in a common learning experience which provides them with a foundation from which further WCD can be explored. WCD is another valuable instructional tool to help all students in pursuit of learning mathematics and small groups can be used to achieve this goal. However, WCD cannot, and should not, be overlooked because another method is preferred. Small group discourse may be more effective in some situations but teachers need to be cautious in using only small groups to support student-to-student interactions. As Larsen and Bartlo (2009) remind us, there is much to be learned, by
teachers and students alike, about what students know through open and inclusive WCD. It is this informal, yet formative assessment of student learning that is the topic of the next section; the absence of WCD as a formative assessment tool.

Assessing for Learning

Assessing student understanding should be diverse and varied in format in order to better determine what students know and are capable of doing as well as recognizing where misunderstandings might exist. Yet far too often assessments are viewed as evaluations; this need not be the case. According to Davies (2000), assessments provide meaningful information to the teacher and student alike on how learning is progressing within the classroom; the three observed teachers also held this belief. Often assessments are thought of as work that is graded, scored, or otherwise collected to provide feedback to students, but WCD is another method by which students and teachers can obtain meaningful information as to what students know and can do. For decades, the NCTM has been vocal in recommending that teachers of mathematics use a variety of sources, not just “traditional” tests and quizzes, to assist in providing a more comprehensive picture of student learning. This recommendation thus implies a call for various forms of assessments to aid in the understanding of student learning, one of which is formative assessment during the lesson or other learning experiences that occur within the class period.

Utilizing Formative Assessments

Formative assessments are a way in which students and teachers can determine the extent to which students’ learning matches the learning goals set by the teacher and
can thus be acted upon to alter, improve, and/or plan for learning situations in the near future. Stiggins (2002) indicates that formative assessment’s primary purpose is to assess for learning rather than an assessment of learning. In other words, the focus of assessments should determine students’ misunderstandings so that the teacher can make immediate instructional adjustments to help the students better understand the content or specific procedural knowledge. Only a couple of the teachers interviewed suggested that WCD could be used to elicit this type of information about student learning, but nearly all of them said that the use of WCD was beneficial in that students could hear what other students are thinking. And while it is highly desired that students interact with each other through WCD, the teacher plays a valuable role in that they are content experts. If the teacher lets students talk without determining the accuracy, validity, creativity, and appropriateness of students’ responses, then one may wonder what the purpose of the teacher is. The teacher cannot simply create an opportunity for students to talk without assessing what students know and providing insights or additional questions to challenge their thinking.

It is likely that most of the teachers in this study do assess students’ learning during WCD. However, when one considers that their typical discursive interactions tended to follow an IRE process and usually only included voluntary responses, only a select few students’ learning will ever be assessed at any given time. In doing so, the teacher misses out again in learning what the majority of the students understand about the topic. If the understanding of only a few students is sought then small group discussions with the teacher would seem like a good choice, but small group discourse
was not what the teachers were describing. Ultimately, assessing what students know, or may not know, is fundamental in providing meaningful and adaptive instruction and this is precisely what WCD creates; opportunities for everyone in the classroom to learn and opportunities for the teacher to assess student learning.

Traci, Ben, and Jasmine mentioned that WCD should not be used when a concept is deemed confusing by the students or when it is a new concept. I would argue that this is an ideal time to facilitate WCD because misunderstandings can be identified and remedied early on, connections can be made to previous learning, and students can support each other in developing relational understanding as they ask questions of each other and explore new ideas that they generated. In each of these instances, the teacher is provided with numerous opportunities to assess student learning and help them better understand the content. If a topic is confusing, and students are able to understand how their interpretation is skewed or incorrect, then the students further develop perspective, one of the six facets of understanding, and will thus have a richer understanding of the concept. Essentially, if teachers limit the methods by which they assess student learning, they are also overlooking avenues in which students might be better able to demonstrate their learning (Gardner, 1983; Kohn, 1993; NCTM, 2000; Tomlinson, 2008).

