The Intersection of Middle-Grade Teachers’ Beliefs Regarding Mathematics and Adolescents

Dissertation

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Abstract

The aim of this study was to gain an enhanced understanding of middle-grade teachers’ beliefs about adolescents and teaching mathematics. The participants were three veteran middle-grade teachers in different school districts who were purposively selected by the researcher. Data collection methods included semi-structured interviews, observations of local contexts, and written responses from the participants. In the data analysis phase, an interpretive approach was used.

From the data analysis, four themes emerged: 1) Teachers’ expressed beliefs about adolescents’ mathematical learning are not necessarily borne out in their pedagogical practice; 2) Confronting their own folk beliefs about adolescents’ mathematical learning allows teachers to consider alternatives to those beliefs, and can influence their teaching practice. In the absence of this confrontation or without impetus for change, teachers will be more likely to abandon thoughts of changing their pedagogical practice; 3) Teachers have firmly embedded traditional beliefs about mathematics instruction, although they may co-exist with student-centered views; and 4) Teachers recognize adolescents’ individual differences and needs but do not necessarily act upon those differences and needs in their instruction.

The findings from this study have implications for middle-grade teacher education and teacher beliefs literature. The study suggests the need for further research on teacher beliefs about adolescents influencing teaching practice.
Dedication

This dissertation is dedicated to Steve, Judy (mom), Sophie, and Maddie, who supported me every step of the way, and to my friends Debbie, Sherry, Kami, and many others, who have encouraged, guided, and tolerated me over the past four years.
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CHAPTER 1: INTRODUCTION

In 1989 and again in 2000, The National Council of Teachers of Mathematics (NCTM, 2000) promoted mathematics principles and standards, which called for teachers to integrate content and process standards into their classrooms. The content standards included number and operations, algebra, geometry, measurement, and reasoning and proof. The process standards included problem solving, reasoning and proof, communication, connections, and representations. The NCTM framed the teachers’ role to be one of choosing worthwhile problems and mathematical tasks, as well as allowing students the time to reflect and communicate as part of the mathematical process. The NCTM promoted “the opportunity for students to experience mathematics in a context” (p. 66) outside of the math textbook.

In order to teach students not only the mathematical content, but also the processes that The NCTM promotes, “effective teachers need to understand what students know and need to learn, and then challenge and support them to learn it well” (NCTM, 2000, p. 16). Mathematical content knowledge is imperative, but it is only one kind of knowledge needed for teachers. It is also essential that teachers have knowledge about the challenges students are likely to encounter in learning these mathematical ideas, as well as knowledge about how students’ understanding can be assessed (National Council on Teaching and America’s Future, 1996). In their
standards, The NCTM promoted pedagogical knowledge, “which is what is acquired and shaped through the practice of teaching, [and] helps teachers understand how students learn mathematics” (NCTM, 2000, p.21).

Understanding how students learn mathematics requires some understanding of how children develop. In addition to a good comprehension of mathematical content, middle grade teachers also need to have an understanding of adolescents within the mathematics classroom. My study examined the intersection of middle grade mathematics teachers’ beliefs about adolescents and observation of their actual teaching practices.

Booker (1996) agreed with NCTM’s principles and standards, and promoted a more constructivist approach in the mathematics classroom. Booker discussed the differences that constructivism offers, and suggested that the “sharing or exchanging of mathematical thoughts and ideas is dynamic, reflecting a continually changing fit between the meaning-making of active interpreters of language and action, rather than as the result of a conduit from teacher to learner” (p. 382). Most importantly to my current study, Booker stated that in order for teachers to assist in this constructivist process of learning, they needed to have a good model of cognitive development in the specific area of mathematics so that they can understand the learner’s conceptions.

Background of the Study

Some teachers have definite beliefs regarding child development and it is noticeable in their teaching. Some teachers may not know that they have certain beliefs regarding child development, but it does show in their teaching (possibly
unconsciously). Other teachers may not have any beliefs regarding child development, and this may also be shown in their teaching; they may just teach without any regard to how children are developing.

Research suggests that teachers’ beliefs and values about teaching and learning affect their teaching practices (Bandura, 1993; Beswick, 2006; Pajares, 1992; Woolfolk Hoy & Davis, 2005). Influencing teachers’ beliefs, therefore, may be essential to changing teachers’ classroom practices (Stipek et al, 2001). Influencing mathematic teachers’ beliefs about adolescents may also be essential to developing their understanding of teaching in an inquiry-based manner. If teachers have deeply held beliefs about children and adolescents and these beliefs are enacted in the learning environments they create, then the teachers’ enacted beliefs through their construction of the classroom and school environment would have a substantial impact on the overall adolescent experience (LeTendre & Akiba, 2001).

When teachers move towards a more inquiry or reform-based practice, a practice based on all children’s learning of mathematics with understanding, they are opening themselves to learning and growth in their practice. This growth should include gaining a better understanding of child development (NCTM, 2000). Without developmental understanding, inquiry-based mathematics will not make much sense, as this type of teaching calls for an understanding of where each individual child is functioning at any given time (Heibert, 1997). Teachers’ beliefs about child development and how development relates to the nature of mathematics can affect how they view their roles as teachers, the role of students, the choices of classroom
activities, and their pedagogy. Research has shown (Mewborn & Cross, 2007) that teacher’ beliefs about the nature of mathematical understanding and knowledge, and how students learn mathematics, affect teaching practices.

Statement of the Problem

Why do the relations between teacher beliefs, mathematics, and adolescents merit study? Beliefs are presumably important because they affect teacher behaviors, and it is the teachers’ behaviors that affect the child’s development (Miller, 1988). I suggest that if middle grade mathematics teachers take an interest in reform-based mathematics, which requires inquiry-based instruction, they may also gain a better understanding of how adolescents develop. I also suggest that teachers who have a good understanding of adolescents may be more open to reform-based mathematics teaching. By examining middle child mathematics teachers’ beliefs, I hoped to ascertain how beliefs might affect teacher practice or vice versa.

There exists research on teacher beliefs and how those beliefs affect their practice (Bandura, 1993; Pajares, 1992; 2001; Strauss, 2001; Wood, Cobb, & Yackel, 1991; Woolfolk Hoy & Davis 2005). There is also research on teacher beliefs about the nature of mathematics (Beswick, 2006; Carter, 1997; McDairmid, Ball, & Anderson, 1989; Stipek et al., 2001), and research on teacher beliefs about adolescents (Eccles & Midgley, 1989; Miller & Davis, 1992; Strauss, 2001; Urdan, Midgley, & Wood, 1995). What appeared to be missing in the literature is what mathematics teachers believe about middle childhood development and how those beliefs affect their practice.
By piecing together different aspects of what is in the field at this time related to beliefs about adolescents and mathematics, I attempted to gain a deeper understanding of the intersection of reform efforts in mathematics and teachers’ understanding of adolescents.

The aim of this study was to gain an understanding of the intersection of middle grade mathematics teachers’ beliefs regarding adolescents and their actual teaching practices, acknowledging that the intersection may work in either direction. The purpose was to provide a view into middle grade mathematics teachers’ beliefs, to explore whether teachers’ understanding of adolescents may have had an impact on their teaching practice, or whether their teaching practice influenced their understanding of adolescents.

Research Questions

The research question that drove this study was: “What is the intersection of middle grade mathematics teachers’ beliefs about adolescents and their teaching practice?” The following sub-questions also guided this study:

- What are teachers' beliefs about mathematics instruction, in particular reform-based mathematics instruction?
- What are teachers’ beliefs regarding adolescents?
- What pedagogical aspects of the teachers’ practices do I observe in the classroom?
- What aspects of the classroom culture and lesson designs of the teachers’ practices do I observe in the classroom?
What is observed in the classroom or interviews that shows an intersection between the teachers’ beliefs about adolescents and their teaching practice?

Theoretical Framework

This study was primarily grounded in the theoretical frameworks provided by the sociocultural and constructivist perspectives. I begin by exploring the sociocultural perspective and then will examine the constructive perspective.

Sociocultural Perspective

The sociocultural approach studies how cultural practices relate to the development of ways of thinking, remembering, reasoning, and solving problems (Rogoff, 2003). Vygotsky (1978), a leader in this approach, pointed out that children and adults in all communities are cultural participants, living in a particular community at a specific time in history. This study particularly looks at middle grade mathematics teachers in their community of practice.

Understanding development from a sociocultural perspective requires examination of the cultural nature of everyday life. This includes studying “people’s use and transformations of cultural tools and technologies and their involvement in cultural traditions in the structures and institutions of family life and community practice” (Rogoff, 2003, p. 10). The overarching perspective for understanding cultural processes, which Rogoff suggested, is that “humans develop through their changing participation in the sociocultural activities of their communities, which also change” (p. 11).
Even though development is often thought of as individual, cultural research has suggested that thinking involves interpersonal and community processes as well as the individual processes. The study of children’s cognitive development includes attention to how people come to understand their world through active participation in shared events with other people (Rogoff, 2003).

From the sociocultural perspective, cognitive development is not the acquisition of knowledge or skills, but a shared process of transformation when people participate in activities together. Mathematics teachers cannot give information to their students if they are to learn the material for understanding, rather the cognition will occur through participation in an activity and from building on previous knowledge. Rogoff (2003) stated, “seeing connections between the old and the new situations often involves support from other people or institutions pointing out similarities. People may not see the underlying similarities unless someone suggests that the problems resemble each other” (p. 13).

According to Vygotsky’s sociocultural view, it is imperative that we understand the nature of the environment in which a child or adolescent develops in terms of the environment’s demands for intelligent behaviors and its opportunities for learning (Steinberg, 2008). Vygotsky stated, “Individuals develop and use intellectual skills not simply as a function of their cognitive maturation, but in response to everyday problems they are expected to solve” (p. 81). For example, children who perform poorly on school-based mathematical tests of knowledge may excel when faced with equally challenging tasks in the real world (finding a route to school,
making monetary transactions with customers) (Carraher, Carraher, & Schliemann, 1985). This means that when we understand the everyday environment in which a child develops, we can better respond to that child’s needs.

The sociocultural theory applies in mathematics, as well any content area. The way people solve mathematical problems relates to the purpose of their calculations and the availability of familiar tools, as Rogoff (2003) stated, “Mathematical tools and skills are not all-purpose; rather they are adapted to circumstances” (p. 262). Rogoff also noted that when vendors or carpenters use mathematics for practical purposes they rarely come up with inaccurate or insensible calculations. Yet, calculations made with the same type of problem in the context of a mathematics classroom will often result in erroneous or nonsense answers.

To summarize, sociocultural theory states that we not only understand the nature of the environment in which a child or adolescent develops, but also how participation with others and past knowledge all tie together. These aspects help us understand how people develop through their changing participation in the sociocultural activities of their communities. By looking through the sociocultural lens of the environment of a mathematics classroom, how the teacher participates in that environment, and how he or she allows the children to participate in it, I will be able to better explore the intersection of middle grade mathematics teachers’ beliefs about adolescents and their actual teaching practice.
Constructivist Perspective

This study will also be grounded in a constructivist framework. This theory emphasizes that teachers guide students in constructing their own mathematical knowledge. Teachers who believe that children learn mathematics by constructing their own understanding in the process of solving problems spend more time developing the skills before teaching facts compared to teachers who believe that mathematics is learned by receiving knowledge about mathematical operations from the teacher (Carter, 1997). Beswick (2006) argued that a set of beliefs about the nature of mathematics seems to be related to teachers’ ability to create classroom environments that can be described as constructivist.

Piaget, through his constructivist approach to children’s cognition, made an impact on mathematics classrooms today. Carr and Hettinger (2003) commented on constructivism:

Constructivist theorists view mathematics strategy development as embedded within developing schemes and cognitive structures about mathematics. Strategies develop as a function of children’s emerging knowledge about mathematics, in particular, the internalization of number as a symbol and emergence of more abstract schemes about number (p. 47).

Booker (1996) discussed constructivism in the mathematics classroom: “[constructivism] suggests that the sharing or exchanging of mathematical thoughts and ideas is dynamic, reflecting a continually changing fit between the meaning-making of active interpreters of language and action, rather than as the result of a conduit from teacher to learner” (p. 382). He continued to say that in order for teachers to assist in this constructivist process of learning, they needed to have a good
model of cognitive development in the specific area of mathematics so that they can understand the learner’s conceptions.

Although a constructivist view of learning mathematics has been commonly accepted by researchers and mathematics educators alike, “learning mathematics in school still continues to be dominated by the traditional transmission of knowledge” (Wood, Cobb, & Yackel, 1991, p. 601). In the mathematics classroom, the constructivist view of learning differs considerably from traditional approaches, in that children are considered to be active creators of knowledge. Children also create new mathematical knowledge by reflecting on their physical and mental actions (Piaget, 1978). Similar to the sociocultural perspective, the constructivist view also has the underlying assumption that “learning is a social process in which children grow into a community, and that mathematical ideas are cooperatively established by the members of this community” (Wood, Cobb & Yackel, p. 600). Finally, the constructivist perspective provides for opportunities for learning to occur during “social interactions that involve collaborative dialogue, explanation, justification, and negotiation of meaning” (p. 591).

To summarize, I used the constructivist perspective to assist me in understanding how teachers guide students in constructing their own mathematical knowledge. From this perspective, instead of teachers providing students with knowledge, constructivists believe that children learn mathematics by constructing their own understanding in the process of solving problems.
Theoretical Perspective of this Study

My theoretical perspectives stem from 16 years of teaching mathematics, as well as studying mathematical content and mathematical pedagogies. Part of my perspective is acquired from the sociocultural perspective, wherein I believe that cognitive development is not the acquisition of knowledge or skills, but a shared process of transformation where people participate in activities together. In the mathematics classroom this looks like students working collaboratively on rich problems, sharing ideas and knowledge as the teacher purposely plans such activities. Another part of my theoretical lens, from the sociocultural viewpoint, acknowledges the importance of looking at the communities in which children are learning. How the teachers, the students, the parents, the administration, and the state, are all participating in that learning environment is significant to the growth of all involved in that community.

My theoretical perspective also stems from the constructivist viewpoint. I believe that teachers need to help their children learn mathematics by constructing their own understanding in the process of solving problems rather than give students their own personal knowledge about mathematical operations. With this perspective comes the belief that children are active creators of knowledge; they create new mathematical knowledge by reflecting on their physical and mental actions.

In summary, educators and researchers often take advantage of both the sociocultural and constructivist theories of cognitive development in their approaches to teaching and learning. Both of these theories maintain that teachers serve as
important organizers, guides and supporters of learning (Arnett, 2007). Piaget argued that cognitive development involves major transformations in the way knowledge is organized. Vygotsky believed that cognitive development represents changes in the cultural tools that children use to make sense of the world (Meece & Daniels, 2008). Both of these theoretical perspectives helped to guide me as I observed mathematics teachers, their teaching practice, and their beliefs about adolescents.

Research Design

Spindler (1982) stated “qualitative work can shed new light on old problems and ask new questions that will make some of the old problems obsolete” (p. 4). Given the research questions and purpose of this study, my goal was to understand, interpret, and shed some new light on how the participants’ (the mathematics teachers) beliefs regarding adolescents affect how they teach mathematics. I did this using a qualitative case study with three veteran, middle-grade mathematics teachers.

By looking at three mathematics teacher behaviors via interviews, written responses and observations, my hope was to be able to ascertain how their beliefs on adolescents’ development impact their mathematical teaching. Qualitative research made this possible by looking at teachers’ behaviors within social and cultural contexts. As a qualitative researcher I studied these teachers in their everyday life, and I discovered situations that were not expected (Anderson-Levitt, 2006).

Data analysis was done with ongoing analysis and redesigning of the study (Anderson-Levitt, 2006). I used Erikson’s (1986) interpretivist approach which
suggested generating assertions, largely through inductions, then looking for confirming and disconfirming evidence by searching the data corpus.

Significance of the Study

This study contributes to research, theory, and practice in middle grade mathematics and adolescents. By using a case study approach, I targeted a gap in the research on how middle grade mathematics teachers’ beliefs on adolescents affect their teaching practice. Much of the research done on teacher knowledge and beliefs has been quantitative in nature and has focused on “implicit and explicit knowledge and beliefs of preservice, novice, and experienced teachers to identify beliefs and to examine how knowledge and beliefs affect learning to teach” (Woolfolk Hoy, Davis, & Pape, 2005, p. 715). There is currently no research on this exact topic, although there is research on teacher beliefs and how those beliefs affect their practice. There is also research on teacher beliefs about the nature of mathematics and about teacher beliefs concerning adolescents.

In this study, I integrated what is in the field at this time related to beliefs about adolescents and mathematics, and also attempted to shape how this could inform middle grade mathematics teachers. Additionally, I discussed how reform efforts in mathematics require constructivist-influenced, inquiry-based teaching, and how that type of teaching requires an understanding of how children develop.

Overview of the Dissertation

This dissertation is divided into five chapters. In Chapter 1, I introduce my research by presenting background information of the study and discussing the
importance of teachers’ beliefs on their teaching practice, and the importance of
inquiry/reform-based mathematics instruction. In Chapter 2, I present a review of
literature related to teacher beliefs affecting their practice, teacher beliefs about
mathematics, and teacher beliefs about adolescents. Chapter 3 presents the research
design, methods, and participant selection, as well as data collection and analysis
methods, and ethical considerations of the study. In Chapter 4, I discuss the themes
that emerged from inductive analysis. In conclusion, Chapter 5 addresses the findings
based on existing literature, the implications for research, and recommendations for
future research.
CHAPTER 2: REVIEW OF LITERATURE

This chapter will provide an examination of what has been studied regarding teacher beliefs, as they relate to mathematics and adolescents. I begin with an overview revealing the conceptual framework of this study. Then, I will present research on how teacher beliefs affect teacher practice. Third, I will examine teacher beliefs about mathematics. Next, current literature will be presented regarding teacher beliefs about adolescents. The last section will be devoted to a discussion summarizing teacher beliefs regarding adolescents in the mathematics classroom.

I am interested in the intersections between teacher beliefs, mathematics, and adolescents. Beliefs are presumably important because they affect behaviors, and behaviors affect a child’s development (Miller, 1988). I suggest that if middle grade mathematics teachers take an interest in reform-based mathematics, which requires inquiry-based instruction, they will also need to better understand how adolescents develop. In other words, will an understanding of adolescent cognitive development help teachers in their practice, or will reform-based teaching practices help teachers understand more about adolescent cognitive development? This literature review will look at these questions as they relate to what middle child mathematics teachers believe regarding adolescents: how teacher beliefs affect their practice, what are teacher beliefs about the nature of mathematics, and what are teacher beliefs about adolescents.
Research (Ball, Hill & Bass, 2005; Fennema & Carpenter, 1996) has shown that when teachers move towards a more inquiry or reform-based practice, a practice based on children’s learning of mathematics with understanding, they are opening themselves to learning and growth in their own practice. This growth should include gaining a better understanding of child development. Without developmental understanding, inquiry-based mathematics will not make much sense, as this type of teaching calls for an understanding of where each individual child is functioning at any given time (Hiebert, 1997). Teachers’ beliefs about child development and how those beliefs relate to the nature of mathematics can affect how the teachers view their roles as teachers, the role of students, the choices of classroom activities, and their pedagogy. Research (e.g., Mewborn & Cross, 2007) has also shown that teachers’ beliefs about the nature of mathematical understanding and knowledge, and how students learn mathematics, affect his or her teaching practices. My research examined teacher beliefs in a different manner by exploring the intersection between teacher beliefs about adolescents and the practice that is actually occurring in the mathematics classroom.

![Diagram](image-url)

**Figure 1.** The solid lines show what has been studied, while the dotted line shows what is missing in the research, and what my research examined.
In this literature review, I explore research that has been conducted and show how my research adds to this research base. I begin by examining research on beliefs about teaching and learning, and how those beliefs affect teacher practice; I then examine teacher beliefs about mathematics; I end with an examination of teacher beliefs about adolescents.

Teacher Beliefs about Teaching and Learning

Research suggests that teachers’ beliefs and values about teaching and learning affect their teaching practices (Bandura, 1993; Beswick, 2006; Pajares, 1992; Woolfolk Hoy & Davis, 2005). Influencing teachers’ beliefs, therefore, may be essential to changing teachers’ classroom practices (Stipek et al., 2001). Influencing mathematics teachers’ beliefs about adolescents may also be essential to developing their understanding of teaching in an inquiry-based manner. If teachers have deeply held beliefs about adolescence, their construction of the classroom and school environment would have a substantial impact on the overall adolescent experience (LeTendre & Akiba, 2001). Meece and Daniels (2008) documented the effects of teachers’ perceptions of adolescents: when teachers believe that adolescents are hormone-driven and are out of control, their classroom environment will mirror those beliefs, and students will tend to behave in the manner expected of them by such teachers. On the other hand, when teachers believe that adolescence is a time of biological, social, environmental, and cognitive change, they are more likely to construct their classroom to guide students as they go through these changes (Meece & Daniels).
Over the past 30 years, research on teacher beliefs suggests that a higher sense of efficacy for teaching is related to many positive learning and instructional outcomes (Woolfolk Hoy & Davis, 2005). Some of these positive outcomes include: student achievement, motivation, and students’ own sense of efficacy. It has also been found that “teachers with higher efficacy judgments tend to be more open to new ideas, and more willing to experiment with new methods to better meet the needs of their students” (Woolfolk Hoy & Davis, p. 120). Teachers with high teaching efficacy impact students, because teachers with a stronger sense of efficacy tend to exhibit greater levels of planning, organization, and enthusiasm. Past research on high teaching efficacy can help us to understand specifically what teachers of mathematics believe about child development. This topic is addressed in the following section.

Teacher Beliefs Affecting Teacher Practice

In this section, I begin by examining some evidence of teacher beliefs affecting their practice; I then look at changing teacher beliefs; I conclude this section by exploring how teacher beliefs affect student beliefs.