Furthermore, from a more global perspective, when teachers miss opportunities to assess for learning, and thus miss opportunities to make adjustments to their planned instruction and the curriculum, they are also not able to meet the students’ needs as effectively. Chappuis and Chappuis (2008) state that the assessment process must be a diverse, flexible, and integral component of the curriculum and instruction that focuses
on assessment for learning, wherein teachers and students are using information to enhance teaching and learning in real-time. There are few assessment opportunities for learning that benefit all students in a more real-time than WCD.

Stenburg (2008) insists assessments that focus on narrow skills and basic memory recall do little to help students learn what strengths they do have and how to capitalize on these strengths to further increase their learning. Yet, this is often what happened with the observed teachers as they attempted to implement WCD using an IRE process. Student responses were frequently short, simple, and lacked complexity. Erin and Carrie occasionally asked a student if they agreed with a previous student’s response but, even then, students rarely had to support their perspectives; a short response was sufficient for the teacher. When WCD is utilized within the classroom, more complex connections to the mathematics are made as students’ ideas are expanded upon, revised, and adapted to fit new understandings. The bridge from instrumental to relational understanding begins to be built but Willoughby (2010) states that developing mathematical understanding in this manner, instrumental first and then relational, is extremely difficult for students. In fact, many students may never develop relational understanding because they struggle in moving beyond rote operations and procedures. Students may not inherently make the connections between what they do well, especially if they do not vocalize their understandings, but with the assistance of the teacher who is the content expert and seeks to elicit responses from a wide range of students, students can better learn what strategies and methods are effective in doing mathematics. It is in this way that the teacher’s role is made more evident.
The teacher should not be a passive member of the classroom during WCD; they cannot simply sit back and watch as Jasmine reported. Nor should teachers be overly active. Teachers need to remember that their ideas and understandings are of value to students, but one of their primary roles as a facilitator is also to learn what students know and how to adjust the curriculum and instruction based on this assessment of student learning.

Shifting Responsibilities

When asked to describe the process by which the teachers facilitated WCD, the most common response was by asking a lot of questions. But again, these questions were commonly described as IRE type questions. Using the same strategies to meet the needs of diverse sets of learners is usually an ineffective means of supporting learning for all students. Tomlinson (2001), in talking about how to differentiate instruction, states that teachers need to “move away from seeing themselves as keepers and dispensers of knowledge and move towards seeing themselves as organizers of learning opportunities (p. 16).” Initially one might argue that WCD is not differentiation because everyone is partaking in a common experience. While the commonality of the learning experience is the same for the students, the process of relinquishing more of the intellectual authority of the classroom, on the teacher’s behalf, and placing more of that authority in the hands of the students, is one of the cornerstones of differentiation (Tomlinson, 2001).

Therefore, in order to create diverse learning situations within the classroom that meet the needs of all learners, opportunities must be provided that allow students to assume greater degrees of leadership. Tomlinson goes on to state that teachers who actively work
towards and create a differentiated learning environment also grow in their ability to
assess students through various means, create opportunities for students to investigate and
“own” ideas, and generate avenues by which students can express what they have learned
and know; traits that are also manifest in meaningful WCD.

WCD should be a student-centered phenomenon which means that the students
need to be the leaders within the classroom. Of the three teachers observed, Carrie was
the closest to shifting responsibilities to the students, but rarely did students ask questions
of each other. The teacher was still the hub through which all questions and comments
were funneled. One change that could have occurred is to refer questions back to the
students. That is, when a student asks a question, the teacher could ask the class to
respond without rephrasing it. In doing so, the teacher builds on the culture of
participation that is already established, assuming that it is established, and helps students
to learn how to interact with each other so that the exchange of ideas is no longer passing
through the teacher.

The teacher should not be the only one asking questions. Students should also be
actively engaged in asking questions to their fellow students as well as the teacher and
defending questions of comments made by others (Larsen & Bartlo, 2009). Questions
can be an effective manner for generating WCD (Roberts & Billings, 2009; Way, 2008)
but according to previous research (Bennett, 2010; Franke, Webb, Chan, Battey, Ing,
Freund, & De, 2007) teachers often struggle with asking appropriate follow up questions
that probe students thinking. This was certainly the case for the three observed teachers.
Samantha rarely asked follow up questions and when she did they were typically rote or
factual type questions that required basic or factual type responses. Erin frequently asked “why,” which is acceptable at times, but also does not help the student focus their thinking in a particular direction. Carrie asked follow up questions on a somewhat regular basis and the types of questions she would ask were a mix of simple or factual and ones requiring analysis or justification.

One way around the dilemma Samantha and Erin faced in asking appropriate follow up questions would be to invite different students to share their thoughts on another student’s response and provide justification to their perspective. In doing so, additional ideas, and the rationale supporting these ideas, are presented which could help take the place of the probing follow up questions that were not asked. Furthermore, more students would be engaged in the WCD thereby shifting the responsibilities away from the teacher and onto the student. Interestingly, this is exactly the process that Erin described and suggested in her initial interview but this practice was witnessed only a couple of times during the observations.

Another way in which teachers can begin to shift the responsibility away from themselves and toward the students is by utilizing more open-ended questions. Chazan (2000) states that frequently teachers present “problems” or “exercises” after new material has been introduced. “Since there are unambiguously correct answers to the problems, the purpose of doing a problem is for teacher and student to evaluate whether students have learned the presented material, not to uncover new material or create a discussion of students’ own mathematical ideas (p. 118).” Open-ended questions will, by nature, often allow for several different representations and thus generate more
opportunities by which meaningful WCD can occur; WCD that would be generated by the students based on their ideas, methods, and solutions.

Furthermore, every teacher believed that an indicator of meaningful discourse was the presence of some physical cue, an increase in the number of hands raised or students fidgeting, wishing to be called upon. To these teachers, this physical response was interpreted as though more students were participating, wanting to participate, or were willing to participate. Raising hands is perfectly acceptable, though some critics would argue that in actual discursive interactions people do not raise hands; they listen and then speak at an appropriate time (Kohn, 1993). Carrie described this as “listening intently.” None the less, for most students, raising hands to speak has likely been the classroom norm since they began kindergarten. Yet this simple act also raises some concerns that are not initially apparent. The problem is not that the students are following an orderly classroom procedure for taking turns, but in the fact that when they raise their hand, which was encouraged by all the observed teachers at some point, the expectation is that the teacher will identify who will participate. This means that the teacher is still central in determining who speaks and when they can speak and thus the responsibility for continuing the discursive exchange remains with the teacher as they remain the hub of the WCD. Okolo et al. (2007), who referred to this as a “wagon wheel” structure of discourse, found that such structures can still yield positive results in student achievement but the intellectual authority and decision making resides with the teacher, even though there is a growing body of research (Franke et al., 2007; Larsen & Bartlo, 2009; Mercer, 2008a; Roberts & Billings, 2009) that recommends that students play a more vital and
participatory role in their own learning. By funneling all comments through the teacher, as was evident with all three of the observed teachers, instead of encouraging and expecting other students in the class to initially respond, the flow and richness of ideas were limited to only the teacher’s intent and perspective. Such actions are diametrically in opposition to Kuhn’s (2005) discourse model.

In addition, by gauging the number of hands as being an indicator of meaningful discourse, the teachers only focused on quantifiable measures and not qualitative measures. It seems to me that an indicator of meaningful WCD should be in the quality of the responses and questions generated by the students as this demonstrates the development of relational understanding. The number of hands raised might be used as a means of determining the potential willingness of students to participate but it does not, by itself, stand as evidence for meaningful WCD which is a rich, complex, inclusive, and dynamic exchange of ideas between the students in the class to generate understandings.