It is important to be able to assess teacher beliefs and to know how to affect them if we expect to improve instruction (Carter, 1997). It is clear from a substantial body of research that teachers’ beliefs influence what occurs in the classroom (e.g. Beswick, 2006; Carter; National Council of Teachers of Mathematics, 2000; Stipek et al., 2001). Beswick’s research included interviews, observations and belief surveys from secondary mathematics teachers and their students. She found that teacher beliefs do indeed impact the math classroom environment, and the students’
perceptions in these classrooms were similar to their teachers’ beliefs. For example, some teachers showed a belief in helping their students understand the nature of mathematics, not just showing the children mathematical procedures; these teachers also indicated that they had beliefs that their students were very capable of learning mathematics. In turn, the students of these teachers believed that they were responsible for the own learning, and that their classroom mathematical learning was connected with existing knowledge.

Similarly, Stipek, et al. (2001) studied 21 4th-6th grade teachers and students, using surveys, videotapes, and student evaluations. Her team found that teachers who had more traditional beliefs about mathematics teaching (for example, beliefs that telling children procedures to memorize was an appropriate way for children to learn mathematics) did indeed have traditional math practices. Those traditional beliefs emphasized student performance (i.e. getting the correct answer or getting good grades) and speed rather than mathematical processes.

Although the “form and intensity of the influence of beliefs vary by individual it could be concluded that teachers’ beliefs shape the way in which they teach” (Carter, 1997, p. 62). Similarly, Beswick (2006) stated that what appears to be important are the beliefs or principles motivating teachers as they implement whatever teaching strategies they choose. If we want teachers to choose strategies in line with reform-based, inquiry-based mathematics instruction, we need to understand how their beliefs, particularly about adolescents, are shaping what they teach.
Evidence that teachers’ beliefs do indeed affect their practice was found in Beswick’s (2006) study on teacher beliefs and practices as they relate to mathematics instruction. She stated, “it is perhaps not surprising that some teachers appear to believe that not all students can learn mathematics and thus place the responsibility for learning firmly with the students” (p. 18). Stipek et al. (2001) saw the same phenomenon with teacher beliefs affecting practice. The researchers found that when teachers believe that mathematics ability is stable and not very amenable to change, they then place an emphasis on performance rather than understanding. The more teachers believed they should “control instruction and the more they claimed to focus on correctness rather than understanding, the less likely they were to consider effort and creativity” (p. 217). Stipek et al.’s, findings indicated that teachers had a fairly coherent set of beliefs, and those beliefs predicted their instructional practice. For example, when a teacher believes in controlling instruction, her direct instruction and modeling indicates that students can only learn long division after she gives them the correct procedures for performing the operation the way she understands it, and then they can perform the operation accurately. This type of belief leaves little room for her children’s understanding the concept of division, how that particular algorithm was derived, why it works, or other ways that division could be done.

Case studies from Wood, Cobb, and Yackel (1991) provide more evidence of how teacher beliefs changed practices. Prior to the classroom experiment, the second grade teacher in their study provided her students with step-by-step instruction, and
then assigned them work, followed by pulling small groups of students who didn’t understand the day’s lesson and re-taught to that group. The researchers stated that when she directed the students’ thinking by revealing the solution bit by bit, “she was depriving the children of the change to think through the solution for themselves” (p. 605). In response, the children stopped listening and reverted to “participating in the traditional pattern of interaction in school in which their goal was to figure out her method, rather than thinking about mathematics” (p. 605). After learning to use the children’s thinking and not be as directive in her teaching, the teacher realized that it was okay for her students to struggle with conflict and confusion; this was actually providing an occasion for them to learn. With a shift in her beliefs about teaching mathematics to second-graders, the teacher came to realize that “children need to make sense of a situation in terms of their existing knowledge [instead of the teacher’s existing knowledge]” (p. 606, italics added).

Kynigos and Argyris (2004) found that teacher beliefs may be inconsistent with actions during classroom teaching practice. What they found during interviews about teachers’ beliefs was often in conflict with what was observed in the classroom. This relation (of beliefs and practice) was characterized by:

- complexity and unpredictability, and this raises the question of how is it more meaningful to perceive teachers’ beliefs … It raises the question of whether coherent belief systems are merely constructs we as researchers may use to interpret those of the teachers rather than actually being present and formative of teaching practice (p. 271).
This is not to say that teacher beliefs do not influence their practice, rather that we, as researchers, need to be careful that teachers’ expressed beliefs (i.e. surveys or interviews) are actually observed in the classroom.

Woolfolk Hoy, Davis and Pape (2005) discussed possible reasons why teachers do not always enact their beliefs. In their discussion on teacher beliefs, they noted several contextual influences (e.g. standards, accountability, classroom contexts, and students) that may prevent teachers from enacting their beliefs. For example, there exists the possibility that achievement tests may force teachers to teach in ways that do not fit their beliefs.

I have cited several cases where teacher beliefs did indeed affect teacher practice. Can those beliefs be changed? This next section examines that question.

*Changing Teacher Beliefs*

National standards such as the NCTM’s Principles and Standards for School Mathematics (2000) maintain that teachers should allow students to construct their own knowledge about mathematics. This is a vastly different belief system for many teachers of mathematics. From past reform movements it is evident that teachers do not change their beliefs simply because it has been recommended; a powerful reason for change must be present for change to occur (Pajares, 1992). Research indicates that teachers’ beliefs do not change much from the time they begin and complete pre-service education training programs. These beliefs are generally not influenced by readings or by being asked to apply findings of educational research (Stipek et al., 2001). Changing beliefs is extremely difficult and occurs over long periods of time.
Pajares (1992) commented, “people are adept at using evidence that would appear contradictory to a belief to support that same belief” (p. 307).

Teacher change can result in a greater understanding of how children learn mathematics and how they develop. When teachers gain a better understanding of their own beliefs and where these beliefs originated, and then are presented with alternative views about their pedagogy, their content, their beliefs about learning or development, they can see genuine alternatives because they can confront their folk beliefs (beliefs that we think are true because of past experience or because our culture believes them to be this way) and begin to teach differently (Strauss, 2001).

In order for any change to occur within a teacher, teachers must first be reflective and dissatisfied with what is happening in the classroom. Teachers must be aware that they are lacking math content, pedagogical knowledge, or child development knowledge, or that the knowledge they do have is inadequate. An important cognitive factor in most models of conceptual change is that “some level of metacognitive awareness seems to be necessary for change” (Patrick, & Pintrich, 2001, p. 130). Woolfolk Hoy, et al. (2006) stated that beliefs are changed in the same way that conceptual change is induced, through cognitive dissonance. It is suggested, therefore, that professional development aimed at changing beliefs should be geared toward creating dissonance by offering experiences where the teachers’ new understandings, from a teachers’ perspective, conflict with their experiences as a student. The same should be applied to preservice teachers; their coursework could be aimed more at creating conflict within themselves by offering experiences that may
differ from their own experiences as students. Gregoire (2003) stated that in order for belief change to occur, researchers and institutions cannot just look at changing practices alone:

To understand the process of change in teachers’ subject-matter beliefs and practices, researchers must take into account teachers’ emotional and affective reactions when presented with messages that contradict their preexisting subject-matter beliefs (p. 150).

In summary, teacher beliefs can be changed, although this is very difficult to accomplish. Next, I will examine how teacher beliefs actually affect students’ beliefs.

Teacher Beliefs Affecting Student Beliefs

Teacher beliefs are important because they have such a great impact on student beliefs. This impact can be seen in self-fulfilling prophecies, an expectation that is realized because teachers act in ways that make behaviors happen (Steinberg, 2008). If teachers believe that girls are poor in math, their teaching of girls may manifest that belief, for example, by not calling on female students or not giving them extra help because they believe the girls will not understand the ideas anyway. This can then affect the girls’ learning and perceptions of their abilities. Some of those females, then, will believe that they are poor in math. Additionally, if the girls are poorly taught and not appropriately challenged, they will likely perform poorly. This reinforces everyone’s belief, including the teachers’. Students who have high academic efficacy have “beliefs about their abilities that influence their actual achievement, which, in turn, shapes their beliefs about their abilities” (Steinberg, p. 410).

Teacher beliefs influence student beliefs, which impact student achievement. In a study of collective efficacy, Bandura (1993) found that students who were taught
by teachers with low efficacy “suffered losses in [their own] perceived self efficacy and performance” (p. 142). This was particularly true for students who already had a low opinion of their academic ability. The opposite also holds true. If a student is taught by a teacher with high efficacy, this helps to increase the student’s efficacy. Woolfolk Hoy and Davis (2005) stated this clearly: “In addition to being related to student achievement, teachers’ sense of efficacy has been associated with other student outcomes such as motivation and students’ own sense of efficacy” (p. 120).

I have established that teachers’ beliefs (about themselves and their students) do indeed affect their practice in the classroom. I have also shown that changing beliefs, although challenging, is what will help mathematic teachers move towards inquiry-based teaching, and ultimately gain a better understanding of adolescents. Next, I will examine teacher beliefs about the nature of mathematics.

**Teacher Beliefs about Mathematics**

In this section I will describe several aspects regarding teacher beliefs about mathematics: 1) how teachers guide or give during mathematics instruction; 2) teachers’ mathematical content knowledge; 3) teachers’ understanding of mathematical cognitive development; and finally, 4) teachers’ understanding of how children learn mathematics.

It is clear that what the teacher does in the classroom influences students’ beliefs about what they are learning in mathematics (e.g. Carter, 1997). It is also clear that what teachers believe about mathematics and the teaching of mathematics
influences what they do in the classroom. As Mewborn and Cross (2007) stated, teacher beliefs may be translated into students’ beliefs:

> Teachers’ beliefs about the nature of mathematics influence their beliefs about what it means to learn and do mathematics. These beliefs, in turn, influence their instructional practices, which dictate the opportunities that students have to learn mathematics. Ultimately, students’ learning experiences affect their beliefs about the nature of mathematics and how an individual learns and engages in the subject (p. 260).

I begin by discussing how some traditional teachers may be giving information to their students, while more reform-based teachers may do more guiding as they instruct mathematics to their students.

> Mathematics Teachers: Guiding or Giving?

Teachers who believe that children learn mathematics by constructing their own understanding in the process of solving problems spend more time developing the skills before teaching facts, than teachers who believe mathematics is learned by receiving knowledge about mathematical operations from the teacher (Carter, 1997). Beswick (2006) argued that a set of beliefs about the nature of mathematics seems to be related to teachers’ ability to create classroom environments that can be described as constructivist. She studied 25 secondary mathematics teachers and their students in 39 classrooms with surveys, interviews and observations, and found important relationships between the teacher’s beliefs and their students’ perceptions of their classroom environments. Even though the teachers had a variety of ways in which they implemented their classroom environments, Beswick found that it was their beliefs that influenced their classrooms in ways that their students could recognize. She stated that it was such beliefs, rather than particular teaching methods or materials
that mattered in terms of students’ perceptions of their classroom environment.

Beswick’s findings concerning the importance of teachers’ beliefs to the kinds of classrooms they create, highlight the importance of allowing teachers in preservice and in-service programs in mathematics education to reflect carefully on the beliefs that they hold about the nature of mathematics and about mathematics teaching and learning.

Teachers who scored higher on surveys regarding more traditional beliefs (beliefs that teachers give students the mathematical knowledge, usually via telling them what they need to know and how to do it) are less self-confident about teaching mathematics and enjoy math less than teachers who hold more inquiry-based views (Stipek et al., 2001). Teachers who are more open to new ideas in mathematics will likely be open to considering other research-based concepts, such as stage-environment fit (Anderman & Midgley, 1997), which is key to understanding adolescent stages and the environment they are in, especially in middle school. Teachers may gain this understanding about adolescents while they are learning such methods as inquiry-based teaching in mathematics, as these methods are based on understanding students’ cognitive processes.

**Teachers’ Mathematical Content Knowledge**

In this next section, I examine the importance of teachers’ mathematical content knowledge. Studies over the past 20 years have revealed that the mathematical knowledge of many teachers is thin (Ball, Hill, & Bass, 2005). Researchers such as Ball, Hill and Bass, have stated that this is a problem that is
cyclical; we fail to reach reasonable standards of mathematical proficiency with most of our students, and those students become the next generation of adults, and some of them, teachers.

One reason mathematical knowledge is suffering is because most people do not like admitting they can be wrong and do not open themselves to alternative assumptions. From the standpoint of the person doing mathematics, “making a conjecture is taking a risk; it requires the admission that one’s assumptions are open to revision, that one’s insights may have been limited, that ones’ conclusions may have been inappropriate” (Lampert, 1990, p. 31). This means that teachers are vulnerable when they are learning mathematics and teaching mathematics, because they may not always be correct. It is a traditional, underlying assumption that the teacher is the all-knowing, giver of knowledge. These teachers went to school in the same pre-standards systems in which they are teaching. The curriculum and teaching methods used in their own schooling, and in the setting in which they are now teaching often:

inundate students with skills and procedures without allowing them to develop an appreciation for the power of mathematics as a system of human thought….Most adults graduate from school never having experienced any of the power, elegance, and beauty of the subject … many conclude that they neither can do nor need mathematics (Ball, Lubienski, and Mewborn, p. 435).

If teachers gained mathematical knowledge by taking these risks, learned from their mistakes, and changed their beliefs, would their classrooms look like the reform-based classrooms that researchers are promoting? Ball (1993) stated that, “current proposals for educational improvement are complete with notions about building bridges between the experiences of the child and the knowledge of the expert” (p.
Ball continued, asserting that teaching and learning would be improved, if classrooms were organized to engage students in authentic tasks, guided by teachers with deep disciplinary understanding. Students would conjecture, experiment, and make arguments; they would also frame and solve problems; and they would read, write, and create things that mattered to them. Ball concluded by stating that teachers would guide and extend students’ intellectual and practical forays, helping them to extend their ways of thinking.

How do teacher knowledge and beliefs fit in a mathematics classroom? As previously mentioned, the importance of teachers having good mathematical understanding cannot be overstated. This increased understanding of mathematical knowledge enhances the quality of their teaching and gives them self-confidence that may (directly or indirectly) contribute to their students’ self-confidence as math learners (Stipek et al., 2001). This self-confidence leads to being more efficacious, which ideally leads to reform-based teaching, which ultimately leads to a better understanding of child development.

It has been shown that teachers who have higher efficacy in their subject matter tend to direct this self-confidence to their students. In one study (Stipek et al., 2001), teachers’ self-confidence as a mathematics teacher was significantly correlated with students’ perceptions of their own competence as mathematics learners. Building teachers’ self-confidence in math (including building mathematical understanding) could be an important ingredient in moving the teacher toward more inquiry-based beliefs and practices.
Recent research highlights the critical influence of teachers’ subject matter understanding on their pedagogical orientations and decisions … Teachers’ capacity to pose questions, select tasks, evaluate their pupils’ understanding, and make curricular choices all depend on how they themselves understand the subject matter (McDairmid, Ball, & Anderson, 1989, p. 198).

Good subject matter knowledge is one vital part that guides teaching, including how teachers make instructional decisions. Those decisions are based on how well the teachers understand how their students are developing.

Fennema and Carpenter (1996) reported on studies that encouraged teachers to develop mathematical knowledge and a constructivist pedagogy by having them participate in workshops that reflected such principles. As the teachers learned these new constructivist pedagogies and learned the mathematics at a deeper level, they were better able to understand children’s thinking. This new knowledge also led them to reflect more on their own teaching and learning processes. This work indicates: “as teachers learned mathematics, they changed their beliefs about the importance of making instructional decisions based on children’s understanding and concurrently changed their instructional practices to more adequately reflect constructivist principles” (Fennema & Carpenter, 1996, p. 403).

*Teachers’ Understanding of Mathematical Cognitive Development*

In addition to a good comprehension of mathematical content, teachers also need to have a good understanding of cognitive development within the mathematics classroom. Booker (1996) discussed constructivism in the mathematics classroom, “[constructivism] suggests that the sharing or exchanging of mathematical thoughts and ideas is dynamic, reflecting a continually changing fit between the meaning-
making of active interpreters of language and action, rather than as the result of a conduit from teacher to learner” (p. 382). He continued, stating that in order for teachers to assist in this constructivist process of learning, they need to have a good model of cognitive development in the specific area of mathematics so that they can understand the learner’s conceptions.

When teachers focus on understanding children’s thinking in ways that are unfamiliar to them, this causes them to re-conceptualize what they ‘know’ about students (Miller & Davis, 1992). For example, one popular, reform-based method of mathematical instruction that has been implemented over the past 20 years is Cognitively Guided Instruction (CGI). This is a way to gain understanding of how children solve problems mathematically through inquiry. By utilizing this type of instruction, teachers’ interpretations of a child’s development might shift to a more specifically mathematically oriented framework that is evident in CGI teaching (Bright & Bowman, 1998). In other words, by using a framework that focuses on children’s thinking, teachers might also understand children’s development.

Bright and Bowman (1998) studied how teachers’ frameworks for human development, curriculum, and mathematics influenced how they interpreted children’s mathematical thinking. This two-year study provided training in CGI, and then had the teachers implement CGI in their own teaching. These researchers showed that after implementing CGI during job-embedded professional development, there was a substantial amount of teacher change that might reflect the changes in philosophy of mathematical teaching. After two years in the project, teachers put more emphasis on
students’ demonstration of understanding math content, rather than on the generic stages of problem solving. As the Bright and Bowman study showed, when teachers have a better understanding of students’ cognitive development in math, it is usually because they are open to new ideas and change. These findings are important to my study because they show a relationship between teachers’ mathematical practice and their understanding or beliefs about student’s cognitive development.

Fennema and Carpenter’s (1996) study also provided strong evidence that knowledge of children’s thinking is a powerful tool that enables teachers to transform that knowledge and use it to change instruction. Their four-year longitudinal study investigated 21 teachers’ instruction and beliefs as the teachers learned about children’s thinking and decided how to use that knowledge to make instructional decisions. The researchers provided weekly on-site support and monthly workshops, training the teachers in how to use children’s thinking to make instructional decisions in mathematics. At the end of four years, 17 of the 21 teachers better understood their children’s’ thinking and development, indicated through their expressed beliefs that children could solve problems without being shown procedures for solving them. They also believed that their role was not to tell children how to think but to provide an environment in which children’s knowledge could develop as the children engage in problem-solving experiences and reported on solution strategies.

Fennema and Carpenter (1996) reported “the gains in students’ concepts and problem-solving performance appeared to be directly related to changes in teachers’ instruction” (p. 430). In their study, as the teacher encouraged the children to solve
problems and talk about their thinking, her beliefs about her own role, the students’ roles, and the nature of the mathematical activity changed. By starting with a research-based model of children’s thinking and applying it to the mathematics classroom, almost all the teachers in this study gained knowledge, changed their beliefs about teaching and learning, and improved their mathematical teaching and their student’s mathematical learning.

*Teachers’ Understanding of How Children Learn*

In regards to teachers understanding children’s’ learning, Ball and Cohen (1999) commented, “to learn anything relevant to performance, professionals need experience with tasks and ways of thinking that are fundamental to the practice. These experiences must be immediate enough to be compelling and vivid” (p. 14). They emphasized that children learn in this same manner - being provided experiences with meaningful tasks. Similarly, Shayer and Adhami (2007) wrote, “teachers’ construction of their teaching and learning process parallels their children’s construction of mathematical concepts and skills. It is their construction that makes it real for them” (p. 288, italics in original). Thus, when teachers understand their own mathematical thinking, they are more likely to understand their students’ thinking as well.

Teachers need ways to “expand the interpretive frames they likely bring to their observations of students so that they could see more possibilities in what students could do” (Ball & Cohen, 1999, p. 8). This also means that teachers need to expand their ideas about what it means to learn, what helps children learn, and how to interpret
children to know more about what they are learning and thinking. This might mean giving up longstanding beliefs about children and learning.

Resnick and Hall (1997) summed up how children learn by stating:

People only acquire robust, lasting knowledge if they themselves do the mental work of making sense of it. Good teaching is a matter of arranging for students to do their own knowledge construction, while assuring that the ideas students develop will be in good accord with known facts and established concepts (p. 11).

The type of classroom that creates learning experiences suggested by Resnick, Hall, and other researchers, a classroom community where the teacher does not necessarily show and tell, but instead lets students grapple with difficult ideas and problems, may cause frustration. This frustration is not necessarily unwanted; it may lead to students inventing their own, non-standard strategies (Ball, 1993). These self-created strategies are what researchers suggest will make sense to students.

I have explored teachers’ beliefs about mathematics and have also looked at how beliefs influence teachers’ instructional practice. In this final section I look specifically at research on what teachers believe about adolescents.

Teacher Beliefs About Adolescents

In this section I examine the origin of teacher beliefs about adolescence, then I discuss the misconception of adolescent storm and stress. Next, I look at different theories teachers may have about development, and finally, I examine the mismatch between adolescents and the environment in which many of them are taught.
Teachers’ ideas about development come from several sources. First, there are personal experiences with children. This might include different parenting scenarios, such as, parents versus non-parents, and parents of one child versus multiple children. Second, there are potentially important experiences, such as babysitting, advice from their own parents, or visits to pediatricians (Miller, 1991). There also may be formal education in adolescent and child development that teacher education programs cover in varying degrees. These theories regardless of their source, shape teachers’ beliefs about their own students’ development. In Smith’s (1991) study about primary teacher beliefs, the prevailing beliefs from the teachers in the study were that available versions of development were not helpful and that these primary teachers needed to devise their own views about securing progress in children’s learning.

In response to developmental questions about children, teachers’ common response was to claim that their teaching was based on a self-made theory, which was due to past experience (Smith, 1991). The beliefs that teachers have probably persist because they serve as filters through which new information is processed (Stipek, Givven, Salmon, & MacGyvers, 2001). Strauss (2001) stated, “although adult laypersons have not formally studied psychology or allied fields, they have notions about the nature of the psychological world of a human being” (p. 219). Teachers have taken some child development in their schooling, but most are not experts in this field. Even so, they do have beliefs regarding how children develop.
Beliefs and knowledge about teaching children can be multifaceted. One’s personal experiences do play a large role. Another factor is how teachers themselves experienced their own schooling: What were they like as learners? Did they have a positive experience? Were they “good” students? How did they learn? Past experiences as a learner will affect one’s belief about how others learn, such as, “I understood the long division algorithm, so that’s the way I will teach it to my students.” Even with formal education, teachers will often rely on what worked for them as learners, if that belief was not truly challenged in their training.

**Adolescent “Storm and Stress”**

Many adults believe that during adolescence there is a great deal of upheaval and disorder, resulting in a time of what G. Stanley Hall (1904) referred to as “storm and stress” (Arnett, 2007). Interviews from LeTendre and Akiba (2001) showed that teachers, although they were influenced by psychological or psychoanalytical theories of development, believed that adolescence is a time of identity crisis and rebellion.

The notion of adolescent identity crisis and rebellion, though, is not supported by research (Arnett, 1999; Arnett, 2007; Meece & Daniels, 2008; Steinberg, 2008). It is a belief that most teachers hold on to without evidence to support their thinking. Despite attempts by researchers to ‘debunk’ these beliefs of adolescent identity crisis, “the classic stereotype of adolescence as a time of detachment, rebellion, and conflict (with self and others) has permeated educators’ thinking” (Urdan, Midgley, & Wood, 1995, p. 30).
There is a time in adolescence, especially in American middle class, where there is a higher likelihood of some degree of storm and stress (conflict with parents over curfew, mood disruptions, changing in sleep patterns, and risk behavior), but “the claim that adolescent storm and stress is characteristic of all adolescents and that the source of it is purely biological is clearly false” (Arnett, 1999, p. 317). Other scholars, (Brooks-Gunn et al., 1994; Meece & Daniels, 2008) agree, stating that hormonal contributions to adolescent storm and stress appear to be small and tend to exist only in interaction with other factors. Yet teachers continue to believe that middle-school-aged children are hormonal, rebellious, emotional, moody, and are in crisis. These beliefs can lead to a self-fulfilling prophesy; the teachers believe that adolescents are this way, they treat them in that manner, and the students do, indeed, behave that way.

Midgley has done a great deal of research on why educators feel that adolescent deterioration is an “evitable result of changes associated with puberty” (Midgley & Edelin, 1998, p. 196). Her work looks at other reasons (besides raging hormones) why adolescents may be going through “storm and stress.” In one study (Eccles & Midgley, 1989), data were collected from 2000 students who had transitioned from 6th grade (elementary school) to 7th grade (middle school). The researchers looked at the nature of adolescents transitioning into middle school as well as the timing. They found that the adolescent crisis was actually due to the students transitioning into a less “facilitative” school environment, “an environment that is less demanding cognitively, that promotes ability evaluation and social comparison, that decreases opportunity for student self-management and choice, and that is more formal.
and personal” (p. 174). These less facilitative environments are what adolescents are moving into as they become the opposite: more skillful and knowledgeable, better able to think critically and work through moral dilemmas, needing more control in their lives, as well as going through the biological changes of puberty. There is an obvious developmental mismatch resulting from a change in classroom environment that is inconsistent with the physiological, social and cognitive changes in young adolescents.

**Teachers’ Theories of Child Development**

Regardless of whether the past theories that teachers learned were useful or not, inaccurate or not, most teachers seem to, at least, be aware of general characteristics of theories regarding children’s cognitive development (i.e. the Piaget stages, Vygotsky, information processing). Smith (1991) indicated that over half the teachers at the beginning of her study claimed that their teaching was Piagetian in inspiration. However, in the end, the majority of the teachers had the dominant belief that those theories of development were not helpful and that they needed to devise their own view about development to secure their children’s learning. More importantly is the way that teachers think they understand children’s learning and thoughts (their folk beliefs) and how those beliefs guide the actual teaching (Strauss, 2001).

Smith (1991) asked teachers questions that dealt with the accuracy of their judgments about the age at which children succeed on 15 Piagetian-type tasks. The tasks would contain a conservation task question, and then follow with, “We want you
to think of a child called Chris. Chris is an average child who will soon be starting full-time schooling. At what age do you think Chris will be able to give the right answer to this problem?” (p. 115). They also did interviews that were designed in an attempt to elicit the categories which the teachers themselves used in thinking about their work in relation to teaching primary school children, children’s explanations, children’s abilities, influences on teaching, and good practice.

In Smith’s (1991) study teachers were asked the following about children’s development: “Some researchers claim that teachers need to use some account of children’s intellectual development; other researchers deny this. Do you have any such ideas in mind in your teaching? If you do, what are they?” (p. 117). Smith found that teachers showed considerable expertise in correctly judging the age at which children succeed on different tasks, but they do not display an expertise in analyzing the demands made by tasks, which they themselves believed to have different age norms. These findings are very relevant to my study because they demonstrate that when teachers do not have a proper understanding of developmentally appropriate tasks, there may not be optimal development taking place in the classroom. There needs to be a fit between the needs of developing students and the opportunities given to them by their teachers.

Mismatch of Cognitive Beliefs and Research

One of the reasons why teachers may have specific beliefs they do about age norms is because of the way American schools are configured. In the United States, our public schools are set up with the belief system that children should be performing
at a certain level because they are in a certain grade. A child’s stage of development is
defined in terms of the grade that children should attend at a certain age. Interestingly,
research does not support this type of schooling. Smith (1991) indicated that there is
no available theory in which children’s progress across the curriculum throughout
compulsory schooling can be explained: “Indirect evidence suggests that the projected
levels of attainment are not supported by research on learning” (p. 117).

An example of this occurring is in secondary mathematics classrooms. There
is significant brain development research that has explained why abstract abilities
increase in adolescence. The regions of the brain that control abstract thinking grow
significantly during this time (Steinberg, 2008). Yet, in secondary mathematics
classrooms, students spend a great deal of time copying work from the board or
memorizing formulas. Even though the children’s brain development is understood,
many secondary math teachers still choose to teach mathematics at inappropriate
cognitive levels, for example memorizing formulas and algorithms, instead of using
inquiry-based teaching or even using manipulatives.

Eccles, et al. (1993) found evidence that there is quite often a mismatch
between the needs of developing adolescents and what is provided to them in the
classrooms. These mismatches can lead to negative psychological changes in
adolescents, such as dropping out of high school, risky behaviors leading to arrests,
consuming alcohol or other drugs. They refer to this as ‘stage-environment fit’, and
suggest that it is the fit between the developmental needs of the adolescent and the
educational environment that is important. Teachers need to create this appropriate
environment, and they can only create it if they have an understanding of how adolescents develop.

Anderman and Midgley (1997) also studied this mismatch between the environment in middle school classrooms and how adolescents are able to perform and think at this stage of their development. They looked at 341 students transitioning from 5th grade (elementary) into 6th grade (middle school). In elementary school, the students were more oriented to task goals during instruction (engaged in academic work to improve their competency or for intrinsic satisfaction); they also felt academically competent. These same students in middle school perceived a greater emphasis on performance goals (engaged in academic work to prove their ability or to avoid looking bad compared to others). The researchers found that there was “a dramatic decline in perceived academic competence after students moved to the middle school environment” (p. 291). This is a time when adolescents can think at higher, more abstract levels. Anderman and Midgley also wanted to take into account the possibility that academic work could be harder in middle school and that is what is causing the drop in perceived competence. However, “there is little evidence to support this, and indeed some evidence that the academic work given to students in middle school is less challenging and demanding than work given in elementary school” (p. 291).

To summarize, the source of teachers’ beliefs about adolescents can come from past experience (for example, personal experiences from home) or from societal beliefs (for example, adolescent storm and stress). There is also a frequent mismatch
between the environments to which adolescents’ are exposed and how those adolescents are actually able to perform and think during this period of their lives. That mismatch can certainly affect teachers’ beliefs about what adolescents can actually do in the mathematics classroom.

Discussion

The importance of mathematics teachers understanding child development is clear: when there is low discrepancy between teacher beliefs and a child’s actual ability, the child’s development is more positive. Eccles et al. (1993) research on stage-environment fit provided evidence that, in early junior high, adolescents experience a marked decrease on higher level thinking skills in the classroom, and this is the same time when cognitive development would suggest the need for more complex academic tasks. They further discussed the negative consequences of the developmentally inappropriate environmental changes on adolescents’ school motivation and academic self-concepts.

Scales and McEwin’s (1994) research indicated that the most important recommendation for strengthening middle grades teacher preparation programs is for the teachers to have a “greater understanding of early adolescents … more coverage of how to involve parents and family members and community resources in young adolescents’ schooling” (p. 44-45). An understanding of adolescents can help lead to a better fit between the students and their environment.

In this literature review I examined the intersection between middle child mathematics teachers’ beliefs about adolescents and their actual teaching practice. I
discussed how teacher beliefs affect their practice, and I also looked at teacher beliefs about the nature of mathematics; and finally, I reported on teacher beliefs about adolescents. By examining existing research on topics that support my study, I have gained a better understanding of the intersection between teachers’ beliefs about adolescents and their practice as mathematics teachers.

As teachers are moving toward inquiry-based mathematics instruction, they are learning how children and adolescents develop. Reform-based, inquiry-based mathematics instruction goes hand in hand with understanding how children develop. The NCTM’s Principles and Standards for School Mathematics (2000) specifically recommend that teachers commit to understanding students’ development and their understanding of math. They can do this by asking good questions, giving rich and meaningful math experiences, connecting the students’ ideas to prior knowledge, and listening to how children think. To improve their math instruction “teachers must be able to analyze what they and their students are doing and consider how those actions are affecting students learning” (NCTM, 2000, p. 19). In order to comply with these standards, teachers must understand how children develop.
CHAPTER 3: METHODOLOGY

I begin this chapter with a restatement of the purpose of the study and research questions. I then describe the research design that I chose to explore the research questions, including a rationale for qualitative research, the case study design, the role of the researcher, selection of participants, and participant descriptions. Next, the data collection methods that I utilized are provided. This chapter will also discuss how the data was analyzed, as well as the criteria for quality (accuracy, integrity, validity) that were implemented.

Restatement of the Purpose and Research Questions

The purpose of this study was to gain an understanding of the intersection of middle grade mathematics teachers’ beliefs regarding their teaching practices and adolescents, understanding that the intersection may work in either direction. The goal was to examine middle grade mathematics teacher’s beliefs, to explore whether teachers’ understanding of adolescents may have had an impact on their teaching practice, or whether their teaching practice influenced their understanding of adolescents.

The research question that drove this study was: “What is the intersection of middle grade mathematics teachers’ beliefs about adolescents and their teaching practice?” The following sub-questions also guided this study:
What are teachers' beliefs about mathematics instruction, in particular reform-based mathematics instruction?

What are teachers’ beliefs regarding adolescents?

What aspects of the classroom culture and lesson designs of the teachers’ practice do I observe in the classroom?

What is observed in the classroom or interviews that shows an intersection between the teachers’ beliefs about adolescents and their teaching practice?

Research Design

Qualitative Perspective

This study was a qualitative case study that was conducted with three middle-grade mathematics teachers. “Qualitative research” is an umbrella term referring to different forms of inquiry that help the researcher understand phenomena in natural settings (Erickson, 1986). Bolster (1983) argued that interpretative, qualitative research can have special relevance for classroom teachers. His view stems from 20 years of being a classroom teacher, while simultaneously working at a university as a professor of education. He felt that qualitative research has the greatest potential of all research models for generating knowledge that is both useful and interesting to teachers. The qualitative approach “focuses on situated meanings which incorporate the various reactions and perspectives of students … the classroom is viewed as a complex system in which both direct and indirect influences operate” (p. 157). The classroom is multifaceted and constantly changing with the different influences on it, and qualitative research can be used to look at one part of classroom culture. Bolster
felt strongly that interpretive research on teaching allows teachers to use this research as a time of reflection on his or her own teaching.

Qualitative studies are, by definition, more open-ended, flexible, and evolving. Because of this evolving nature, “orienting” research questions (Kantor & Fernie, 1999) also progressed and were refined for further focus throughout the research process. Qualitative researchers study behavior that occurs naturally; they do not manipulating or controlling variables. What professional interpretive researchers do is to make use of the “ordinary skills of observation and reflection in especially systematic and deliberate ways” (Erickson, 1986, p. 27).

One of the assumptions of study was that in order to understand what beliefs teachers hold and to capture the meaning of those beliefs in the classroom, the researcher needed to use qualitative methodology. One aim of this study was to make visible the beliefs about adolescents and how those beliefs affect the teaching of mathematics. Using qualitative methodology allowed me to look closely at mathematics teacher behaviors via interviews and observations. A goal was to see the interaction of their beliefs on adolescents and their observed mathematics teaching practices. The purpose of interpretive research is “not to determine whether general propositions about learning or teaching are true or false but to further our understanding of the character of these particular kinds of human behavior” (Lampert, 1990, p. 52).
The Case Study Design

This study used the case study research approach. Stark and Torrance (2005) described a case study as:

An ‘approach’ to research which has been fed by many different theoretical tributaries. What is common to all approaches is the emphasis on study-in-depth. Case study seeks to engage with and report the complexity of social activity [and] assumes that ‘social reality’ is reacted through social interaction (p. 35).

A case study design fit well in my study because it is particular, descriptive and inductive; it helped me to illuminate an understanding of the issue regarding teachers’ beliefs regarding adolescence.

The strength of a case study is that it can take an example of a single situation (a classroom activity, a conversation, a meeting) and use multiple methods and data sources to explore it and interrogate it (Stark & Torrance, 2005). The idea is to achieve a rich description of a phenomenon represented from the participants’ perspective. A weakness of a case study is that it is not possible to generalize from a small number of cases to an entire population.

By spending considerable time in only three classrooms, I hoped to gain an understanding of those mathematics communities. It was important to keep in mind that “focusing in cultural communities does not assume that observations are general beyond the people observed” (Rogoff, 2003, p. 83). My approach was to treat findings from this particular study as pertaining to the specific groups studied. One of the most common misconceptions is believing that case studies are to represent a “formal sample from some larger universe” (Yin, 2006, p. 114).
I did not look to generalize to an entire population with this study, rather I sought to have readers recognize aspects of their own teaching experiences in my study and intuitively generalize from it (Stark & Torrance, 2005). I accomplished this by observing, surveying, and interviewing three mathematics teachers rather than hundreds of them. A key issue in case studies “concerns depth versus coverage … the recommended choice is always depth” (Stark & Torrance, p. 35). Yin (2006) concurred with this statement: “Compared to other methods, the strength of the case study method is its ability to examine, in-depth, a ‘case’ within its ‘real-life’ context” (p.115).

Selection of the Participants

According to Patton (1990):

There are no rules for sample size in qualitative inquiry. Sample size depends of what you want to know, the purpose of the inquiry, what’s at stake, what will be useful, what will have credibility, and what can be done with available time and resources” (p. 184). In-depth information from a small number of people can provide valuable information, especially when the cases are information-rich.

Jones (2002) suggested establishing a “minimum sample size based on the number of participants needed to provide reasonable coverage of the phenomenon given the purpose of the study (p. 465).

Qualitative researchers have shown that “validity, meaningfulness, and insights generated from qualitative inquiry have more to do with the information-richness of the cases selected and the observational, analytical capabilities of the researcher than with the sample size” (Patton, 1990, p. 185). This point is easy to appreciate when we
think of Piaget’s initial studies, involving his own children, or Freud’s theories based on 10 client cases.

As I began a search for mathematics teachers to study, I first interviewed prospective middle-grade mathematics teachers. I employed purposive sampling as this is used for information-rich cases and in-depth studies. Information-rich cases are those from which “one can learn a great deal about issues of central importance to the purpose of the study” (Patton, 1990, p. 185). My goal was to eventually find and work with three middle-grade mathematics teachers.

Yin (2006) suggested some screening criteria for selecting participants: 1) willingness of participants; 2) opportunity to collect rich data; 3) evidence that the participant had experience with the phenomena; 4) access to the context. By choosing willing fourth- through eighth-grade mathematics teachers, whom have had experience with adolescents in the mathematics classroom, I felt that should be able to meet Yin’s suggested criteria.

The participants of this study were three veteran middle-grade mathematics teachers in different school districts. As a doctoral student, I had previous experience in the Mathematics Coaching Program (Brosnan & Erchick, 2004), and had a good sense of the type of professional development training these teachers had received. Because of this, I purposefully sought out previous mathematics coaches who had returned to the classroom. After posing some initial interview questions to two of these former coaches, I asked one (Ms. Blue) to be in my study. The other two participants were not former mathematics coaches, but were chosen based on
availability and willingness to participate in the study. After initial interviews with Mr. Green and Ms. Red, I asked them to become part of the study, and they were willing to participate. I did include one other teacher in an initial interview, but because she had a student teacher beginning in January, the timing did not work.

**Participant Descriptions**

**Ms. Blue.** Ms. Blue was a veteran teacher of 13 years. She has taught fourth through eighth-grade, and within those grades taught science, language arts, mathematics, writing, and social studies. For two years, she was a mathematics coach in the Mathematics Coaching Program (Brosnan & Erchick, 2004). Concurrently with her 13 years of teaching, she often taught evening college algebra and pre-algebra classes. During this study, Ms. Blue was teaching three sections of fourth-grade mathematics as well as language arts to her homeroom class. Each of those three classes had 23 children. My observations included a mixture of the three mathematics classes. Ms. Blue’s school’s population was 474 and was in a rural area in a Midwestern town. She described the town as mostly farming and blue-collar, with some white-collar workers. Ms. Blue’s school was predominately white (96%), 39% economically disadvantaged, and 18% of the population identified as having disabilities ([http://www.ode.state.oh.us](http://www.ode.state.oh.us), retrieved April 2009).

**Mr. Green.** Mr. Green was a veteran teacher of 18 years. The school where he was teaching during this study is the only school in which he has taught. For all of his 18 years at this school he taught eighth-grade mathematics, this included pre-algebra and algebra I. Mr. Green saw 121 students each day during his five classes. The class
sizes ranged from 21-32 students. My observations were mostly in the morning in Mr. Green’s school, therefore I generally observed periods one, two and three. The school where Mr. Green taught was in a rural area and was one of two middle schools in the district. The school’s population was about 500 students. Mr. Green described his school as lower socio-economic status (SES) than it used to be in the past. In his words, this school was in the city limits, and many white-collared workers moved to the outskirts of the city. According to the 2007-2008 report card from Ohio Department of Education website (http://www.ode.state.oh.us, retrieved April 2009), Mr. Green’s school was about 85% white, 6% black, 7% multi-racial, with 46% of the population identified as economically disadvantaged, and 20% identified with disabilities.

Ms. Red. Ms. Red was a veteran teacher of 18 years. Her first year teaching was as a primary Learning Disabilities teacher, she then taught kindergarten for six years, sixth-grade for three years, and the last eight years have been in fifth-grade. In these last eight years, she has taught three sections of fifth-grade mathematics, as well as language arts to her homeroom class. Ms. Red described her school as urban with “urban types of kids … we do have a fairly good amount of free and reduced lunch kids, but compared to other schools in our district, we have fewer” (interview, November 2008). Ms. Red also thought that her school had changed in clientele in the past few years, and stated that the professional, well-educated families are moving out of the district. According to the ODE website (http://www.ode.state.oh.us,
retrieved April 2009), Ms. Red’s school was 82% white, 8% black, and 8% multi-racial, with 13% of the students identified as having disabilities.

*Role of the Researcher*

This study took place in three different school settings and contexts. In order to get permission to be in the school, I met the principals at each building. I provided them with copies of my Institutional Review Board (IRB) approval and asked them for a letter, explaining that they knew about my study and their teacher’s participation in the study (See Appendix A).

I provided the three teachers with a copy of my approved IRB, and with an informed consent according to Human Subject Research Protocol (See Appendix B). After they signed these, I provided them with a copy of the signed form. I explained in detail what my study entailed, and what my presence would look like in their classroom. I assured the participants that I would not interfere with their teaching, nor would I use their students, school, district or their own name in any way. I used pseudonyms for each of the teachers and their schools. None of the teachers expressed concerns and each welcomed me into his or her classroom. During the first day of observations, each of the participants introduced me to their classes. The first week I was in the classrooms I sent home an informational letter (See Appendix C) to parents to let them know about the study, and to assure them that their children were not the subjects of this study; I was only looking at the teacher’s interactions with the students.

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Research takes on a variety of roles; Anderson-Levitt (2006) stated that research is:

a dualistic approach … it requires elicits the insiders’ view and thus requires the researcher to participate to some degree in the situations studies. However, because insiders cannot articulate the tacit levels of culture, the researcher must also observe from an outsiders’ perspective to make visible the invisible (p. 285).

Outsiders can have the advantage of noticing what insiders do not notice because they are not so ingrained in the culture. As a former classroom teacher, my own views and experiences gave me a partial insider viewpoint and may have affected my perceptions and observations of the teachers and their classrooms. As Anderson-Levitt suggested, “implicit or explicit comparisons with their own insider knowledge makes cultural meaning making visible to them [the outsiders]” (p. 286).

Discovering the culture of what is occurring in the mathematics classrooms is partly a matter of learning by doing. Because I was coming in as an outsider, I negotiated entrée into classrooms and sought to establish rapport with the insiders (the students and teachers). The hope, of course, was that people really let me witness what went on rather than putting on a “falsified performance” (Anderson-Levitt, 2006).

My most important role was that of a listener. Researchers suggest that we not have pre-formed conceptions as we go into a study (Anderson-Levitt, 2006). The next important way to participate is to ask questions. Questioning helped me to gain a better understanding of what I saw and heard, it will also helped me in developing
relationships with participants. Trusting relationships are imperative in order to enter the participants’ worlds and to assure them of strict confidentiality from the researcher.

Observations involve viewing other people’s space and constructing meanings from the experience of participating in their activities, rather than listening to their account of their activities. This could very well mean that researchers’ constructed meaning from their observation data is unlikely to match the participants’ own constructions of the meaning from their experience of taking part in what was observed (Jones & Somekh, 2005). Observations, therefore, can be more threatening to the participants than interviewing. Observers always have some impact on those they are observing. Some participants may become tense and have a strong sense of performing, even of being inspected (Jones & Somekh, 2005, p. 140). I was sure to make clear to the students and teachers how the data would be used and who would be given access, and to assure them of my efforts to reduce any negative effects of my presence in the classrooms.

**Data Collection Methods**

Case studies benefit from having multiple sources of evidence, as Yin (2006) suggested, “case study research is not limited to a single source of data … in collecting case study data, the main idea is to establish converging lines of evidence to make your findings as robust as possible” (p. 115). Qualitative researchers use many different data collection techniques, so that data collected in one way can be used to cross-check the accuracy of data gathered in another way (Zaharick, 1992). In my
study, I used audio-taping along with field notes, observations, and both verbal and written interviews, in my data collection.