In essence, Erin, Samantha, and Carrie’s perceptions of WCD were frequently self-contradictory or simultaneously incongruent. At times their perception and beliefs towards WCD matched their actual performance, practices that were also supported by the current literature in establishing inclusive learning environments through WCD, but the lessons that I observed showed that, more often than not, the perceptions they had of those performances were incongruent with their actual practice. In essence, their perceived reality was noticeably different from the reality of the classroom. This reality deficiency was evident throughout but one area in which Erin, Samantha, and Carrie each held strong beliefs was with respect to the shifting and sharing of intellectual authority
within the classroom. That is, each of these teachers strongly believed that it was their responsibility to ensure that students assumed more leadership roles when it came to initiating and perpetuating meaningful WCD, but I did not observe them making this shift in responsibility. I believe that their “wagon wheel” approach to facilitating WCD was the primary factor inhibiting this shift of responsibility because the teachers inadvertently established themselves as a necessary and essential component of every discursive exchange in a whole-class setting.

Creating Change

The purpose of this study was to determine middle level mathematics teachers’ perceptions of WCD and learn the strategies they use to facilitate meaningful WCD in their classrooms. One unanticipated result was that teachers’ perceptions would change during the course of this study. During several of the interviews (Ben, Carrie, Erin, Sarah, and Warren) the teachers made comments that they had not given much consideration to using WCD before this study in their classrooms; and for Ben not at all. Based on the teachers’ comments from the interviews, the teachers did not regard WCD as an actual teaching strategy as they did with small group discourse. I had no reason to suspect that their perceptions of WCD would not remain consistent through this study. For one teacher this was not the case.

During my first few observations with Erin, I noticed that there was a slight difference in how she was facilitating WCD when compared to her beliefs and perceptions from our initial interview. Specifically, Erin was adamant that students should not be directly called upon to participate if they do not wish to participate; she
said she simply would not put them in a situation that she deemed to be embarrassing or uncomfortable for them. Yet, on a few occasions, she did just this; she asked students who had not said anything in class to share their thoughts. It was not until our second interview that I understood her change in perspective and realized the extent to which our interactions influenced the results of this study.

During the second interview, I asked Erin to elaborate on how she came to her understanding of WCD. I was expecting her talk about her previous course work in her Master’s program, observations of other teachers, or possibly by attending other workshops or professional development opportunities. Instead, she said that she had been thinking a lot about our initial conversation, which occurred three months prior to the second interview, and how WCD can positively influence and impact adolescent students. Erin strongly believed that every student can contribute and add something to the WCD, but where she previously stated that she would not call on students, she now believed that when the teacher elicits a response from a student in a way that validates the student’s ideas, the student will also benefit affectively.

I went through most of my education as the quiet one and was more than willing to let the dominate students take over, but I think it is important to draw all students out. It only takes one right answer for the quite one to be willing to contribute again. (Erin, personal interview, August, 20, 2010)

Such a change in perceptions was certainly a surprise as habits and schemes which are rooted in personal experiences are not always easily modified. This is not to say that it was easy for Erin to modify her own perceptions, but as a result of making her
modifications, she was strengthening her classroom culture of participation. Even though Erin’s perceptions of her practice were not fully aligned to her actual practice, she had become aware of certain benefits for WCD as they relate to the affective development of adolescents and was actively working on implementing and improving upon her practice. For other teachers it will likely take more than just having a conversation about WCD, but Erin’s shift in perception is encouraging as it illustrated how one aspect of an educator’s practice can be transformed to be more inclusive to all students.

Recommendations

The population that seems likely to benefit the most from this study would be teachers themselves, but if other teachers misunderstand the term discourse as so many did in this study, then it seems unlikely that teachers would read the results of the study as the title includes the word discourse. Why would a teacher-generated framework for WCD be useful if discourse is something “bad” or the result of “something gone wrong?” With that said, other professionals within the field of education, be they administrators, classroom mentors, university faculty, or other personnel responsible for educating pre-service and in-service teachers will need to determine how they will utilize the findings from this case study to best meet the needs of the teachers with whom they work alongside.