Stark and Torrance (2005) offered their opinions on interviews and observations, the most commonly employed research methods: “Interviews offer an insight into respondents’ memories and explanations of why things have come to be what they are. Observations can offer an insight into the sedimented” (p. 33).

Of course, I was flexible and adaptable in my study, making changes in what I initially believed I needed to gather data. Research is a constant process of decision-making, “openness to smaller or very major changes in research design is crucial … data gathering and data analysis are interrelated and ongoing throughout most ethnographic research” (Goldbart & Hustler, 2005). By continually refining and redefining my questions, I followed part of what Zaharick (1992) suggested in qualitative study:

Through firsthand, long-term, participant observation, using themselves as research instruments and using an eclectic approach to data collection and analysis, ethnographers view human events in the larger context in which they naturally occur. Through a dynamic process, interactive-reactive research process, ethnographers engage in continuous analysis to explore, refine, and define questions and adjust the study design and research techniques (p. 121).

Field Notes / Observations

Obbo (1990) stated that fieldwork is such a personal and subjective experience. Clifford (1990) agreed, stating, “It is difficult to say something systematic about fieldnotes, since one cannot even define them with much precision” (p. 53). Geertz (1973) described what happens in this undefined process of fieldwork:
The ethnographer ‘inscribes’ social discourse, *he writes it down*. In so doing, he turns it from a passing event, which exists only in its own moment of occurrence, into an account, which exists in its inscription and can be reconsulted (p. 57, italics in original).

The implications of these suggestions for me, is that I was sure not only to take notes during my observations, but also to audio-record each session so that I could refer to those for accuracy and details.

Before beginning my research, I created an observation model (Appendix D), which helped me to observe for developmentally appropriate middle grade mathematics teaching methods. Many of the pedagogical aspects stemmed from the NCTM’s process standards and drew upon research from experts in adolescents including Eccles and Roeser (2003) and Steinberg (2008). Thus, the model also helped me to focus on the culture of an adolescent classroom. Because of the aim of this study, I particularly looked and listened for utterances and behaviors of teachers and students that pertained to adolescents in the mathematics classroom, and put these into context as suggested by Spindler (1982). In this case, contextualizing or seeing events in “the framework of relationships of the immediate setting being studied but is pursed, as necessary, into contexts beyond” (Spindler, p. 6) meant that I was constantly looking for meaning in what was said or observed from the participants.

Of course, researchers cannot observe all that occurs, and they cannot record everything that happens in writing. We, as researchers in the field, often go back over our notes, and add to them and revise them. So, where does the field begin and end? The process of taking fieldnotes or being in the field is potentially endless. Researchers can never have enough conversations, learn the language well enough, or
grasp all the hidden messages. Yet, for the researcher, “one must arrive at some baseline or adequate corpus of facts. The writing of descriptive fieldnotes, ‘good’ data oriented toward a coherent cultural object, provides a body of knowledge prefigured for theoretical development” (Clifford, 1990, p. 67). Because I could not possibly write down all that occurred, I also audio-taped (with permission) the class sessions that I observed. This helped me, as I went back through my notes, to help me check for accuracy and completeness.

In my field notes, I paid particular attention to the classroom culture through the social interactions that occur. I also looked for themes in the mathematical and social patterns in the lessons. These themes and patterns helped me to find assertions about teacher beliefs relating to their practice. I paid particular attention to the mathematics teaching as it pertained to adolescents and their development.

On Sunday nights, I emailed the participants and asked for the best times to come in and observe. When field trips, tests or other non-teaching times occurred, the participants let me know, and we schedule around those. It was relatively easy to schedule observations each week with all three participants. It was my desire to have a minimum amount of disturbance in the classrooms in which I observed. It is suggested that inquiry and observation must “disturb as little as possible the process of interaction and communication in the setting being studied” (Spindler, 1982, p. 7). After the first few times in each classroom, I felt my presence was not a distraction to either the teachers or the students.
Interviewing

Interviewing is a way of listening to other’s stories. Vygotsky (1978) stated that every word people use in telling their story is a microcosm of their consciousness. He explained that individual’s consciousness give access to complicated social and educational issues because those issues are abstractions based on the concrete experience of people.

Semi-structured, formal interviews were planned with each of the participants. Within the first two weeks of observations, I planned a 30-60 minute time to ask prepared questions (Appendix E). Through these interviews, I tried to understand the teachers’ beliefs, feelings and thoughts that could not be observed from their teaching. I chose the semi-structured interview because it allowed me to respond to each situation with new ideas; I often had follow-up questions that were different depending on responses given.

Seidman (1998) commented on the importance of interviewing: “To observe a teacher, student or principal, or counselor provides access to their behavior. Interviewing allows us to put behavior in context and provides access to understanding their action” (p. 4). The purpose of interviewing is not always to get to the answer to a question or to test a hypothesis, but rather to understand the experience of other people, trying to make meaning of that experience. In the first set of interviews, I tried to learn as much about the participants’ background experiences and general thoughts on adolescents. In the second and third interviews, I was more specific, asking questions particularly related to their beliefs about how to teach adolescents.
In my research, I looked closely at middle grade mathematics teachers’ beliefs regarding adolescents. Observations certainly helped in generating questions and noticing behaviors; but interviews were a powerful way to gain insights into this educational issue by understanding the experiences that I observed. The main goal of the interviews was to get an index of the participants’ stated beliefs.

I chose to audio-tape the interviews instead of taking notes, as I felt this allowed me to pay better attention to the teachers. I later transcribed each of the interviews to use for data-analysis.

During observations, especially before or after class time, there were often informal interviews with the participants. These were often not recorded, and I took notes afterwards to capture what was discussed. These informal talks usually revolved around something that was occurring at that time. For example, with Ms. Blue, as we walked to get her class from the gym, we talked about the upcoming achievement test and how she prepared for that. In between classes with Mr. Green, we discussed the differences between the first hour class of the day and classes that came later. Table 1 indicates the frequency and length of only the scheduled interviews with the teachers:
<table>
<thead>
<tr>
<th>Participants</th>
<th>Interview Dates</th>
<th>Duration of Interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr. Green</td>
<td>December 10, 2008</td>
<td>29 minutes</td>
</tr>
<tr>
<td></td>
<td>January 21, 2009</td>
<td>10 minutes</td>
</tr>
<tr>
<td></td>
<td>February 25, 2009</td>
<td>written interview questions</td>
</tr>
<tr>
<td>Ms. Blue</td>
<td>December 12, 2008</td>
<td>34 minutes</td>
</tr>
<tr>
<td></td>
<td>January 29, 2009</td>
<td>17 minutes</td>
</tr>
<tr>
<td></td>
<td>March 5, 2009</td>
<td>written interview questions</td>
</tr>
<tr>
<td>Ms. Red</td>
<td>December 8, 2008</td>
<td>28 minutes</td>
</tr>
<tr>
<td></td>
<td>January 13, 2009</td>
<td>18 minutes</td>
</tr>
<tr>
<td></td>
<td>March 17, 2009</td>
<td>written interview questions</td>
</tr>
</tbody>
</table>

Table 1. Dates and Duration of Semi-Structured Interviews

Observations are one of the most important methods of data collection because they entail “being present in a situation and making a record of one’s impression of what takes place” (Jones & Somekh, 2005, p. 138). What participants indicated during interviews may or may not match what was actually observed. Firsthand observation allowed me to see how the teachers diverged from the “idealized model of behavior they presented through interviews and other data collection activities” (Zaharlick, 1992. p. 110).

Data Analysis

Ongoing analysis and redesign of the study begins from the first day of fieldwork (Anderson-Levitt, 2006). As one takes field notes, he or she should also take analytical notes, ask questions, follow-ups, and make initial hypotheses about what is happening. Analysis in this study was about making sense, as an outsider and an insider. To do this, I tried to look not only at what I had for data, but what was missing; what was not said or done that could have been or should have been?
Jones (2002) suggested, “Telling the stories that emerge from an evolving research design is a process that carries great responsibility and the need for integrity, honest and rigorous analytic procedures” (p. 467). However, simply observing, taking notes, and interviewing does not mean that qualitative research is being done. I needed to be sure that I also interpreted the beliefs and behaviors of the participants (Jones). Until the interpretation or analysis was finished, the qualitative research was not complete.

Additionally, simply pulling out a few themes or ideas does not indicate that analysis is occurring; I needed to engage in inductive analysis while concurrently staying close to the participants own words and behaviors. To know if this had been done effectively, the story that was told must be one that was recognizable to those who told it; that emerges directly from their words and behaviors and “that it holds together as coherent, believable, and cogent to all who read it” (Jones, 2002, p. 467). There are multiple ways to interpret any action, and sometimes the different meanings that are discovered conflict with each other. It is then the researchers’ role to decide where to go with her interpretations.

*Data Management and Storage*

Data organization began immediately with data collection. All observations, interviews, field notes, and audio-tapes were dated and labeled. All data was collected electronically, immediately saved on my computer, and backed-up on an external hard-drive. The participants were given pseudonyms and those names were used
throughout the data collection process. I colored-coded each participant’s information for easy retrieval.

Data Coding

One basic task of data analysis is to generate assertions, largely through induction (Erikson, 1986). In my study this was done by searching the data corpus, and reviewing the set of field notes, interview notes, and audiotapes. Erikson suggested that to test for an assertion, “the researcher should conduct a systematic search of the entire data corpus, looking for disconfirming and confirming evidence, keeping in mind the need to reframe the assertions as the analysis proceeds” (p. 146). My assertions continually changed as my research advanced, which then lead to more questions and observations from the participants.

During observations, and later while transcribing, I used the Observation Protocol (Appendix D) to guide me. I compiled this protocol of developmentally appropriate middle grade mathematics teaching from experts in adolescents and mathematics such as Eccles and Roeser (2003), the National Council of Teachers of Mathematics (2000), and Steinberg (2008). For example, if I saw or heard a teacher allowing the students to see connections between related ideas, I would code this as PA2 (Pedagogical Aspects 2). By using the protocol as a guideline, I could then begin to see patterns within each participant and across the participants. I then reviewed the three sources of data (field notes, interviews, observations) to generate and test assertions. I looked for key linkages to code among the various items. A key linkage is key in that it is “of central significance for the major assertions the researcher wants
to make. A key linkage is linking in that it connects up many items of data as analogous instances of the same phenomenon” (Erikson, 1986, p. 148). After finding these linkages, I was able to find patterns of generalizability within this case study, rather than generalizing to other cases. The task of pattern analysis is “to discover and test those linkages that make the largest possible number of connections to items of data in the corpus” (p. 149).

After coding the data, I read and re-read the data until I began to see relationships. I used prior research on mathematics education (e.g., Ball, 1999) and research on expressed beliefs (e.g. Chen, 2008; Keys, 2005) to help guide me in this process. By transcribing the interviews and audio-tapes of the observations, I became more immersed in the data. Instead of imposing existing frameworks, my goal was to determine patterns in the data as they emerged throughout the study.

At one point I asked the participants to provide me with additional written information about their backgrounds that I felt was important to add to the data corpus. Along the way, I continued to read the data and reflect on it, reorganizing it in different ways until it began to make some sense to me. The coding helped me to make initial categories, and then I revised and revisited them until I felt that the data had created the meaningful themes, which I discuss next.

Categories and Themes

The first step in discovering categories occurs through the process of coding and recoding. As Corbin (1986) suggested, “In the initial code, the facts and incidents have been largely restated … the same field notes recorded at a later date, demonstrate
the process of refining codes” (p. 111). Recoding at a later date allows the researcher to further conceptualize the original codes. My data had been coded and I was ready to begin creating categories. The code, themes and categories that were created are discussed in Chapter 4.

In order to define a category, it must be thought through by the researcher, its characteristics listed, and comparisons with other categories made (Swanson, 1986). According to Glaser (1978), categories and their characteristics (properties) are conceptual codes representing the essential relationship between data and theory. Categories and their properties are mid-point indicators. Categories are building blocks to theory and are important for description and initial analysis of qualitative data.

During the time of category discovery, I addressed several questions: What is the name of the category? What are its properties? Under what condition does it occur and under what conditions does it not occur? How does it happen or not happen? What is involved and with what consequences?

After a while, the categories and themes were developed. The next phase required me to link the categories into theoretical codes, to look for what the relationship might be between categories. As Glaser (1978) suggested, to link the categories, “the analyst might ask about the major categories, the ones that are coded repeatedly in the data. What are the categories that all others seem to relate to as properties, conditions, strategies, or consequences?” Swanson (1986) proposed that
once a researcher is so close to the data, he or she needed to step away from it, and then begin to look at relationships between the categories.

Initially, categories may look like data. In order to help see the difference, I took Swanson’s (1986) suggestion to make lists of substantive codes from the data, and then to collapse those codes into manageable sizes by grouping them into clusters by similarities and differences. As Swanson suggested, I then labeled each cluster, and, of course, reworked and adjusted them several times during analysis.

I noticed, expectantly, the large amount of data that pertained to differences between expressed beliefs and observed practices. By grouping that data together, I notice patterns emerging that related to this difference: 1) there was a lack of consistency that may have been due to social desirability from teachers; 2) there was a lack of consistency that may have been due to perceived external factors; and 3) there was a lack of consistency that may have been due to limited or improper theoretical understanding. Those three categories lead me to my first assertion: teacher’s expressed beliefs about adolescents’ mathematical learning are not necessarily borne out in their pedagogical practice.

From the data, I also noted that one teacher, Ms. Blue, expressed that she once had very traditional beliefs about teaching mathematics. After challenging those beliefs, through training in the Mathematics Coaching Program (Brosnan & Erchick, 2004), she considered and acted upon alternative beliefs. These findings led me back to my data to discover if Mr. Green and Ms. Red had similar challenges. I found that both of them did challenge their beliefs about mathematical teaching practices, but that
they had little impetus for change. The culmination of these findings lead me to my second assertion: confronting their own folk beliefs (Strauss, 2001) about adolescents’ mathematical learning allows teachers to consider alternatives to those beliefs and can influence their teaching practice. In the absence of this confrontation or without impetus for change, teachers will be more likely to abandon thoughts of changing their pedagogical practice.

The observations of a great deal of traditional mathematics practices lead me to look through my data once again. I noticed from interviews that the participants had expressed beliefs about traditional mathematic teaching, and I noticed from observations that there were indeed traditional mathematical practices occurring in all three classrooms. These data lead me to my third assertion: teachers have firmly embedded traditional beliefs about mathematics instruction, although they may co-exist with student-centered views.

Through observations and interview responses, I noted that the participants recognized that there exist differences in adolescents. Evidence from the data showed teacher recognition of differences in students’ thinking and learning, maturity, reasoning, and intelligence. For example, Mr. Green stated that different students need to be taught in different ways. Mrs. Red commented that humor and having fun were important in teaching, which led me to imply that she had an understanding of differences in students’ emotional and social needs. Comments and observations such as these, guided me to make a fourth assertion, that teachers recognize adolescents’ individual differences and needs.
Criteria for Quality

Qualitative research emphasizes credibility, accuracy, integrity, validity, and transferability. In order to increase these, I was sure to include prolonged engagement, persistent observation, triangulation, and peer debriefing in my study. In this section, I devote a short description of these procedures and how they were used to increase the quality of my study.

Accuracy and Credibility

The collection and analysis of data must be accurate and credible. Accuracy here means that the data collected creates a fairly true picture of the bit of reality being observed. Credibility meaning trustworthy or capable of being believed; this enables you to use your data with confidence (Johnson, 2008). Some steps that I took that helped me create an accurate and credible study were: 1) Audio-taping observations, as well as taking notes on them; 2) Fully reporting data, even when it was a counter-example to a category or theme; 3) Striving to stay objective to observation, even when I did not agree with certain styles or pedagogies; 4) Using multiple data sources, for example, observations, verbal interviews, written answers, and audio-tapes; 5) Conducting sustained and deep observations and data collection.

Integrity and Validity

The concept of validity in qualitative research is defined using a wide range of terms; therefore, the concept does not appear to be a fixed or universal concept. Even though there is not a single definition of validity, many researchers (e.g. Davies & Dodd, 2002; Golafshani, 2003; Lincoln & Guba, 1985) have used terms such as
quality, rigor, and trustworthiness, as their own generated terms to more appropriately explain validity. Golafshani (2003) stated validity is “a contingent construct, inescapably grounded in the processes and intentions of particular research methodologies and projects” (p. 602). Regardless of the inconsistency in definition, there are ways to help ensure that there is “quality, rigor and trustworthiness” in qualitative research.

One way of ensuring that the research holds integrity and validity is by doing a member check. The member check is used:

whereby data, analytic categories, interpretations, and conclusions are tested with members of those stakeholding groups from whom the data were originally collected, is the most crucial technique for establishing credibility (Jones, 2002, p. 469).

Member checking should occur throughout the research process with the participants, in both formal and informal ways.

In this study, I completed member checks with the teachers, because it was with the integrity of their beliefs that I was interested in preserving. I accomplished this by re-asking some of the same questions, to ensure their answers agreed, or by restating their answers to them to check for accuracy. I asked the participants questions for clarification or verification. I also asked for some questions to be answered in writing, which allowed their words to be preserved.

Spending sufficient time learning the culture of each classroom was another way that helped me to check for validity. I was in the classrooms from November through March so that I could become acquainted with the participants, their settings, and their students. I visited each participant 10-15 times. I also had weekly email
communication to determine observation times or to ask follow-up questions. I spoke with the participants informally before school, after school, and in between classes. I believe that this prolonged engagement, along with the persistent observations, allowed me to get in-depth information about the problem being studied.

**Triangulation**

Golafshani (2003) suggested that the way to achieve validity and reliability in qualitative research is to eliminate bias and “increase the researcher’s truthfulness of a proposition about some social phenomenon using triangulation” (p. 604). Triangulation is defined as “a validity procedure where researchers search for convergence among multiple and different sources of information to form themes or categories in a study” (p. 604). Johnson (2008) referred to triangulation as looking at something from more than one perspective, or seeing all sides of a situation, stating, also, that it also provides greater depth and dimension, enhancing the accuracy and credibility.

By using three different teachers, I was able to triangulate by means of data sources. By collecting data via observations, verbal interviews, written documents, as well as audiotapes, I was able to triangulate by multiple data collection methods. I was also able to benefit from multiple theoretical perspectives, such as constructivism, and sociocultural views, by referring to prior research in these different perspectives. I was able to use peer briefing to discuss my findings and representation of data by obtaining expertise from my doctoral advisor and another mathematics education professor.
Transferability

With this study, I was not looking to generalize to an entire population, nor was it possible to do that. Rather I sought to have the mathematics teaching process of adolescents more clearly defined. This is more in line with an interpretive paradigm, transferability. As opposed to generalizing to a large population, I wanted to provide ample descriptions of the content and results so that other researchers can judge how the findings can be applicable to their study.

The goal of this study was to provide deeper, multi-layered descriptions of teachers’ beliefs about mathematics and adolescents in order to provide transferability and credibility. Yin (1994) stated that using multiple case studies could strengthen the transferability of the results. By studying three teachers’ classrooms and their beliefs, I hoped to have a strong study that could be transferred to others.
CHAPTER 4: FINDINGS

I begin this chapter by illustrating how the themes were developed in regards to teacher beliefs about adolescents and the teachers’ mathematical practices. Next, I discuss the five themes that emerged from the data collected. The purpose of this study was to explore the intersection of middle grade mathematics teachers’ beliefs about adolescents and their teaching practice. The primary sources were observations, interviews, written responses, and document collection. The research questions in this study were:

- What is the intersection of middle grade mathematics teachers’ beliefs about adolescents and their teaching practice?
- What are teachers' beliefs about mathematics instruction, in particular reform-based mathematics instruction?
- What are teachers’ beliefs regarding adolescents?
- What pedagogical aspects of the teachers’ practices do I observe in the classroom?
- What is observed in the classroom or interviews that shows an intersection between the teachers’ beliefs about adolescents and their teaching practice?

In order to help answer these questions, I first developed themes by coding my data. In the first part of this chapter I discuss how these themes were developed.
Development of Themes

Data collection consisted of semi-structured interviews, observation of teacher practice and written responses. During observations, and later, while transcribing, I coded the data using the Observation Protocol (Appendix D) as my guide. I compiled this protocol of developmentally appropriate middle grade mathematics teaching from previously published work in adolescents and mathematics education such as Eccles and Roeser’s *Schools as Developmental Contexts* (2003), the National Council of Teachers of Mathematics, *Principles and Standards of School Mathematics* (2000), and Steinberg’s *Adolescents* (2008). The research from these three sources had previously looked at what was appropriate for middle grade mathematics classes or for adolescents in general. I looked for commonalities between these three sources, and first made two categories: classroom culture and pedagogical aspects. I then made subcategories under each of those two main categories. For example, under pedagogical aspects, the NCTM recommended problem solving and reasoning, Steinberg and Eccles and Roeser suggested the need for adolescents to be able think flexibly. Therefore the first pedagogical aspect (PA1) I defined was if the teacher’s pedagogy would “help the students to think flexibly in their problem solving and reasoning.” For each “pedagogical aspect” in parentheses I indicated which NCTM process standard was covered in that particular sub-category. I used this same process with classroom culture. For example, Eccles and Roeser, Steinberg, and the NCTM discussed the need for teachers to provide clear feedback to adolescents, and NCTM mentions this as well. Therefore, in my Observation Protocol, I felt it was
developmentally appropriate for middle grade mathematics teachers to “provide clear and expectations about performance” and I coded this first aspect as classroom culture (CC1).

In addition to the Observation Protocol, I also asked the teacher participants direct questions pertaining to mathematics and adolescents. These questions helped me to gain a deeper understanding of the teachers’ beliefs about mathematics and adolescents. These were simply coded as interview questions about mathematics (IM1) or interview questions about adolescents (IA1).

The combined codes from both the Observation Protocol and the interviews eventually lead to themes, which then guided me to answer to my original questions regarding the intersection of teacher beliefs about adolescents and mathematics instruction.

*Teacher Beliefs about Mathematics*

In order to ascertain the participants’ beliefs regarding mathematics or mathematics instruction, I implemented the ‘pedagogical aspects’ portion of the Observation Protocol. I also asked interview questions related to mathematics beliefs. Tables 2 and 3 illustrate these responses:
<table>
<thead>
<tr>
<th>Pedagogical Aspects (PA)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA1</td>
<td>Help the students to think flexibly in their <strong>problem solving and reasoning</strong>.</td>
</tr>
<tr>
<td>PA2</td>
<td>Give the students opportunities to see <strong>connections</strong> between related ideas.</td>
</tr>
<tr>
<td>PA3</td>
<td>Integrate the mathematics (e.g. algebra and geometry) so students can understand the <strong>interconnectedness</strong>.</td>
</tr>
<tr>
<td>PA4</td>
<td>Engage the students in interesting and challenging problems (<strong>problem solving, reasoning, connections, representations, communication</strong>).</td>
</tr>
<tr>
<td>PA5</td>
<td>Ask students to construct or produce knowledge rather than reproduce or repeat facts (reinforce <strong>representations</strong>).</td>
</tr>
<tr>
<td>PA6</td>
<td>Encourage students to engage in deep cognitive work that requires them to rely on a field of knowledge, searching for understanding (<strong>problem solving/connections</strong>).</td>
</tr>
<tr>
<td>PA7</td>
<td>Provide active instruction in metacognitive skills (<strong>reasoning</strong>).</td>
</tr>
<tr>
<td>PA8</td>
<td>Use material that is relative to students’ community and culture (<strong>connections</strong>).</td>
</tr>
<tr>
<td>PA9</td>
<td>Provide abundant opportunities to rethink one’s work and understanding (<strong>reasoning</strong>).</td>
</tr>
<tr>
<td>PA10</td>
<td>Provide multiple ways for students to learn new material and demonstrate their learning (<strong>representations</strong>).</td>
</tr>
<tr>
<td>PA11</td>
<td>Provide highly interactive and cooperative learning activities that allow students to work with and tutor each other without the class getting out of control (<strong>communication/problem solving</strong>).</td>
</tr>
<tr>
<td>PA12</td>
<td>Provide hands-on activities (<strong>problem solving, reasoning, connections, representations, communication</strong>).</td>
</tr>
<tr>
<td>PA13</td>
<td>Be sure that all students participate fully in learning activities.</td>
</tr>
<tr>
<td>PA14</td>
<td>Help students understand the importance and larger meaning of what they are being taught (<strong>connections</strong>).</td>
</tr>
</tbody>
</table>

Table 2. Model of Teaching Adolescents: Developmentally Appropriate Middle-Grade Mathematics Teaching (Pedagogical Aspects)
<table>
<thead>
<tr>
<th>Interview question about Mathematics (IM)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IM1</td>
<td>What coursework or training have you had in inquiry-based/reform-based/constructivist approach (or other similar) mathematics? Describe this.</td>
</tr>
<tr>
<td>IM2</td>
<td>Do you find any correlation between what you know or have learned about adolescence and what you know or have learned about inquiry-based mathematics teaching?</td>
</tr>
<tr>
<td>IM3</td>
<td>What are the changes in adolescent thinking about mathematics, especially abstractly? What evidence do you have of that?</td>
</tr>
<tr>
<td>IM4</td>
<td>In mathematics, what is hard/easy for adolescents? Why?</td>
</tr>
</tbody>
</table>

Table 3. Interview Questions Related to Inquiry-Based Mathematics

After coding the interviews and observations, I sought to discover if there were any hallmark characteristics for each participant. The following tables display my observations during only the four months I spent in these classrooms. I later coded these as: observed often, observed sometimes, or not observed. Based on a review of my fieldnotes, during my four months in the classrooms, if I observed a characteristic almost every time, I noted that as “often” in the table. If I observed a characteristic some of the time I was there, but not always, I noted this as “sometimes.” An example of this occurred with Ms. Red. I observed her approximately six different times asking her students to think flexibly, in that, she asked for multiple students to explain their reasoning to the same problem on the board. Approximately eight different times, I observed Ms. Red in a much more direct teaching mode, wherein she would tell her students her way of thinking through a problem and expect them to imitate that thinking. Therefore, in this table, in PA1 (help students to think flexibly in their
problem solving and reasoning), I noted her as “sometimes.” Tables 4 and 5 summarize this next step:

<table>
<thead>
<tr>
<th>Pedagogical Aspects (PA)</th>
<th>Mr. Green</th>
<th>Ms. Red</th>
<th>Ms. Blue</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA1</td>
<td>Not observed</td>
<td>Sometimes</td>
<td>Often</td>
</tr>
<tr>
<td>PA2</td>
<td>Sometimes</td>
<td>Sometimes</td>
<td>Sometimes</td>
</tr>
<tr>
<td>PA3</td>
<td>Sometimes</td>
<td>Sometimes</td>
<td>Often</td>
</tr>
<tr>
<td>PA4</td>
<td>Not observed</td>
<td>Not observed</td>
<td>Often</td>
</tr>
<tr>
<td>PA5</td>
<td>Not observed</td>
<td>Sometimes</td>
<td>Often</td>
</tr>
<tr>
<td>PA6</td>
<td>Not observed</td>
<td>Sometimes</td>
<td>Often</td>
</tr>
<tr>
<td>PA7</td>
<td>Not observed</td>
<td>Sometimes</td>
<td>Often</td>
</tr>
<tr>
<td>PA8</td>
<td>Not observed</td>
<td>Sometimes</td>
<td>Sometimes</td>
</tr>
<tr>
<td>PA9</td>
<td>Sometimes</td>
<td>Sometimes</td>
<td>Often</td>
</tr>
<tr>
<td>PA10</td>
<td>Not observed</td>
<td>Sometimes</td>
<td>Often</td>
</tr>
<tr>
<td>PA11</td>
<td>Not observed</td>
<td>Not observed</td>
<td>Often</td>
</tr>
<tr>
<td>PA12</td>
<td>Not observed</td>
<td>Sometimes</td>
<td>Often</td>
</tr>
<tr>
<td>PA13</td>
<td>Sometimes</td>
<td>Often</td>
<td>Often</td>
</tr>
<tr>
<td>PA14</td>
<td>Not observed</td>
<td>Often</td>
<td>Often</td>
</tr>
</tbody>
</table>

Table 4. Mathematical Pedagogical Aspects Observed in Participants

In regards to answers to the interview questions about mathematics teaching, I coded these as more succinct, short phrases. My hope was that these few words would help show hallmark characteristics in the participants. For example, I asked the teachers, “In mathematics, what is hard/easy for adolescents? Why?” Ms. Blue’s answer related ideas about teachers needing to create a comfort zone for their students and teaching them in a non-threatening manner. She also thought it was important for teachers to let the students know they could be successful in math. Therefore, in the fourth interview question about mathematics (IM4), I coded her response as “comfort
zone.” These were key words that she used that would later help me as I looked at patterns. The answers from all three participants are summarized in Table 5:

<table>
<thead>
<tr>
<th>Interview questions about Mathematics (IM)</th>
<th>Mr. Green</th>
<th>Ms. Red</th>
<th>Ms. Blue</th>
</tr>
</thead>
<tbody>
<tr>
<td>IM1</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>IM2</td>
<td>Yes, but not applied</td>
<td>Yes, but applied some</td>
<td>Yes, applied often</td>
</tr>
<tr>
<td>IM3</td>
<td>Potential for abstract thinking</td>
<td>Cannot think as abstractly as we think they can</td>
<td>Potential for abstract thinking if given opportunities</td>
</tr>
<tr>
<td>IM4</td>
<td>Knowing what’s important</td>
<td>Anything beyond basic computation</td>
<td>Comfort zone</td>
</tr>
</tbody>
</table>

Table 5. Interview Responses Related to Inquiry-Based Mathematics

Explanation of Tables 4 and 5

Using the information gathered regarding mathematics and mathematics instruction from observations of the participants (Table 4) and interview questions (Table 5), I next summarize each participant.

Mr. Green. When looking at Table 4 for Mr. Green, I noted that many of the pedagogical aspects that were identified as developmentally appropriate for middle grade teaching were not present. The pedagogical aspects that were present, were only present some of the time that I observed during the four months of my research. This led me to infer that Mr. Green’s beliefs about mathematics were more towards traditional teaching rather than constructivist teaching. When looking at Mr. Green’s interview responses in Table 5 regarding mathematics teaching, I noted that there
existed more of an expressed belief about constructivist-type teaching of mathematics. For example, in response to questions IM3 and IM4 regarding specifically teaching adolescents and if he believes they can think abstractly, he stated, “By not knowing where they are going to be in a few years, adolescents need to look at a wide range of options for their lives. Too many of them start shutting doors on their futures too early.” Mr. Green also added:

Adolescents are ready to learn whatever they want to learn. I’ve seen them do amazing things when they are motivated. A motivated student with average to above average background can get pretty deep into many subjects. They also are capable of solving complex and complicated problems.

I coded this in IM3 as “Potential for abstract thinking” and in IM4 as “Knowing what’s important.” Looking specifically at what he discussed in these interview, I also noted that Mr. Green did recognize individual differences in his students, especially pertaining to special education students. He stated, “I think the higher end special end kids it’s been a benefit to them [being in a regular education mathematics classroom as opposed to being pulled out].”

Ms. Red. My observations of Ms. Red’s mathematics teaching, as displayed in Table 4, showed some aspects of developmentally appropriate middle grade mathematics teaching. Although I did not observe cooperative work or deep, cognitive problems for students to engage in, I did note that Ms. Red did use connection in her mathematics teaching and that she was aware if students were or were not participating in class discussions. Ms. Red’s interview responses, shown in Table 5, contrasted with some of the observed teaching and agreed with other responses. For example, Ms. Red’s beliefs about abstract thinking in adolescents
agreed with her not using challenging and deeper cognitive problems. She stated, “Their [adolescents] irrational choices makes me think that they’re not capable for the higher level reasoning that we expect them to demonstrate.” In Table 5 for IM3, this was coded as “Cannot think as abstractly as we think they can.”

_Ms. Blue._ All of the developmentally appropriate middle grade mathematics teaching pedagogical aspects from Table 4 were observed in Ms. Blue during my four months in her classroom, at least some of the time, if not most of the time. Ms. Blue used rich problems to teach multiple concepts, she allowed her students the opportunities to work cooperatively on high-level mathematics, and she encouraged multiple ways of learning concepts. Ms. Blue’s interview responses, shown in Table 5, also demonstrated a more constructivist-type teaching approach. For example, in question IM4 I asked what is easy or hard for adolescents in mathematics. Ms. Blue responded, “Because I create a comfort zone, I think it’s easy for them to be comfortable with a topic that’s difficult. [It’s easier for adolescents to understand mathematics] if you present it to them in a way that’s non-threatening, if you tell them that’s it going to be okay.” In Table 5, I coded this response for IM4 as “Comfort zone.”

Discussion. When looking at Tables 4 and 5 across the three participants’ pedagogical aspects, and when looking at the participants’ interview responses regarding mathematics, there were many inconsistencies. For example, Ms. Blue talked about adolescents in a traditional manner, yet taught them in a constructivist manner. All three teachers talked about being taught using traditional methods; and
Mr. Green expressed that traditional methods may not be the best way to teach adolescents, but that was what he was going to use for a variety of reasons.

These codes for mathematics teaching led me to my first theme, that teachers’ expressed beliefs about adolescents’ mathematical learning are not necessarily borne out in their pedagogical practice. These codes also led to me to my third theme, that teachers have firmly embedded traditional beliefs about mathematics instruction. These themes will be discussed in detail later in this chapter, where I will show specific examples of this dichotomy. Next, I discuss the codes I used regarding teachers’ beliefs about adolescents.

*Teacher Beliefs about Adolescents*

In order to ascertain the participants’ beliefs regarding adolescents, I asked direct questions pertaining to adolescents. These questions were meant to help provide a better understanding of the participants’ beliefs about adolescents listed in Table 6:
Table 6. Interview Questions Related to Beliefs about Adolescents

<table>
<thead>
<tr>
<th>Interview questions about Adolescents (IA)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>IA1</td>
<td>What is the secret of working with adolescents?</td>
</tr>
<tr>
<td>IA2</td>
<td>What do you know or believe about adolescents based on your experience, not necessarily what you learned in courses?</td>
</tr>
<tr>
<td>IA3</td>
<td>Picture a typical adolescent student. How do you reach him/her? What gets in the way?</td>
</tr>
<tr>
<td>IA4</td>
<td>If you could teach an adolescent in any way you thought would work best, how would you?</td>
</tr>
<tr>
<td>IA5</td>
<td>What coursework and/or additional training have you taken in adolescent or child development?</td>
</tr>
<tr>
<td>IA6</td>
<td>As compared to elementary-aged children, how do you think it is different to teach to adolescents?</td>
</tr>
<tr>
<td>IA7</td>
<td>What teaching approaches (pedagogies) do you use that you feel is effective for adolescents?</td>
</tr>
<tr>
<td>IA8</td>
<td>What feelings/emotions/thoughts come to mind when you think of ‘adolescents’?</td>
</tr>
<tr>
<td>IA9</td>
<td>How are these students different from younger students?</td>
</tr>
<tr>
<td>IA10</td>
<td>How does development change from younger children to adolescents? Or even from your own children throughout the year?</td>
</tr>
<tr>
<td>IA11</td>
<td>What are the learning needs of adolescents?</td>
</tr>
<tr>
<td>IA12</td>
<td>Teachers have a special kind of knowledge. What can you tell me about what you really believe about adolescent’s minds and what is the basis for this?</td>
</tr>
</tbody>
</table>

In order to code these responses, I used a few words to succinctly capture the participants’ responses. I attempted to use common words so that I could see patterns emerging. For example, I asked the teachers, “What is the secret of working with adolescents.” Mr. Green’s response was that he wanted to have fun with them, make fun of them and they understood him, entertain them, and just be himself with them.
Therefore, to succinctly summarize Mr. Green’s response, I inserted “humor” for the first interview question about adolescents (IA1).

<table>
<thead>
<tr>
<th>Interview questions about Adolescents (IA)</th>
<th>Mr. Green</th>
<th>Ms. Red</th>
<th>Ms. Blue</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA1</td>
<td>Humor</td>
<td>Humor</td>
<td>Confidence building</td>
</tr>
<tr>
<td>IA2</td>
<td>Need to have fun</td>
<td>Need approachable teacher</td>
<td>Need approval/confidence</td>
</tr>
<tr>
<td>IA3</td>
<td>Want to entertain</td>
<td>Peers most important</td>
<td>Hormones/peers</td>
</tr>
<tr>
<td>IA4</td>
<td>Having fun / understanding them</td>
<td>Cooperative working</td>
<td>Blend traditional and inquiry</td>
</tr>
<tr>
<td>IA5</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>IA6</td>
<td>Sense of humor / patience</td>
<td>Cooperative working</td>
<td>Continue to let them explore</td>
</tr>
<tr>
<td>IA7</td>
<td>Teacher control / show</td>
<td>Doesn’t matter – it is dictated because of test</td>
<td>Mix of traditional and inquiry</td>
</tr>
<tr>
<td>IA8</td>
<td>Have fun</td>
<td>Peers / acceptance</td>
<td>Needy, confused, hormonal</td>
</tr>
<tr>
<td>IA9</td>
<td>Can help each other more</td>
<td>Different focus / peers more important</td>
<td></td>
</tr>
<tr>
<td>IA10</td>
<td>Trust in adults / selective listening</td>
<td>Reasoning / peer importance</td>
<td>Mostly concrete to abstract</td>
</tr>
<tr>
<td>IA11</td>
<td>Take chances, learn about many things</td>
<td>Time, patience, humor</td>
<td>Exploring time, allowed to develop at own rate</td>
</tr>
<tr>
<td>IA12</td>
<td>They need discovery</td>
<td>Irrational / cannot think abstractly</td>
<td>Constantly growing/able to think ‘outside box’</td>
</tr>
</tbody>
</table>

Table 7. Interview Responses Related to Beliefs about Adolescents

Explanation of Table 7

Using the information gathered regarding adolescents from interview questions (Table 7), I next summarize each participant.
Mr. Green. After looking at the responses pertaining to adolescents, Mr. Green’s beliefs had a tendency to be centered on having fun with adolescents. This includes understanding them, and having an appropriate sense of humor with them. When asked about the secret of working with adolescents and what he knew about adolescents (IA1, IA2, and IA4), Mr. Green’s response was, “My secret, the thing is that I just have fun with them. I can sit here and make fun of them, and they love it. And I’ll just do some goofy stuff; you’ve got to entertain them. That’s a big thing.” In Table 7, I reference this in IA1 as “Humor,” in IA2 as “Need to have fun,” and in IA4 as “Having fun / understanding them.”

Mr. Green expressed beliefs about adolescents needing discovery and taking chances in their mathematical learning (IA11 and IA12). He stated, “If I had unlimited time and it didn’t matter, I would definitely have them do more discovery type things, where they find things on their own.” In Table 7, I references this in IA11 as “Take chances, learn about many things,” an in IA12 as “They need discovery.”

Mr. Green indicated in one written response that adolescents, “need to take chances of learning and trust that their efforts will pay off.” Mr. Green also expressed beliefs about teacher control (IA7) in the classroom. He indicated more than once that he wanted to be in control of the environment in his classroom, as well as what the students were learning. For example,

My thing is that I like to control things so I feel much more comfortable with everyone listening to me, watching at me, instead of having them on their own and seeing where they’re going. I’d rather have just have them all get it all at once with me and then work with individuals who are having trouble.
In Table 7 I referenced this quote in IA7 as “Teacher control, show.” Mr. Green’s beliefs helped me to form Theme 3 regarding traditional teaching, as well as Theme 1 regarding differences between expressed beliefs and teaching practices.

Ms. Red. Comments from Ms. Red regarding adolescents helped me to gain a better understanding of her beliefs. When asked about the secret of working with adolescents, and what she believed about adolescents (IA1 and IA2) Ms. Red indicated that she believed in using a sense of humor and having fun with adolescents:

[The secret is having] a sense of humor. Really I find myself being serious too much of the time. I would like to play around with them more and still not lose order. I think they appreciate it when their teachers joke with them and I think they are much more willing to work with you if they think you’re approachable.

In Table 7 I referenced this in IA1 as “Humor,” and in IA2 as “Need approachable teacher.”

When asked about specifically teaching adolescents (IA4 and IA9) Ms. Red commented about her beliefs in the importance of cooperative working, “They are really good at helping each other. I’m not so arrogant to realize that sometimes they can learn it better from a peer…. Last year I worked with the science teacher and we did a collaborative unit together.” In Table 7 this was referenced in IA4 as “Cooperative working,” in IA9 as “Can help each other more.”

When asked about her beliefs about the way adolescents think (IA12), Ms. Red indicated that she believed that adolescents can not think as abstractly as we educators, think that they can: “What I notice is that I expect them to be able to do more than they really are ready to do. Even in their reasoning skills; they are not well enough
developed to consider them as adults, and I feel that we think they should be adults.”

In Table 7 I references this in IA12 as “Irrational / cannot think abstractly.”

Ms. Red’s beliefs helped to guide me in Theme 1, regarding differences between expressed beliefs and teaching practice. Her comments regarding adolescents also helped me to form Theme 2, regarding confronting traditional beliefs and Theme 4, regarding teachers recognizing individual differences.

Ms. Blue. Interview responses from Ms. Blue about the secret of working with adolescents and her beliefs about adolescents (IA1 and IA2) centered on giving students confidence and allowing exploration:

I believe that if you tell them they can be successful, they will, and I believe that they crave that. They crave someone telling them it’s okay you made a mistake, let’s try something else. I see my biggest role as a teacher is building their confidence level.

I referenced this in Table 7, IA1 as “Confidence building,” and in IA2 as “Need approval/confidence.”

When asked about specifically teaching adolescents (IA4), Ms. Blue commented on the need to mix traditional teaching with inquiry-based teaching, “Some students need the direct approach and some need to explore. The only thing that is consistent is that all students learn at their own rate, have their own needs and reach developmental levels on their own time.” She also stated, “Sometimes I don't think that we as adults give the students enough credit. I just try to present material in many different ways and help students find their own comfort zone.” I referenced this in IA4 as “Blend traditional and inquiry.”
Ms. Blue had some conflicting answers regarding adolescents, as well. When asked to picture a typical adolescent (IA3), she stated more traditional beliefs about adolescents being, “Needy, confused, hormones, wanna please, want to do a good job, want structure, need pampering, need tough love sometimes, they need everything.” In Table 7 I referenced this in IA3 as “Hormones/peers.”

When asked about how to best teach adolescents (IA6 and IA7), she expressed reform-based beliefs about adolescents being about to learn through inquiry and exploration, “I see where the inquiry-based stuff comes in, especially kids that are grappling with they can’t even memorize the algorithm and they have no sense to make of it, so they’re not creating a good one in their head.” I referenced this in IA6 as “Continue to let them explore,” and in IA7 as “Mix of traditional and inquiry.”

Ms. Blue’s interview responses guided me when forming Theme 1, regarding expressed beliefs differing from teaching practice, as well as Theme 2, regarding teachers confronting their folk beliefs, which eventually may lead to changing teacher practice. Her responses also helped me when forming Theme 3, regarding teachers having traditional beliefs mixed with student-centered views.

Discussion. When looking across the three teachers’ responses regarding beliefs about adolescents, I noted some commonalities. All three teachers discussed some aspects of inquiry-based teaching (e.g. cooperative work, exploration, discovery) being effective for adolescents. All three also indicated the need for traditional teaching, as well. Mr. Green and Ms. Blue discussed the need for using humor and fun with adolescents. Ms. Blue and Ms. Red both indicated the importance of peers
and the acceptance of others in their interview responses. Mr. Green and Ms. Red indicated that having control over their students was important to them.