Furthermore, Zhang, McInerney and Frechtling (2010) who examined the collaboration effects between in service science, technology, engineering, and mathematics teachers and university professors with content knowledge from the same fields of study, found that the in-service teachers reported learning more about teaching
pedagogy than they did about specific content knowledge. What this means is that educators and educational leaders who are in roles that provide professional development to current teachers are in a position to better help current teachers learn more about the benefits of WCD and various instructional methods by which teachers can effectively facilitate WCD even if the planned professional development is focused on content knowledge; teachers seem to be attuned to learning new instructional techniques regardless of the intended setting.

A second recommendation for educational leaders would be to provide on-going or more extensive professional development based on the methods Sarah learned during her undergraduate studies. Sarah talked about having to create and present a lesson based only on the use of questions. That is, the teacher had to create a lesson and help the students attain the learning goals established in this lesson but could only do so by asking questions. If teachers were provided on-going support, via mentoring, and had multiple opportunities to practice and refine this technique it seems likely that they would also become better at asking questions that required higher order thinking skills and thus more effectively probe and assess students’ thinking.

Furthermore, the teachers in this study emphasized the use of small group work for adolescent learners; an instructional technique well supported by research. However, there is also ample research supporting the use of WCD and thus teachers should be implementing this type of instructional technique as well to help all students learn mathematics. The primary problem lies in the fact that the framework for WCD by which teachers operate did not always match the current literature or even their own
framework. Thus the problem is two-fold: 1) even those teachers who strongly held that WCD was beneficial in helping all students learn mathematics only marginally implemented WCD, and 2) these teachers were unaware of the discrepancy in their practice. Unfortunately, marginally discursive habits and practices were all that I ever witnessed.

The teachers’ discursive interactions were more aligned with IRE structures wherein the teacher asked a question, received a response from a student, and then evaluated and replied to the student’s response. IRE structures can be an effective method for teaching and learning mathematics, but if questioning is limited to factual information or requires few higher order thinking skills, then the possible benefits of WCD will not be realized. Perhaps there has been a greater push towards implementing practices that are viewed as being more innovative. Such practices may be perceived as a welcome break from familiar instructional techniques, for example, stand-and-deliver. Thus unfamiliar practices like small group work may be becoming more prevalent. Regardless, the teachers in this study seem to better understand how to support and facilitate small group discourse than WCD. Thus, WCD seemed to be the proverbial ugly step child; few of the teachers saw the beauty and strengths of WCD and those who did were either reluctant to use it or implemented less inclusive, IRE type versions of WCD.

Secondly, with respect to adolescent development, WCD has the potential to support individual learners affectively, as well as cognitively, if a classroom culture of inclusion and expected participation is created and supported by the teacher. Teachers, both pre-service and in-service, should be encouraged to use Carrie’s strategies of wait
time beyond ten to twenty seconds and teachers should feel comfortable telling students to think about their responses because the teacher will be coming back to hear from them in a little bit. Also, teachers of adolescent learners should continue to be cognizant of the emotional changes that students often undergo during adolescence and recognizing that many may feel that they are on center stage with everyone critically watching them. Teachers should be aware that they may send a negative message to students whom they rarely ask to answer, even if they teacher’s reason is based on the perception that these students are shy, or not intellectually ready, or unsure of themselves. By not including these students in WCD teachers may begin to unintentionally alienate students; the precise opposite effect teachers strive to create. Validating students’ efforts in a one-to-one situation is important, but sometimes, maybe not every time, students need to be validated in front of their peers; each student’s ideas matter and each student should feel this at some time.