The common beliefs as well as the difference in beliefs amongst the participants’ responses about adolescents led me to several themes, which I discuss in greater detail later in this chapter. When I compared the participants’ expressed beliefs about adolescents to observed teaching practice, I noted substantial differences. These differences led me to identify Theme 1, in which teachers’ expressed beliefs about adolescents’ mathematical learning were not necessarily borne out in their pedagogical practice. I also noticed that Ms. Blue discussed the difference between how she previously taught in a traditional manner, and after training in-depth for two years in the Mathematics Coaching Program, she changed her beliefs about how to best teach children mathematics, and thus, changed the way she taught. When comparing Ms. Blue’s responses to Mr. Green and Ms. Red, I noted that they expressed beliefs about inquiry-based learning but also indicated a variety of reasons why they did not implement these. The difference between Ms. Blue and the other two participants led me to Theme 2, that confronting folk beliefs (in Ms. Blue’s case, her beliefs about traditional mathematics teaching) could lead to a change in those beliefs and possibly a change in teacher practice. Next, I examine teachers’ beliefs regarding teaching and learning.

Teachers’ Beliefs about Teaching and Learning

In order to ascertain the participants’ beliefs regarding teaching and learning, I implemented the ‘classroom culture’ aspect of the Observation Protocol. These
aspects were gathered from research from Steinberg (2008), Eccles and Roeser (2003), and the National Council of Teachers of Mathematics (2000). As I observed the participants’ teaching, I recorded the “teacher belief” codes as they occurred. For example, Ms. Blue presented a problem to her students and then gave them time to work. She had blocks available, if they wanted to use them, and she instructed them that they could work alone or in groups or partners. Because of this I noted that she allowed for her students to make decisions and have autonomy, and thus marked CC13 in my field notes. Table 8 shows the codes that were used.

<table>
<thead>
<tr>
<th>Classroom Culture (CC)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CC1</td>
<td>Provide clear feedback and expectations about performance</td>
</tr>
<tr>
<td>CC2</td>
<td>Give ample praise to students when they perform well in effort, process of thinking, correctness of answer</td>
</tr>
<tr>
<td>CC3</td>
<td>Be supportive and responsive, but firm and demanding</td>
</tr>
<tr>
<td>CC4</td>
<td>Have high, well-defined standards for behavior and academic work</td>
</tr>
<tr>
<td>CC5</td>
<td>Spend a high proportion of their time on lessons, rather than on setting up equipment or on discipline</td>
</tr>
<tr>
<td>CC6</td>
<td>Begin and end on time (respect students’ time)</td>
</tr>
<tr>
<td>CC7</td>
<td>Have high expectations that all students can learn</td>
</tr>
<tr>
<td>CC8</td>
<td>Have strong and clear norms and rules (for discipline)</td>
</tr>
<tr>
<td>CC9</td>
<td>Build a sense of community in their classrooms</td>
</tr>
<tr>
<td>CC10</td>
<td>Show a positive, caring attitude toward their students</td>
</tr>
<tr>
<td>CC11</td>
<td>Create a positive, caring peer climate for all students</td>
</tr>
<tr>
<td>CC12</td>
<td>De-emphasize comparison and competition, and emphasize effort and improvement</td>
</tr>
<tr>
<td>CC13</td>
<td>Allow for students to make decisions and have autonomy</td>
</tr>
<tr>
<td>CC14</td>
<td>What is the physical set-up of the classroom?</td>
</tr>
</tbody>
</table>

Table 8. Model of Teaching Adolescents: Developmentally Appropriate Middle-Grade Mathematics Teaching (Classroom Culture)
In order to use the information gathered from the Classroom Culture aspects, I went through my field notes to gain a better sense of which aspects were observed, if at all, from each participant. I later coded these as: observed often, observed sometimes, or not observed. During my four months in the classrooms, if I observed a teaching aspect almost every time, I noted that as “often” in the table. If I observed a characteristic some of the time I was there, but not always, I noted this as “sometimes.” An example of this was observed with Ms. Blue. I noted that she often used technology, such as the Smartboard, in her classroom. When she used this, there was little to no “down time” for setting up her equipment. I asked her about this, and she expressed that she set up her equipment before school. Therefore, I noted CC5, that she spent a high proportion of their time on lessons, rather than on setting up equipment or on discipline, on that field note. Table 9 summarizes the coding used for classroom culture aspects of teachers’ beliefs about teaching and learning:
<table>
<thead>
<tr>
<th>Classroom Culture (CC)</th>
<th>Mr. Green</th>
<th>Ms. Red</th>
<th>Ms. Blue</th>
</tr>
</thead>
<tbody>
<tr>
<td>CC1</td>
<td>Not observed</td>
<td>Observed sometimes</td>
<td>Observed sometimes</td>
</tr>
<tr>
<td>CC2</td>
<td>Not observed</td>
<td>Observed sometimes</td>
<td>Observed often</td>
</tr>
<tr>
<td>CC3</td>
<td>Not observed</td>
<td>Observed sometimes</td>
<td>Observed often</td>
</tr>
<tr>
<td>CC4</td>
<td>Observed sometimes</td>
<td>Observed sometimes</td>
<td>Observed often</td>
</tr>
<tr>
<td>CC5</td>
<td>Not observed</td>
<td>Not observed</td>
<td>Observed often</td>
</tr>
<tr>
<td>CC6</td>
<td>Observed often</td>
<td>Observed often</td>
<td>Observed often</td>
</tr>
<tr>
<td>CC7</td>
<td>Not observed</td>
<td>Observed sometimes</td>
<td>Observed often</td>
</tr>
<tr>
<td>CC8</td>
<td>Observed often</td>
<td>Observed sometimes</td>
<td>Observed sometimes</td>
</tr>
<tr>
<td>CC9</td>
<td>Not observed</td>
<td>Not observed</td>
<td>Observed often</td>
</tr>
<tr>
<td>CC10</td>
<td>Observed sometimes</td>
<td>Observed sometimes</td>
<td>Observed sometimes</td>
</tr>
<tr>
<td>CC11</td>
<td>Not observed</td>
<td>Observed sometimes</td>
<td>Observed often</td>
</tr>
<tr>
<td>CC12</td>
<td>Not observed</td>
<td>Not observed</td>
<td>Observed sometimes</td>
</tr>
<tr>
<td>CC13</td>
<td>Not observed</td>
<td>Not observed</td>
<td>Observed often</td>
</tr>
</tbody>
</table>

Table 9. Classroom Culture Aspects Observed in Participants

The interview questions that particularly helped me understand teachers’ beliefs about teaching and learning are listed in Table 10:

<table>
<thead>
<tr>
<th>Interview questions about teaching and learning (IT)</th>
<th>IT1</th>
<th>IT2</th>
<th>IT3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>How would you characterize your pedagogical or instructional approach to teaching mathematics?</td>
<td>What teaching approaches do you use that you feel is effective for adolescents?</td>
<td>What background, experience and/or expertise do you think influences your teaching?</td>
</tr>
</tbody>
</table>

Table 10. Interview Questions Related to Teacher Beliefs about Teaching and Learning
In regards to answers to the interview questions that pertained to teachers’ beliefs about teaching and learning, I coded these in Table 11 as succinct, short phrases. My hope was that these few words would help show hallmark characteristics in the participants. For example, when I asked Mr. Green how he would characterize his instruction approach to teaching mathematics, he indicated that many people researched before writing a textbook, so he should not reinvent the wheel; therefore, he uses the textbook. He also indicated that his past college professors influences how he teaches, and they were mostly traditional in nature. Therefore, in the first interview question about teaching and learning (IT1) I wrote, “using the book, old college professors” to succinctly summarize what Mr. Green had stated about his pedagogical approaches.

<table>
<thead>
<tr>
<th>Interview questions about teaching and learning (IT)</th>
<th>Mr. Green</th>
<th>Ms. Red</th>
<th>Ms. Blue</th>
</tr>
</thead>
<tbody>
<tr>
<td>IT1</td>
<td>Using the book, old college professors</td>
<td>Does not matter because state dictates</td>
<td>Mix of traditional and inquiry, exploration</td>
</tr>
<tr>
<td>IT2</td>
<td>Traditional, but tried cooperative, decided by the state</td>
<td>Need more time, project-based and cooperative, but can’t fit it in</td>
<td>Confidence building, creating safe atmosphere</td>
</tr>
<tr>
<td>IT3</td>
<td>One undergrad class on child development</td>
<td>General education in undergrad, Standards from the state,</td>
<td>CGI and inquiry training, extra math classes in college</td>
</tr>
</tbody>
</table>

Table 11. Interview Responses Related to Teacher Beliefs about Teaching and Learning
Explanation of Tables 9 and 11

Using the information gathered regarding teaching and learning from observations (Table 9) and interview questions (Table 11), I next summarize each participant.

Mr. Green. From observations listed in Table 9 of Mr. Green’s teaching, I noted that he sometimes had high standards for student behavior and academic work. I also observed a caring attitude towards his students some of the times I was in his classroom. I observed that he respected his students’ time by starting and ending class on time. Mr. Green’s interview responses, as shown in Table 11, regarding teaching and learning indicated that his beliefs centered on a traditional style of teaching mathematics. His college professors taught him in this manner, and he felt that it worked for him; although he’s attempted other styles of teaching, such as cooperative learning or providing rich problems, he believed that his traditional methods were adequate for most of his students.

Ms. Red. Observations from Table 9 of Ms. Red’s teaching indicated that sometimes I saw her providing clear feedback and expectations to her students. I also sometimes observed her praising students for their efforts instead of correctness of answers. Ms. Red also was observed sometimes having high expectations that all students could learn, and also sometimes I observed a caring attitude towards her students or in the classroom climate as a whole. Through interview responses (Table 11), I noted Ms. Red’s beliefs regarding teaching and learning indicated that she would have liked to implement more cooperative work and long-term projects, but that there
were many outside factors restraining that from happening including state-mandated testing and a limited amount of teaching time.

Ms. Blue. My observations of Ms. Blue’s teaching, shown in Table 9, indicated that she often gave praise to her students for their efforts, and also often had high expectations that all students could learn. Ms. Blue was often observed as building a sense of community in her classroom, and often created a positive, caring climate for all students. Ms. Blue’s interview responses (Table 11) indicated that her beliefs about teaching centered on student confidence building and student-inquiry.

Discussion. Through observations of teaching practice and direct interview questions pertaining to teacher beliefs about teaching and learning, I noted that all three participants were respectful of their students’ time, and that all three, at least sometimes, were observed as having well-defined standards for academic work and behavior in their classrooms. All three teachers also were observed as, at least sometimes, showing a caring attitude towards their students, and also had strong and clear norms and rules. The teachers’ interview responses regarding teaching and learning indicated that all three participants had no formal training in adolescents, and all indicated that they were taught in a traditional manner in college. Their beliefs about teaching and learning were similar in some aspects, as they all indicated that traditional teaching was needed, but to a much difference extent. For example, Mr. Green indicated that traditional teaching was all he used, while Ms. Blue indicated that she used a mix of inquiry and traditional.
These observations combined with the interview responses about teacher beliefs regarding teaching and learning helped me to form Theme 1, that teachers’ expressed beliefs about adolescent mathematical learning is not necessarily borne out in their pedagogical practice. The observations and interviews also guided me in forming Theme 3, that teachers have firmly embedded traditional beliefs about mathematics, and Theme 4, that teachers do recognize individual differences and needs, although they may not act upon that recognition. Further evidence for these themes is provided in the next section of Chapter 4, Themes.

To summarize, in this research I looked at the intersection of teachers’ beliefs regarding adolescents and mathematics. Table 12 shows a summary by teacher and belief. This table guided me in developing the four themes, which are discussed in detail in the next section.

<table>
<thead>
<tr>
<th>Beliefs about adolescents</th>
<th>Mr. Green</th>
<th>Ms. Red</th>
<th>Ms. Blue</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Need to be entertained, having fun with them is important,</td>
<td>Peers are important, cannot think as abstractly as assumed, seek attention</td>
<td>Needy, hormonal, want to please, peers most important</td>
</tr>
<tr>
<td>Beliefs about mathematics</td>
<td>Learned traditional, teaches traditional, stick with what works</td>
<td>Peer work and projects are needed but not possible</td>
<td>Constructivist teaching works best</td>
</tr>
<tr>
<td>Beliefs about teaching and learning</td>
<td>Cooperative and rich problems have been tried, traditional works just as well, outside issues with trying inquiry</td>
<td>Cooperative might be nice, but is not possible because of mandates, time</td>
<td>Mixture of traditional and inquiry; most important is building confidence</td>
</tr>
</tbody>
</table>

Table 12. Summary of Intersection of Three Participants’ Beliefs Regarding Adolescents, Mathematics, and Teaching and Learning
Themes

After analyzing the codes from the data described earlier in this chapter, themes emerged; to summarize, these themes were: 1) Teachers’ expressed beliefs about adolescents’ mathematical learning are not necessarily borne out in their pedagogical practice; 2) Confronting their own folk beliefs (Strauss, 2001) about adolescents’ mathematical learning allows teachers to consider alternatives to those beliefs, and can influence their teaching practice. In the absence of this confrontation or without impetus for change, teachers will be more likely to abandon thoughts of changing their pedagogical practice; 3) Teachers have firmly embedded traditional beliefs about mathematics instruction, although they may co-exist with student-centered views; and 4) Teachers recognize adolescents’ individual differences and needs but do not necessarily act upon those differences and needs in their instruction. The findings revealed how strong teacher beliefs about adolescents and mathematics can be. Specifically, from the data analyses, I inferred from the teachers’ interviews and observations, that without strong aspirations to change, or without long-term training, teachers will remain in their belief systems. I also found some evidence to show that without aspirations, teachers may not change. Although their beliefs regarding adolescents and mathematics teaching varied, they shared some distinctive similarities. Table 13 shows the main themes and categories. In the following sections, I show in detail how each theme was formed from actual data.
Teacher’s expressed beliefs about adolescents’ mathematical learning are not necessarily borne out in their pedagogical practice

Lack of consistency may be due to social desirability from teachers
Lack of consistency may be due to contextual factors
Lack of consistency may be due to limited or improper theoretical understanding

Confronting their own folk beliefs about adolescents’ mathematical learning allows teachers to consider alternatives to those beliefs, and can influence their teaching practice. In the absence of this confrontation or without impetus for change, teachers will be more likely to abandon thoughts of changing their pedagogical practice

Confronting folk beliefs
Changing folk beliefs
Confrontation of folk beliefs influencing teaching practice

Teachers have firmly embedded traditional beliefs about mathematics instruction, although they may co-exist with student-centered views.

Firmly embedded beliefs about mathematics instruction
Student-centered beliefs

Teachers recognize adolescents’ individual differences and needs

Differences in learning needs
Differences in development (cognitive, emotional, social, maturity)

<table>
<thead>
<tr>
<th>Themes</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher’s expressed beliefs about adolescents’</td>
<td>Lack of consistency may be due to social desirability from</td>
</tr>
<tr>
<td>mathematical learning are not necessarily</td>
<td>teachers</td>
</tr>
<tr>
<td>borne out in their pedagogical practice</td>
<td>Lack of consistency may be due to contextual factors</td>
</tr>
<tr>
<td></td>
<td>Lack of consistency may be due to limited or improper</td>
</tr>
<tr>
<td></td>
<td>theoretical understanding</td>
</tr>
<tr>
<td>Confronting their own folk beliefs about</td>
<td>Confronting folk beliefs</td>
</tr>
<tr>
<td>adolescents’ mathematical learning allows teachers</td>
<td>Changing folk beliefs</td>
</tr>
<tr>
<td>to consider alternatives to those beliefs, and can</td>
<td>Confrontation of folk beliefs influencing teaching practice</td>
</tr>
<tr>
<td>influence their teaching practice. In the absence</td>
<td></td>
</tr>
<tr>
<td>of this confrontation or without impetus for</td>
<td></td>
</tr>
<tr>
<td>change, teachers will be more likely to abandon</td>
<td></td>
</tr>
<tr>
<td>thoughts of changing their pedagogical practice</td>
<td></td>
</tr>
<tr>
<td>Teachers have firmly embedded traditional beliefs</td>
<td>Firmly embedded beliefs about mathematics instruction</td>
</tr>
<tr>
<td>about mathematics instruction, although they may</td>
<td>Student-centered beliefs</td>
</tr>
<tr>
<td>co-exist with student-centered views.</td>
<td></td>
</tr>
<tr>
<td>Teachers recognize adolescents’ individual</td>
<td>Differences in learning needs</td>
</tr>
<tr>
<td>differences and needs</td>
<td>Differences in development (cognitive, emotional, social,</td>
</tr>
<tr>
<td></td>
<td>maturity)</td>
</tr>
</tbody>
</table>

Table 13. Themes Found in the Research and Sub-Categories from Themes

Theme 1: Lack of Consistency Between Expressed Beliefs and Observed Teachers’ Practice

Smith (1991) suggested that teachers’ beliefs about adolescents are devised by teachers through their own experiences, and that formal education in adolescents has little to do with teachers’ actual beliefs. Each of the three middle-grade teachers in this study noted the lack of formal study of adolescence, either in their undergraduate, or graduate studies. Additionally, none of them had any professional development as a practicing teacher that they could recall that pertained to adolescents. One mentioned a graduate class in brain development that may have touched on adolescents; another mentioned an undergraduate course that included, but was not exclusively,
adolescents. Because of this lack of specific training in adolescents, it is my position that the majority of these three teachers’ beliefs regarding adolescents came from their own experiences, in and out of the classroom.

The teachers did have beliefs about adolescents; yet, I found that at times these expressed beliefs, either written or verbal, were in contrast to their actual teaching practice. In other words, the teachers’ expressed beliefs about adolescents’ mathematical learning were not necessarily borne out in their observed pedagogical practice. The teachers indicated through their verbal interview responses or written responses that their beliefs about adolescents did not necessarily match what was observed in their teaching practice.

I presumed that part of the reason for this inconsistency may have been situational and due to social desirability; the teachers were giving me, as the researcher, the answers that they believed I wanted to hear. Another reason for the contradiction may have been due to perceived contextual factors, such as lack of time, and parental involvement. A third factor that might have contributed to the inconsistency could be limited or improper theoretical understandings. Figure 2 illustrates the categories that support this first theme. The following section details these categories.
Leading researchers in teacher beliefs including Kagan (1990) and Pajares (1992) stated that it is inadequate to investigate teachers’ beliefs on the basis solely of teachers’ talk or solely on the basis of teachers’ action. Researchers in other content areas, including Chen (2008), Judson (2006), and Levin and Wadmany (2006), in technology, and Keys (2005) in science, found that there was an inconsistency between teachers’ expressed beliefs and teachers’ practice. In this research, I make the assumption from that data, that at times the teachers did not know how to describe their beliefs, or they felt reluctant to express their beliefs if they felt the beliefs were not popular. Regardless, there was an inconsistency between the teachers’ expressed beliefs about adolescents’ mathematical learning and their mathematics teaching practices.

In both verbal interviews and written responses, I asked the participants a variety of questions pertaining to adolescents: What is the secret of working with adolescents? What are adolescents ready to learn? How would they describe a typical adolescent? How they would teach an adolescent differently from teaching an early
elementary child. These questions were asked to help give me a sense of the participants’ beliefs about adolescents.

I also spent several hours each week observing the participants’ teaching styles and pedagogies. What I noted were some pointed inconsistencies between expressed and observed beliefs. These inconsistencies were observed in bi-directional ways. For example, Ms. Blue stated some very conventional beliefs about adolescents, yet her teaching practice was constructivist based. Conversely, Mr. Green had some verbal and written responses that were student-centered, yet his instruction remained teacher-centered and lecture based.

*Mr. Green*

What follows are some of the dichotomous examples, beginning with Mr. Green. First are examples of some verbal and written responses, which are representative of what most of his recorded expressed beliefs regarding teaching mathematics to adolescents. Mr. Green expressed that students need motivation, the opportunity to solve complex problems, the opportunity to take chances, discovery, and cooperative grouping:

Adolescents are ready to learn whatever they want to learn. I’ve seen them do amazing things when they are motivated. A motivated student with average to above average background can get pretty deep into many subjects. They also are capable of solving complex and complicated problems (Written response, February 2008).

They [the students] need to take chances on learning and trust that their efforts will pay off (Written response, February 2008).

If I had unlimited time and it didn’t matter, I would definitely have them do more discovery type things, where they find things on their own. I would do more cooperative – I let them work together but that’s not cooperative. You know throw some complex problems at them and see what happens (Interview, December 2008).
These quotes provide evidence for a very cooperative, exploratory-type environment with statements that Mr. Green made regarding students solving complex problems and discovery teaching being the better method to use. In contrast to these expressed and more constructivist views about adolescent students’ needs and capabilities, I observed more of a traditional style of teaching, one that did not match Mr. Green’s expressed needs of adolescents in the mathematics classroom:

*On the PowerPoint, there was “line segment” with definition on slide. Students copied down the notes. Teacher went to chalkboard and explained the definition and how to name it. He went on to next slide, “ray” with the definition on slide. Teacher went to board and explained a ray, and then explained how to name it* (Observation of Mr. Green, November 2008).

*Mr. Green: “What about inequalities?” No wait time for students to answer. Teacher continued on with explanation from book and then gave the answer. Teacher: “What kind of graph is that, and or or?” Student raised his hand and said “or.” Teacher: “NO!” Several students said “and.” Teacher explained why it’s “and.” First responding student: “Oh yeah, I was looking at the wrong one.” Teacher continued to explain the “and” answer* (Observation, December 2008).

*Mr. Green went through step-by-step how to find the sum of angles in a regular polygon; he showed the steps on blackboard and students took notes. “How many degrees in each polygon?” No wait time. “If we wanted to find the sum of all the angles. Let me put this on the board for you. Write this down, ‘The sum of angles equals the number of triangles times 180 degrees’* (Observation, December 2008).

*Mr. Green asked: “How do you solve proportions – does anyone remember how to solve these?” No one responded. Teacher gave the answer: “cross multiply …..” and told/showed students how to solve this. Teacher told them that they should memorize these and learn the ones they did not know. Teacher gave students the rest of the time to work on three worksheets and said he will help them set up proportions if they needed it* (Observation, February 2009).

In these observations, there was mostly teacher-talk, rather than student inquiry. Mr. Green did most of the telling and showing of the mathematics, for
example when he went through his own thinking of finding the sum of angles in a polygon. When he posed a question to the students, Mr. Green gave little wait time, and answered the question himself. There was also little time given to meaning of the mathematics, instead, memorization of terms or procedures was emphasized. For example:

*Mr. Green:* “What is the tool called that we use to measure angles?” *Several students said “protractor.” Teacher: “What do we use to measure those angles?” Students: “angles”* (Observation, November 2008).

Mr. Green sought one-word answers from students rather than posing higher-level, open-ended questions, which would have allowed for students’ construction of ideas.

During observed lessons, Mr. Green did not display opportunities for discovery, taking chances, cooperative grouping, or complex problem solving, which were the characteristics he expressed as important when teaching adolescents. Mr. Green’s *observed practice* was teacher-centered, although his *expressed beliefs* were student-centered. There was a clear inconsistency between his expressed beliefs and his mathematical teaching practice.

*Ms. Blue*

Next, I examined Ms. Blue’s expressed beliefs about adolescents’ mathematical learning, and noted that verbally she expressed many traditional beliefs about adolescents, for example, that adolescents are hormonal, their priorities are out of order, and they are needy:

*[How would you describe a typical adolescent?] Their hormones are a mess, their bodies are changing, they have no idea what is going on around them most of the time. I think school is not a priority to an adolescent. It’s boys, it’s girls, it’s what are you doing this weekend. It’s the social circles that you build,*
and it starts right in 4th grade, they start building those social circles. An adolescent is to me, a well-rounded child, but school is not their priority. And that’s when it’s tough for the teachers, because you gotta get them any way you can. [Adolescents are] needy, confused, hormones, wanna please, want to do a good job, want structure, need pampering, need tough love sometimes, they need everything. The further along they are in adolescents, the less that the inquiry is effective (Interview, December 2008).

Ms. Blue’s expressed beliefs were traditional in nature, specifically, that adolescents are hormonal, needy and confused. These are socially accepted and long-established beliefs about adolescents. Yet, in my observations of Ms. Blue’s mathematics instruction, I saw a dispute with these expressed beliefs, which indicated a teacher who would be more traditional and teacher-centered. I noted, instead, an instructor who used her students’ thinking to make instructional decisions. She allowed autonomy and decision-making; something that would not be expected of someone with her expressed beliefs:

Teacher went to Smartboard, she had a question “penny a day” up. She instructed students to work in groups, and use scratch paper. The students seemed to understand how to work in groups. Teacher passed out calculators. Students began talking about problem and got right to work (the problem was already to go on computer to put on Smartboard – no down time to set it up). For 40 minutes the students worked in groups on the problem. The teacher walked around the room and asked the students questions, sometimes guiding them, but not giving them answers: “Are you sure?” “What do you think?” “Why?” (Observation of Ms. Blue, December 2008).

On warm-up problem 5, teacher read it twice and then said she was going to stop and let them work together on it. “Inga was riding on a train that had 96 cars. This particular train had one engine for every 24 cars. How many engines did the train have?” Teacher waited about 3 minutes and walked around to see what they were doing. “Let me see.” “How did you figure that out?” Teacher asked one girl to go to Smartboard and she worked out the problem “24+24+24+24=96” and then put the answer “4” up. Teacher then went up to the board to asked the girl a few questions on how she did the problem. Teacher then asked another boy to explain how he did the problem. Teacher showed his work on Smartboard. The boy made 96 tallies – and then
During my observations, Ms. Blue’s teaching practice was mostly inquiry-based, non-traditional, and student-centered. She posed rich problems, there was very little teacher-talk, she asked higher-level questions, such as “How did you figure that out?” and she asked her students to explain their thinking. Ms. Blue used her students’ thinking to guide her with what she would do next in her lesson. Yet, her expressed beliefs about adolescents were much more traditional in nature. Ms. Blue’s mismatch entailed a more positive view in action than in word. This inconsistency demonstrated that this teacher’s expressed belief about adolescents’ mathematical learning was not necessarily borne out in her pedagogical practice.

There were some occasions where Ms. Blue did express beliefs that better matched her teaching:

*What do you think is easy and difficult for adolescents?* I create a comfort zone, I think it’s easy for them to be comfortable with a topic that’s difficult. If you present it to them in a way that’s non-threatening, if you tell them that’s it going to be okay. Kids are more open to different ways of thinking (Interview, January 2009).

*What do you believe about adolescents based on your own experience?* I believe that if you tell them they can be successful, they will, and I believe that they crave that. They crave someone telling them it’s okay you made a mistake, let’s try something else. I see my biggest role as a teacher is building their confidence level (Interview with Ms. Blue, December 2008).

These expressed beliefs about adolescents from Ms. Blue showed a better match with her teaching practice. Ms. Blue expressed that teachers should present material in non-threatening ways and that her way of thinking through a problem was not the only way; she encouraged different ways of thinking. These comments were
more in line with the teaching that I observed, where more student thinking and inquiry were encouraged.

In the next three sections, I discuss potential explanations for the lack of consistency between expressed beliefs and observed practice. I begin with evidence indicating that the lack of consistency may be due to social desirability from the participants.

*Lack of consistency may be due to social desirability from teachers*

Kynigos and Argyris (2004) found that teacher beliefs might be inconsistent with actions during classroom teaching practice. What they found during interviews about teachers’ beliefs often conflicted with what was observed in the classroom. This is not to say that teacher beliefs do not influence their practice, but rather that we, as researchers, need to be careful that teachers’ expressed beliefs put on paper (written or verbal) are actually observed in the classroom. One reason for this discrepancy, as Kynigos and Argyris noted in their research, and the findings from the presented observations and interviews from this study support, may be due to social desirability from teachers. Social desirability is commonly thought of as the tendency of individuals to project favorable images of themselves during social interaction (Johnson & Fendrich, 2002).

*Ms. Red.* Observations from Ms. Red’s classroom provided evidence of what might be social desirability. My first scheduled observation of Ms. Red was in November. During this observation, I noted student-centered, inquiry-based mathematics instruction:
One student is taking role and lunch count, another student is walking around with a clipboard, checking off each student’s homework (Observation, November, 2008)

I noted that Ms. Red was giving her students autonomy and responsibility.

Let’s have someone come up and do the addition, the subtraction, the multiplication, the division.” Many students raised their hands. Teacher pointed to four students, who went to the board and worked out their problem. Student doing addition explained to class how he did problem; teacher asked him questions as he explained. The other students were to compare their answers to his, and find their error if they didn’t have the same answer. Student doing subtraction problem explained her procedure, she also explained how she checked her answer with addition. (Observation, November 2008).

This observation illustrated how the teacher allowed her students to use their own thinking, and demonstrate their thinking to others.

Teacher read next question from worksheet, “You know my next question will be why; explain why.” Several students raised their hand to answer and one student explained why (Observation, November 2008).

During this initial observation Ms. Red often asked her students to use their own reasoning and to explain the “why.” She also empowered her students by giving them some of the classroom duties. On this first day, Ms. Red’s teaching approach appeared to be student-centered.

Interestingly, as the weeks went on, I observed less of this student-centered instruction, and more teacher-talk and teacher modeling. Ms. Red used lower-level questioning, and not as much student thinking as I observed on that first day.

Teacher read the example in the book. Teacher continued going through the book verbally. Teacher asked a question, several students have hands raised. Teacher moved on to more examples from the book, she was going through this very quickly and stated that this is review for the students because they had this last year. Teacher walked around the room, although she spent most of her
time at one of the two blackboards at the front of the room (Observation of Ms. Red, December 2009).

Instead of having the students work out the problems and explain their thinking, as she did on the first observation, Ms. Red took on all of the responsibility by reading the examples herself and working the problems on the board using her thinking. This demonstrated a teacher-centered atmosphere, as noted in the following observational notes:

Teacher passed out today's worksheet; she started by going over vocabulary, and then went over the rest of the directions. She told parent helpers to go around room and help the students. She told the students that they would be given time to do the front of the worksheet alone, and then she said, “Let’s do #4 together before I let you go,” and she went to board and showed them how to make a 60 degree angle (Observation of Ms. Red, December 2009).

Ms. Red demonstrated her thinking of constructing angles instead of allowing the students to explore this on their own. She asked the students to mimic her way of thinking about angle construction.

Teacher showed different 3-d shapes (about 3 inches big) and held them up to show the difference (i.e. between triangular pyramid and triangular prism). Teacher asked student to read the next page, which was a review of triangles. Student began to read and teacher stopped him several times to ask the class questions; she mostly answered the questions herself or reiterated what he was reading (Observation of Ms. Red, January 2009).

Compared to the first observation in November, Ms. Red used less inquiry and less student thinking. She used her own thoughts about shapes instead of allowing students to create meaning, as evidenced by the following observational transcript:

Teacher asked class about order of operations. Several students said, “please excuse my dear aunt sally.” Teacher wrote PEMDAS on board and then asked students what each meant. Students yelled out each step. Teacher then went through each problem on board. She wrote, but asked students to give answers
along the way, making sure they “re-write the problem” after each step of the problem solving (Observation of Ms. Red, January 2009).

From this episode I noted that that Ms. Red relied on mathematical “tricks,” such as PEMDAS, to help the students memorize steps. In a more inquiry or standards-based classroom, a teacher would allow students to create their own meaning with order of operations, helping them to discover the “why” instead of the “how.”

In sum, as I spent more time in Ms. Red’s classroom more and more of it during unscheduled times (which she encouraged), in my observations I noted an increase in teacher-centered instruction. I observed more teacher-talk and teacher modeling. One supposition that I might make regarding this inconsistency in instruction is that Ms. Red showed me what she felt was the socially desirable teaching practice at the beginning of my observations, and as time went on, I saw a more realistic picture of her day-to-day mathematics instruction. There are other possible explanations. For example, Ms. Red could have been responding to pressures to cover the curriculum faster, or she could have felt that her students were falling behind.

Mr. Green. Next, I examine Mr. Green’s beliefs and observed teaching practice. I noted that Mr. Green expressed some inquiry-based beliefs: he expressed verbally that it was good for adolescent students to work together cooperatively, and he felt students were capable of solving complex and complicated problems.

Examples from an interview and a written response represent this:

The couple of years that I didn’t have testing over my head I did a lot more cooperative work, had them works in groups and stuff. You know, throw some complex problems at them and see what happens (Interview, December 2008).
Adolescents also are capable of solving complex and complicated problems (Written response, February 2009).

Over four months of observations in Mr. Green’s classes, I did not observe him using cooperative grouping or posing complex problems, suggesting that these are not regular or prominent features of his classes. As a result, they did not appear to be a significant component of his classes, in spite of his verbal and written expressions regarding cooperative group work and inquiry-based instruction. I might presume that Mr. Green was giving me the socially desirable answer to my questions about teaching adolescents.

*Lack of consistency may be due to perceived contextual factors*

All of the participants discussed various contextual factors when they expressed their beliefs about teaching mathematics to adolescents. These contextual factors included lack of time, achievement tests (which were referred to as ‘the test’), lack of student motivation, and parental involvement (or lack of it). These contextual factors may have had an impact on the participants’ expressed beliefs and their teaching practice. In other words, they may have believed in teaching one way, but because of these perceived contextual factors they believed they could not control, their actual teaching differed from that belief. Beginning with the parental contextual factor, examples follow:

*Parental contextual factor:*
What I see in the classroom is that I want them to think outside the box and abstract as much as possible. I think that I’m working against what they get at home sometimes. Take a step forward then take a step back. Especially when parents just show them at home and the kids don’t understand what they’re doing. But they follow their parents because that’s what they’re supposed to do. They get it a different way and their parents don’t think that they because
they were taught so traditional. Kids are more open to different ways of thinking (Underlines added. Interview with Ms. Blue, January 2009).

I think the good thing, teaching the way I do now [in a more traditional way], is that it’s not any better or worse [than using inquiry or cooperative groups]. I don’t think I’m doing anything worse than that – but I think it [the inquiry/cooperative way] was more fun, more creative on their part, more ownership than me just telling them what to do. There were good aspects about it, except it takes time and it’s non-traditional, and parents had a problem with that. One parent who was involved in everything made a big deal about it (Underlines added. Interview with Mr. Green, December 2008).

Both Ms. Blue and Mr. Green indicated that the parents were part of the reason they could not teach mathematics the way they really wanted to teach. Either the parents complained about the constructivist-style of teaching or the parents only knew the traditional mathematical methods, so they would only encourage those at home. This perceived contextual factor of parental involvement might explain the inconsistencies between expressed beliefs and actual practice. Time was another factor that was expressed as being problematic to the teachers, as evidenced by the following interview responses:

*Time Factor:*
*If you weren’t tied down to curriculum or state testing, how would you teach adolescent?* The best way if you had no restrictions. My biggest problem is time – what I do and the way I teach more than anything – you know, having so much covered in each grading period, and the test in the spring. The race is how much you get covered. This fortunately works for most kids – you know, the old, show them how to do stuff and let them do it thing. But it doesn’t work for all kids, so they kinda feel left out. If I had unlimited time and it didn’t matter, I would definitely have them do more discovery type things, where they find things on their own. You know that slows things down a lot! (Underlines added. Interview with Mr. Green, December 2008).

*If you had the ideal world what would you do?* I would teach math for more than 45 minutes. I would allow a lot more independent work time which they don’t have much of because we’re constantly going over assignments and quickly preparing for the next day, the next skill. And doing that all over
again. And I feel if they had more time to work they could ask more questions, I could be better serving the needs of especially those kids who are struggling. Time is not on my side. Because we rotate schedules, 45 minutes is all we can do (Underlines added. Interview with Ms. Red, November 2008).

Last year I worked with the science teacher and we did a collaborative unit together, where they were doing food webs, food cycles, food chains, and we did a game with coyotes where they had to find a certain amount of food or they starved to death and died. So they showed whether they survived and if they didn’t they showed the kinds of food they found, and we graphed it in 4 different ways. And that was really great but it took so many class periods to do those graphs in class that I didn’t do it this year. So again it was meaningful but it took so much class time that I felt like we couldn’t linger, especially because I was out of school for three weeks this year. I didn’t have time for that (Underlines added. Interview with Ms. Red, November 2008).

Ms. Red and Mr. Green both expressed concerns about the contextual factor of time. They expressed that they would like to use cooperative grouping, rich problems, and more student questioning, but those took a lot of time. Therefore, they expressed that these elements were taken out of their teaching practice for the most part. This factor of time might be a reason there was an inconsistency between the participants’ expressed beliefs about teaching mathematics to adolescents and their actual teaching practice.

Following are interview responses illustrating teachers’ thoughts on the achievement test and how it might be a contextual factor preventing them from teaching in the way they expressed they would like to teach:

The Test Factor:
I’m going to be totally honest with you. I feel like it doesn’t even matter any more, and that sounds like a horrible attitude, but I feel like so much of what we do is dictated now that it really doesn’t matter what I think. So much is dictated what we teach and when we teach it, you know that I’m just really fighting hard to slug through it all and make sure that they are prepared as they can be for that achievement test when March or April comes (Underlines added. Interview with Ms. Red, November 2008).
I feel as if there’s less time for lessons that they would appreciate more, because there is so little time. I believe that’s because of the test. We’ve had (in her class) discussions about the test and I’ve explained to them I’m not saying “the test the test the test” to scare you, it’s the goal we’re working towards. We want to be prepared because everything we do is in preparation for this because you’ll be tested on this and this is what you are supposed to know by the end of 5th grade. It isn’t ideal (Underlines added. Interview with Ms. Red, November 2008).

Because of the achievement tests, another perceived contextual factor, Ms. Red’s expressed beliefs about how she should teach adolescents, did not always match her actual teaching practice. She indicated that the achievement test dictated what she would teach and the preparation for it takes up so much of her teaching time. The achievement tests are a possible reason for the mismatch between expressed beliefs and actual mathematical instruction.

Finally, the following responses provide evidence that teachers might consider students’ motivation to be a contextual factor to their teaching:

_Students’ Motivation Factor:_

The motivation isn’t going to be there to try so hard on something you don’t get right away; you’re going to lose them because they don’t care enough (Interview with Ms. Blue, December 2008).

Adolescents are ready to learn whatever they want to learn. I’ve seen them do amazing things when they are motivated. A motivated student with average to above average background can get pretty deep into many subjects. They also are capable of solving complex and complicated problems (Written responses from Mr. Green, February 2009).

The participants expressed that student motivation was a contextual factor, a factor that they could control. The teachers’ expressed beliefs about student motivation (or lack of it) did not necessarily match their teaching practice. For example, Ms. Blue expressed verbally that her students’ motivation was ‘not going to
be there.’ Yet, my observations revealed quite motivated students: they paid attention, answered questions and were eager to learn in Ms. Blue’s inquiry-based classroom.

Another example illustrated Mr. Green expressing his ideas about students having the capability to solve complex, deep problems. Yet, my field notes indicated, during the time I spent in his classroom, that such instruction was not implemented in Mr. Green’s classroom. His expressed beliefs about student motivation did not match his teaching practice. With both Ms. Red and Mr. Green, these contradictions could have been due to their perceived contextual factor of students’ lack of motivation.

_Lack of consistency may be due to limited or improper theoretical understanding_

Perceived contextual barriers or social desirability could result in teachers’ inconsistency between expressed beliefs and practice, and in some cases, teachers’ lack of theoretical understanding could also explain this discrepancy. Fullan (2001) suggested, “teachers may value and precisely state the concepts of promoted change but fail to understand how to put these concepts into practice” (p. 71). All participants in this study expressed some kind of agreement with constructivist principles, however two of the teachers (Mr. Green and Ms. Red) implemented their mathematical teaching practice on the basis of their own understanding or folk beliefs rather than constructivism. Mr. Green and Ms. Red considered constructivist concepts ideal rather than practical. Next, I examine how the mathematics classrooms look both with the guidance of constructivist theoretical principles and without.
Ms. Blue. Through the Mathematics Coaching Program (MCP), Ms. Blue received two years of extensive training in constructivist principles, such as Cognitively Guided Instruction (Fennema & Carpenter, 1999), the National Council of Teachers of Mathematics (NCTM) Process and Content Standards (2000), and inquiry-based instruction. She was taught to use student thinking in her teaching. She spent approximately 20 hours per month learning from experts on these techniques, in addition to implementation, and self-learning.

Ms. Blue learned, in-depth, a new theoretical understanding, and applied it in a K-6 setting for two years. She stated that she had not previously subscribed to any of the beliefs she was taught in the MCP, as expressed in the quote below:

[Categorize your pedagogy/instructional of teaching math.] Before math coaching, it was, just learn it, you’ll realize what’s happening later, really it was. And that’s how I learned math. I didn’t really understand what I was doing. And then I had the CGI training and I see where the inquiry-based stuff comes in, especially kids that are grappling with they can’t even memorize the algorithm and they have no sense to make of it, so they’re not creating a good one in their head (Interview, December 2008).

Ms. Blue expressed that before her involvement in the MCP, she was very traditional in her teaching, asking her students to just follow her procedures. After her training experiences in the MCP, she indicated that she understood how inquiry-based instruction worked. My observations showed the majority of Ms. Blue’s instruction displaying an inquiry-based, CGI-type approach. For example:

*Teacher gave directions about fraction cards; these were cut out from the back of their Everyday Math book. The students filled in the fraction on one side and there were colored fraction bars to match on the backside.*

*Teacher went to Smartboard and asked student to make 3 piles: she wrote “less than ½, equal to ½ and more than ½ on the smart board” directions on the smart board and verbally told them this, as well.*
Students worked diligently and independently sorting out their cards. Teacher went around and asked individual students about their piles. Teacher then asked students to get in partners to see if their piles match, and discuss. Students did this immediately and were on task (Observation, February 2009).

The examples of Ms. Blue, who posed problems such as “put these cards into three piles: less than 1/2, equal to 1/2, and more than 1/2, and be able to tell why you put them there,” indicate a student-centered approach to teaching mathematics. She used students’ thinking as in the above episode where she asked individual students about why they placed cards in certain piles. Ms. Blue used less direct instruction, for example, she would often pose rich problems and allow the students to work through them, instead of standing at the front of the room teaching them a certain way to work through that problem. These examples illustrated that with proper and long-term theoretical training, it is possible for a teacher to change his or her beliefs about mathematical instruction. Even though Ms. Blue did make changes and was much more inquiry-based than she was before MCP, she did rely on some traditional mathematics teaching, as well. It is important to note that I did not observe these changes from traditional to reform-based. Ms. Blue commented on teaching in a traditional manner beginning in her first year of teaching and lasting until several years ago; I did not witness this. My comments regarding Ms. Blue’s change in practice relied on her statements.

Mr. Green and Ms. Red. When examining the data from Mr. Green and Ms. Red, the evidence showed a more limited theoretical understanding of constructivist mathematical teaching. This evidence may shed light on the inconsistency between
their expressed beliefs and their teaching practice. Ms. Red expressed that adolescents need “time to think and reason,” an idea that constructivist would agree with, yet she spent a great deal of mathematics instruction time using teacher-modeling and direct instruction. Mr. Green expressed that the best way to teach adolescents, if there were no constraints, would be to “definitely have them do more discovery-type things, where they find thing on their own, then go from there, ‘how did you do that?’” This is a constructivist-type approach to learning mathematics, but it was not implemented in the participant’s classroom during my observations. Mr. Green’s teaching was observed as being teacher directed and traditional in nature.

The National Council of Teachers of Mathematics (NCTM) and the Ohio Department of Education encourage teachers to integrate more constructivist approaches in their mathematics teaching. The NCTM’s Process Standards (2000) (reasoning and proof, problem solving, representations, connections and communication) are included in the Ohio Academic Content Standards (2001). It appeared, though, that the teachers either did not necessarily have appropriate understanding about the theoretical concepts, or did not necessarily know how to incorporate the promoted concepts in their daily practice.