Shifting the practice of in-service teachers is not always easily accomplished (McKeown, & Beck, 1999). Therefore, I recommend that pre-service teachers have experiences that help them learn how to facilitate WCD in a way that places students at the center of the discourse. One way in which this may initially be understood and implemented is through the use of Socratic seminars though ultimately the discourse should shift to a more maieutic structure (Roberts & Billings, 2009). Interested teachers may access literature on Socratic Seminars (Chorzempa & Lapidus, 2009; Chowning, 2009; Polite & Adams, 1997; Tanner & Casados, 1998) as a means of creating student-centered learning environments in order to help their students reap the benefits of WCD.
Limitations

As with most case studies the findings are based on a small sample of subjects whose stories have been based on a limited number of observations and responses. Furthermore, perceptions, by nature, are not permanent or fixed and thus it is possible that the perceptions held by these teachers have greater variability than those perceptions reported in similar studies conducted using other forms of empirical research. In fact, a few of the teachers interviewed expressed that their understanding of WCD changed from the beginning of the interview to the end. Ben initially thought that one could not conduct WCD in a mathematics class, but by the end of the interview questioned even his own beliefs. In essence, perceptions are likely to change over time and thus with continued research within this area of mathematics education, it is possible that the teacher-generated framework described will change as well over time. Though, with the emphasis placed on WCD from the leading professional communities, such as the NCTM, over the last few decades and with teacher practice not matching the professional community’s call to action, it is questionable how quickly this framework will change.

Furthermore, this study’s purpose was to better understand teachers’ perceptions of WCD in helping all students learn mathematics. And while classroom observations were conducted to determine the extent to which the teacher-generated framework of their attempts to implement WCD matched their actual practice, further research should be conducted examining their practice over time with respect to this framework. That is, a more solidified understanding of their practice, and the WCD framework as well, would
likely become more evident if observational data could be collected and analyzed throughout an entire school year of for several school years.

Finally, it is likely that some of the findings from this study would have been different under different circumstances. Specifically, the teachers at New Town Middle School had just finished an extensive and exhausting school-based initiative in mapping the mathematics curricula for kindergarten through eighth grade with extensive detail on the various levels of understanding students may have with respect to the curriculum for a specific grade level. As a result, many of these teachers were unwilling to participate in the study beyond the initial survey though in subsequent observations and conversations unrelated to the study, it was clear to me that their perceptions and understandings towards WCD would have been beneficial to the study. Additionally, Samantha, who was one of the participating teachers in Phase Three, believed that she was a less effective teacher this year as a result of feeling ignored and marginalized at her new school as well as a result of personal circumstances unrelated to teaching. Even though Samantha’s reported perceptions of WCD and her descriptions of meaningful WCD in her classroom were incongruent, it is unclear from this study to know the extent to which her disenfranchisement with her school and her extenuating circumstances affected her practice during the observations.

Conclusion

This four phase study examined teachers’ perceptions towards WCD and identified instructional techniques used to facilitate WCD and found that there were often discrepancies between teachers’ perceptions of WCD and the description of their practice...
or between their perception of WCD and their actual practice. Phase One involved thirty middle level mathematics teachers from Hawaii public schools on the island of Oahu who were initially surveyed to identify teachers that placed a high value on WCD as an instructional tool to help all students learn mathematics. Phase Two included nine of the teachers from Phase One and these teachers were interviewed to create a more precise understanding of WCD and how it is implemented within the classroom; the TGF was based on these detailed interviews. Phase Three included three of the nine teachers from Phase Two who were observed for several class periods to determine the extent to which their perceptions of WCD coincided with their actual practice; the TGF was used to help analyze and understand the observational data. The final phase consisted of semi-structured interviews with the teachers from Phase Three to clarify emergent themes and answer new questions that arose from the observations.

This study identified specific roles, responsibilities, instructional techniques, and perceptions of WCD that the teachers had but also identified concerns in teachers’ understanding of WCD and discrepancies between the teachers’ reported beliefs towards WCD and in how they described WCD in their classrooms or in how they actually implemented WCD. These concerns and discrepancies included such things as being unfamiliar with or misunderstanding the academic language associated with WCD. Namely, believing that discourse was something negative or off topic; stating that WCD included all students but teachers only accepted voluntary responses from a few students; believing that WCD provided meaningful assessment opportunities but again only based student understanding on the responses of a select few students; and stating that students
should be leaders of the WCD but the teachers remained the hub through which student responses were funneled. Furthermore, teachers believed that students, and their ideas, should feel valued within the classroom and thus have a sense of belonging to the classroom; tenets of strong a middle level philosophy. However, many teachers also deliberately excluded students from WCD because the teacher believed the student didn’t want to participate. Teachers cannot claim to have crated a classroom that is inclusive and supportive of students unless all students are welcome and participate. Thus, another contradiction arose between teachers’ perceptions of WCD, as it relates to students’ affective development, and the teachers’ described or actual practice.

Despite these concerns, promising change was found in the classrooms that strove to create cultures of participation. In the observed classrooms that created cultures of participation or had elements that supported a culture of participation, students were not only expected to participate and contribute to the mathematical understandings that were generated, but were invited, encouraged, and sometimes chosen to participate based on various methods. The teachers in these classrooms recognized the benefits of WCD and created classroom norms to reap these benefits. One teacher, Erin, shifted her perception about WCD because she realized the confidence, success, and self-efficacy that is nurtured for students who typically do not participate voluntarily when they have opportunities to share their thoughts and to have these ideas validated by the teacher and their peers. As a result, there was a change in Erin’s practice that reflected the change in her perceptions.
This study has shown that examining teachers’ perceptions with respect to WCD has revealed surprising discrepancies between teachers’ beliefs and their practices. This study also identified a TGF that supported the facilitation of WCD so that more students could be actively engaged in generating mathematical understandings. Furthermore, this study supports Larson and Bartlo’s (2010) recommendation that classrooms should shift from structures that are teacher-centered, wherein the teacher is the primary source of knowledge, to student-centered that require all students to be active participants in the learning of mathematics. Mathematics should be a collaborative social endeavor that is inclusive of all adolescent learners; it should be explored, digested, and realized within a learning environment that places students at the forefront (Okolo et al., 2007; Roberts & Billings, 2009; Van de Walle et al., 2010). While this study is limited, cases of this sort assist in constructing theory and methods that support future research into the perceptions and instructional techniques used to facilitate inclusive whole-class discourse. Further research into the interaction and relationship between teachers’ perceptions of WCD and the instructional tools and strategies they use to implement and facilitate meaningful WCD will help create a more precise understanding of this phenomenon.
Appendix A

Whole Class Discussion Questionnaire

The purpose of this questionnaire is to better understand teachers’ perspectives towards whole class conversations. You do not have to participate but your expertise and opinion are greatly appreciated. All of your information will be kept confidential and your contact information will only be used to contact you later on if I have more questions for you.

Please circle one number that is the closest to your belief.

1. It is important for students to talk about mathematics as an entire class.

   1  2  3  4  5
   Strongly     Neutral    Strongly
   Disagree           Agree

2. When the whole class has a discussion about mathematics it can be more beneficial than in small groups.

   1  2  3  4  5
   Strongly     Neutral    Strongly
   Disagree           Agree

3. I feel that I can comfortably facilitate discussions with the entire class.

   1  2  3  4  5
   Strongly     Neutral    Strongly
   Disagree           Agree

4. I plan for whole class discussions (circle one):
   A) Nearly daily          B) About one to two times a week
   C) About once every two weeks   D) Once a month or less
Appendix B

Semi-structured Interview Questions on Discourse

(1) How would you describe discourse?

(2) What does discourse mean to you?

(3) Describe a situation where discourse is useful? What makes it useful?

(4) Describe how you see your role in classroom discussions?

(5) How do you know when meaningful discourse is occurring? Can you describe what it looks or sounds like?

(6) Describe the difference in your capability to facilitate discourse now compared to when you first started teaching?

(7) How do teachers describe meaningful discourse in their classroom?

(8) How do you get your students to talk to each other during a whole class discussion?

(9) How do you include those students who tend to more quiet in the conversation?
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