To summarize, in Theme 1, I identified inconsistencies between the participants’ expressed beliefs about adolescent mathematics instruction and their observed mathematics teaching practices. I acknowledged three possible explanations for this inconsistency: social desirability from the teachers, contextual factors, and a limited or improper theoretical understanding. Table 14 summarizes these findings:
Inconsistencies between expressed beliefs and practice may be due to:

<table>
<thead>
<tr>
<th>Social Desirability</th>
<th>Ms. Blue</th>
<th>Mr. Green</th>
<th>Ms. Red</th>
</tr>
</thead>
<tbody>
<tr>
<td>No evidence observed for this factor</td>
<td>Observed in difference between expressed beliefs (inquiry-based) vs. observed practice (traditional)</td>
<td>Observed in difference between earlier (student centered) vs. later (teacher centered) observations</td>
<td></td>
</tr>
</tbody>
</table>

| Contextual Factors | Observed regarding parents and student motivation | Observed regarding “the test,” time, student motivation, and parents | Observed regarding “the test,” time, and student motivation |

| Limited Theoretical Understanding | No evidence observed for this factor | Observed in difference between expressed beliefs (constructivist ideals) and observed practice (traditional in nature) | Observed in difference between expressed beliefs (constructivist ideals) and observed practice (traditional in nature) |

Table 14. Summary of Theme 1, Inconsistencies between expressed beliefs and practice, by Teacher

Theme 2: Confronting Their Own Folk Beliefs about Adolescents’ Mathematical Learning Allows Teachers to Consider Alternatives to those Beliefs, and can Influence Their Teaching Practice. In the Absence of this Confrontation, Teachers will be More Likely to Abandon Thoughts of Changing their Pedagogical Practice.

With all of the participants, I noted some challenge of their own beliefs regarding adolescents’ mathematical learning to a certain extent. While examining the data from Mr. Green and Ms. Red, I noted that the confrontations were minimal. They expressed having given brief thought to changing the way they taught adolescents, but those thoughts did not go any further, and it appeared that they did not take any action to change. In regards to Ms. Blue, I noted greater conflict than the others about the
way adolescents were taught. She not only verbalized her dissatisfaction with her traditional teaching methods, she acted upon it.

I first examine the two teachers whose interviews indicated minimal self-confrontations with their beliefs about adolescents’ mathematical learning. I preface this by noting that my assertion was based only on the four months I spent with these participants and not on their entire teaching careers. Their confrontations of beliefs, or lack of, are only what I noted during this research timeline.

*Mr. Green*

During one interview, Mr. Green seemed to challenge his own belief regarding the use of a more constructivist approach:

If I had unlimited time and it didn’t matter, I would definitely have them do more discovery-type things, where they find things on their own. You know, where I give them a problem and they come up with some of the stuff on their own. Then go from there, “How did you do that?” and then make up the rules and see how it matches what we already do. I would do more cooperative (December 2008).

However, that challenge was quickly stifled, and he indicated that he did not need to make any changes; he justified that his instructional strategies are working just fine:

You know that slows things down a lot! I think the good thing, teaching the way I do now, is that it’s not any better or worse. I don’t think I’m doing anything worse than that (Interview, December 2008).

It appeared as if Mr. Green had little reason to consider alternatives to his beliefs about teaching mathematics to adolescents because his teaching methods were just as good and more time efficient. From the interviews and observations, it seemed that in his attempts to re-evaluate his teaching instruction, Mr. Green found no better student achievement results than teaching the way he had always taught mathematics:
I like to talk and show them stuff on the board. I’ve tried other approaches, more cooperative learning, working in groups. It did work, but not any better. I tried to keep an open mind. In the end when it came down to testing and what they know, I don’t think they knew much better and my thing is that I like to control things so I feel much more comfortable with everyone listening to me, watching at me (Interview, December 2008)

Mr. Green preferred to show the entire class his method of solving the mathematics. He felt that this type of teaching practice allowed all the students to receive the same information. Additionally, Mr. Green, was, himself, taught in this same manner. He expressed an attitude of, “Why change something that worked for him?”

[What influences how you teach?] The style of my college professors, my high school teachers, which is really old school. The education professors would say, “Lecture is not the best way.” I’ve never really had a model of different teaching styles to me, even at grad level. I’ve tried to change it a little bit. My past teachers have influenced my teaching. My math teachers were all very similar ---- the good ones” (Interview, December 2008).

Mr. Green’s “good” and “traditional” mathematics teachers helped him to understand math. Even though some professors told him not to “lecture,” they also seemed to not have modeled anything different. He emulated their pedagogical approaches in his classroom, because no other way seemed to be any better.

Ms. Red

As with Mr. Green, a similar type of exchange was found with Ms. Red. This quote from an interview demonstrated a glimpse at an alternative belief to her teaching practice:

Sometimes they can learn it better from a peer … so I guess it would be good if I gave them more opportunities to do that (Interview, November 2008).
Ms. Red considered cooperative groups as an alternative to the way she taught adolescents, and even went on to acknowledge that when the students had computer time, they did work together. Some factors (e.g. the students’ behavior) interfered with her continuing this alternative practice, “I think the behavior and attention seeking gets in the way of it. Maybe it’s just me because I don’t respond well to it” (Interview, January 2009).

Possibly more important with Ms. Red was that she had somewhat strong beliefs about how students reason at a higher, abstract level. Namely, she believed intelligence and effort were the keys to students’ abstract thinking ability:

I think they come in with a certain level of it [abstract thinking] just because of their level of intelligence. Sometimes their effort isn’t as good. Cory will be lazy and could give me more than he does. Tom consistently does what he needs to do, but I think that’s because he’s a higher-level thinker. Jack is very bright gives a lot of effort because he desires a lot of attention – he is bright and can think of things (Interview, January 2009).

What do you think/believe about the way adolescent mind’s work?] What I notice is that I expect them to be able to do more than they really are ready to do. Even in their reasoning skills – they are not well enough developed to consider them as adults, and I feel that we think they should be adults. But I see these kids make choices or have behaviors, and I think, “That just doesn’t make sense, why did you think that would be okay?” Their irrational choices make me think that they’re not capable for the higher level reasoning that we expect them to demonstrate (Interview, January 2009).

These were not necessarily confrontations of Ms. Red’s belief, but rather affirmations of her beliefs that factors outside of her teaching, namely the intelligence and effort level that students come in with, and their reasoning skills at this age, are what decided how much abstract thinking the students would be able to do. In other words, there
was no reason to confront her belief because she could not control the abstract thinking or reasoning in her students.

This belief was displayed in her teaching. Although Ms. Red asked her students higher level questions, “Why? Explain that to me? Tell me your thinking. What do you know about squares?” She also made the connections for her students, a higher-level reasoning skill:

Teacher was at board. She told students she was going to show them the rainbow method of finding factors. She used 36 as example, putting each factor that students gave in order and drew rainbow lines to connect them (Observation, February 2009).

Teacher went to the board to work out dividing 84 by 6. Joe helped her work out the problem out loud. When he got stuck, she reminded him ‘Dracula Must Suck Cold Blood’ on how to do long division, and then continued problem with Joe. Later she commented, ‘We don’t guess in math’ (Observation, February 2009).

Ms. Red guided her students’ thinking; she made the mathematical connections for them. Ms. Red’s beliefs indicated that her students’ abstract thinking or reasoning skills were outside factors to her teaching. She could not control these; the students came in with certain levels of abstract thinking because of their intelligence and their effort. Her beliefs, expressed verbally, were borne out in her teaching practice.

Ms. Red, like Mr. Green, had no need to spend a great deal of time confronting her beliefs. Her students’ behaviors, efforts, and work reinforced her beliefs. She did not confront her own beliefs, and, as a result, there was not much of a reason to seek alternatives. In other words, with Ms. Red and Mr. Green, there was not a strong confrontation of their folk beliefs regarding adolescents’ mathematical learning.
Because of this, they seemed to abandon their thoughts of changing beliefs about adolescents and, ultimately, their pedagogical practice.

Ms. Blue

I now examine Ms. Blue’s folk beliefs. Before working in the Mathematics Coaching Program, learning about CGI, or practicing inquiry-based instruction, Ms. Blue described herself as traditional. She learned mathematics very well in a traditional setting, therefore, she taught in that same manner. She expressed that if you just showed students how to do the math that was good enough:

I didn’t really understand what I was doing when I was multiplying 3 digit by 3 digit, but I had learned the algorithm, and somewhere along the way it kinda made sense. And then I got the number sense after the fact, so that was how I thought it was done. The traditional side pulls me because when they’re [her students] getting ready for a test I just want to show them. And there’s a part of me that thinks that’s good enough only because that’s how I learned and I have fantastic number sense. I don’t know where I got it. All my teachers were traditional from beginning to end. I never had an inquiry-based instructor, I never had anyone who let us explore (Interview, December 2008).

These comments reflect a very traditional nature regarding teaching mathematics: showing procedures, understanding the ‘how’ without understanding the ‘why’. Even though Ms. Blue did not teach in an entirely reform-based or inquiry-based manner, “I bet I am 50/50 in the middle,” she reported that she did confront her beliefs about mathematics instruction, and made a change to her beliefs. She noted that before the MCP, her pedagogical approach was:

I just want to show them. This is what you’re going to do this is how you’re going to do it, these are the words you’re gonna look for, just go. Don’t understand, just know how to do it and maybe the understanding will just come later (Interview, December 2008).
After two years of training in inquiry-based mathematics instruction, her beliefs changed to statements such as:

- I believe that if you tell them they can be successful, they will, and I believe that they crave that. They crave someone telling them, ‘It’s okay you made a mistake, let’s try something else’. I see my biggest role as a teacher is building their confidence level (Interview, December 2008).
- What I see in the classroom is that I want them to think outside the box and abstract as much as possible (Interview, January 2009).

These comments indicated an inquiry-based approach to teaching mathematics, as opposed to Ms. Blue’s expressed traditional beliefs before the MCP. After her two years of inquiry-based training, Ms. Blue’s alternative beliefs to teaching mathematics changed to:

- If you present it [mathematics] to them in a way that’s non-threatening, if you tell them that’s it going to be okay, I think it’s easy for them to be comfortable with a topic that’s difficult (Interview, January 2009).
- Adolescents are so different developmentally. Sometimes I don't think that we as adults give the students enough credit. I just try to present material in many different ways and help students find their own comfort zone (Written answers, March 2009).

These statements were distinctly different from her folk beliefs; they were more student-centered and based on inquiry. Ms. Blue, through her two-year training in the MCP, confronted her beliefs and considered alternative beliefs.

Additionally, Ms. Blue’s contemplation of alternate beliefs led to an influence in her teaching practice:

- Teacher said, “Someone will need to repeat what J just said, so listen up.”
- And then teacher said, “Henry, tell me what Jackie just said” and Henry did repeat, not word for word, but the same idea (Observation, January 2009).
Teacher prepared (before school) by putting problems on computer and then projected it onto the Smartboard. The problem was, “There are 6 rows of chairs. There are 4 chairs in each row. How many chairs are there in all?” Teacher then put up a chart with 3 columns: rows/chairs per row/ chairs in all. She told the students that they were to solve this with the people at their table, and they could use the chart or not (Observation, January 2009).

Students were working with one question that the teacher had posed. Some were talking to each other, and some were working alone. Some students asked teacher questions during this short work time. When they asked her questions, teacher responded with: “Tell me how you got this. Prove it. Why do you think? I think that’s fantastic. Is it? How do you know?” (Observation, February 2009).

As illustrated in the above passages, Ms. Blue used higher level questioning, group work, rich problems, and communication building, which indicate a more inquiry-based teaching approach than a traditional one. It is my assertion that, because of the confrontation of her traditional beliefs (via the two years of MCP training), Ms. Blue not only changed her beliefs about teaching mathematics but also changed her mathematics’ instructional approach. I did not observe Ms. Blue during what she identified as her more traditional years; I relied on data gathered from her statements to support this assertion.

To summarize this second theme, I affirmed that confronting their own folk beliefs about adolescents’ mathematical learning allowed teachers to consider alternatives to those beliefs, and could influence their teaching practice. I illustrated this with Ms. Blue and the change in her beliefs and practice. I also affirmed that in the absence of confrontation regarding folk beliefs about mathematical practice, teachers would be more likely to abandon thoughts of changing their pedagogical practice. This was shown with Ms. Red and Mr. Green, as they considered belief
changes, but abandoned them for various reasons. Their beliefs, then, were not changed, nor were their pedagogical practices. I note again, that these statements were made with the information gained over a four-month period and cannot account for the teachers’ practices throughout their teaching experiences. Table 15 summarizes this theme:

<table>
<thead>
<tr>
<th>Observation</th>
<th>Ms. Blue</th>
<th>Mr. Green</th>
<th>Ms. Red</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confronted folk beliefs</td>
<td>Observed in interviews regarding her past traditional teaching practice vs. current inquiry-based practice</td>
<td>Observed in interviews regarding using inquiry-based approach</td>
<td>Observed in interviews regarding cooperative group work</td>
</tr>
<tr>
<td>Changed beliefs</td>
<td>Observed in interviews regarding her past traditional teaching practice vs. current inquiry-based practice</td>
<td>Not observed</td>
<td>Not observed</td>
</tr>
<tr>
<td>Confrontation influenced teaching practice</td>
<td>Observed in interviews regarding her past traditional teaching practice vs. current inquiry-based practice</td>
<td>Not observed</td>
<td>Not observed</td>
</tr>
</tbody>
</table>

Table 15. Summary of Theme 2, Observations of Confronted Beliefs, by Teacher

Theme 3: Teachers have firmly embedded traditional beliefs about mathematics instruction, although they may co-exist with student-centered views. When called upon in traditional classrooms, children are expected to tell the class what the teacher wanted them to learn rather than express their own thinking.
(Voigt, 1996). The type of teaching that reform educators recommend requires both teachers and students to think differently about the nature of mathematics (Lampert, 1990). This is not an easy transition for teachers who have spent many years learning and teaching in a more traditional manner. For teachers this transition includes knowledge of mathematical ideas, skills of mathematical reasoning and communication, fluency with examples and terms, and thoughtfulness about the nature of mathematical proficiency (Ball, Hill, & Bass, 2005). Administrators and school board members, if preoccupied with test scores, put pressure on teachers to emphasize basic skills such as computation and fact memorization.

All three of the participants in this study expressed traditional beliefs about mathematics instruction. I use the term “traditional” to represent a teacher-centered classroom, where students are given little opportunity to construct their own knowledge (Ball & Cohen, 1999). In traditional mathematics classrooms, students tend to be given information that they are to memorize and perform in ways that are shown to them. To some extent, these traditional beliefs co-existed with student-centered views for all three of the participants.

*Ms. Blue*

Most of Ms. Blue’s observed teaching was inquiry-based. She used student thinking, cooperative groups, rich problems, and high level questioning. The one aspect of Ms. Blue’s instruction that was traditional was the memorization of math facts. She acknowledged that traditional mathematics teaching pulled at her, because
it was what worked for her as a student, and because it had worked for test preparation before.

The traditional side pulls me because when they’re getting ready for a test I just want to show them. This is what you’re going to do this is how you’re going to do it, these are the words you’re gonna look for, just go. Don’t understand, just know how to do it and maybe the understanding will just come later. And there’s a part of me that thinks that’s good enough only because that’s how I learned and I have fantastic number sense (Interview, December 2008).

Her comment about being “good enough” was interesting because it showed that she knew the traditional way of teaching was not the best method, but that it might be the easier path.

More than once, Ms. Blue indicated a mix in her beliefs about mathematics instruction:

So I’m definitely pulled more towards the middle, and I could not and would not teach entirely in inquiry-based math and I wouldn’t go back and teach entirely in traditional anymore. I bet I am 50/50 in the middle (Interview, December 2008).

Some students need to memorize, then understand. Some need to understand before they memorize. Some students need the direct approach and some need to explore. The only thing that is consistent is that all students learn at their own rate, have their own needs and reach developmental levels on their own time (Written response, March 2009).

Ms. Blue seemed to not be able to let go of some of the memorization aspects of teaching mathematics, which are more traditional. Even though she mentioned exploration and inquiry, she expressed reluctance of abandoning the traditional method of memorizing. This belief was carried out in her teaching when students competed on math facts:
Students were ready to do “around the world” with math facts. Teacher gave star points for ‘beating’ 5 people or 10 people or going around the world. Students were very excited about this. The game went on for about 20 minutes. The competing students were very involved, and if they were not competing, they sometimes looked back at the multiplication tables hanging in the back of the room. Even if they were not the two competing, they seem involved in the game (Observation, December 2008).

Teacher told students to get out their flash cards, find a partner and practice math facts for 10 minutes. Students went to different parts of the room and immediately started this (Observation, December 2008).

Competing to do math facts in the quickest time is a more traditional method of teaching mathematics. Ms. Blue’s hesitancy to let go of some of her more traditional beliefs played out as she had her students compete to memorize their multiplication tables. Ms. Blue wanted her students to quickly be able to recite their multiplication facts. This firmly embedded, traditional mathematical belief seemed difficult for her to let go. Even though most of Ms. Blue’s observed teaching was not traditional, this particular belief was rooted in her teaching.

Ms. Blue’s approach to multiplication fact memorization is consistent with research on the brain and the need for automaticity in basic mathematics processes (Pegg, Graham & Bellert, 2005; Royer, Tronsky, & Chan, 1999; Zbrodoff & Logan, 1996). Research indicates that the practice of information in short-term memory, like when a learner rehearses multiplication facts, appears to be critical in establishing permanent memory in the long-term stores of the brain (Dautrich, 2009; Pegg, Graham & Bellert, 2005). In mathematics,

basic knowledge becomes consolidated in long-term memory, and math facts and procedures gradually become automatic. It is exactly this automaticity that “frees up” the processing load on the brain so it can dedicate more mental
energy to the higher-order tasks of reasoning and complex problem solving (Dautrich, 2009, p.3).

Ms. Blue’s method of instruction was predominately non-traditional and inquiry-based; she only used this ‘rehearsal’ approach for computational facts. Interestingly research is consistent with such an approach, and there is evidence that in basic mathematics “a pupil’s lack of automaticity can result in a reduced ability to solve problems and understand mathematical concepts” (Pegg, Graham & Bellert, p. 4-50).

Mr. Green

Mr. Green’s traditional belief about mathematics instruction also appeared to be firmly embedded. He stated that his past instructors were his main influence.

The style of my college professors, my high school teachers [influenced the way I teach], which is really old school. The education professors would say, ‘lecture is not the best way.’ I’ve never really had a model of different teaching styles to me (Interview, December 2008).

Mr. Green indicated that his education professors told him not to lecture (which is more traditional); yet he does not recall that they showed him any better way.

These unchallenged traditional beliefs were carried out with Mr. Green as he discussed what material he used in teaching mathematics:

What I’m going back to, and I got away from in the past couple years, is going in the order of the book, just because I figured they’ve done research and have people who have figured out what the order should be, and why should I change that (Interview, December 2008).

Mr. Green was going through the mathematics book, chapter by chapter. This is considered a more conventional belief to teaching mathematics.
Another firmly embedded, traditional belief of Mr. Green’s was that students should listen quietly and be able to absorb what he was telling them to do using his way of thinking:

I like to control things so I feel much more comfortable with everyone listening to me, watching at me, instead of having them on their own and seeing where they’re going. I’d rather have just have them all get it all at once with me and then work with individuals who are having trouble (Interview, December 2008).

Mr. Green believed that having better control over the students, which entailed them to better listen to him, was the best way to teach them mathematically. This, again, showed a more traditional manner of mathematics instruction. In another conversation about using groups to work with such a wide range of student levels, Mr. Green brought up the control issue again:

So that’s the other thing, I can control. If the low kid wants to mess up themselves, and if they want to mess around that’s fine, but they’re not messing everyone else up. In a group situation, that can hurt other kids (Interview, December 2008).

This quote showed evidence of Mr. Green not wanting to relinquish control. If he utilized group work, his control might be gone. If he used group work, he expressed beliefs that some students (the higher ones) might be hurt by other students (the lower ones).

Mr. Green was taught mathematics in a traditional manner; even in his graduate work he indicated that he was not shown any reform-based or inquiry-based methods of teaching mathematics. My observations indicated that Mr. Green’s teaching was also very traditional in nature. He indicated beliefs about teaching mathematics that were conventional, and taught in a manner that mimicked those
beliefs. He appeared to have no intention of letting go of those beliefs. His beliefs indicated that his instructional methods were working in his classroom, and that his way of teaching mathematics to adolescents was satisfactory.

Ms. Red

Ms. Red’s beliefs tended to focus on getting the students through as much mathematical content in the short time she had. This is a more traditional thought process of quickly “stuffing” the students full of information. Researchers affirm the dilemmas Ms. Red exhibited:

Teachers are generally responsible for a curriculum that is both traditional and warranted by these very traditions … The structure of the school days also means that teachers are isolated from one another and have little time to support each other (Ball, Luienski, & Mewborn, 2001, p. 435).

Ms. Red’s expressed beliefs indicated that she was concerned more about her students figuring out the methods of “how to,” rather than “why.”

It is very difficult to get them to move to the application/problem solving level from the lower level knowledge of basic skills and computation level. Unfortunately, the Fifth Grade OAT includes much more problem solving than basic computation. Though some are quite proficient at decoding word problems and problem solving situations, a great many have difficulty even knowing what operation to perform (Written response, March 2009).

This quote is evidence of Ms. Red’s concern regarding her students knowing which operation to use, rather than understanding the mathematics. This also shows evidence of a more traditional belief regarding the importance of basic computation.

Ms. Red’s traditional belief about getting students to understand the steps instead of concepts was similar to a teacher studied by Wood, Cobb and Yackel (1991). Prior to the classroom experiment, the second grade teacher in that study
provided students with step-by-step instruction, and then assigned them work, followed by pulling small groups of students who didn’t understand the day’s lesson and re-taught to that group.

When she directed their thinking by revealing the solution bit by bit, she was depriving the children of the chance to think through the solution for themselves. In response, the children stopped listening and reverted to participating in the traditional pattern of interaction in school in which their goal was to figure out her method, rather than thinking about mathematics (p. 605).

The type of instruction that Wood, Cobb, and Yackel (1991) discussed is evident in Ms. Red’s classroom:

What’s the most important thing to remember when adding decimals? Teacher pointed to student, who responded, “To line up the decimal point.” “That’s right, to line up the decimal point” (Observation, November 2008).

The teacher asked questions about the problem, “What operation are we talking about? So, what should the expression be?” (Observation, November 2008).

Teacher went through a lengthy explanation on how to find an angle measurement with the protractor (Observation, December 2008).

All of these examples displayed Ms. Red’s traditional instructional methods: showing step-by-step methods on how to solve problems, and expecting one certain type of thinking. These observed practices match Ms. Red’s traditional beliefs regarding mathematics instruction.

In sum, all three participants acknowledged traditional beliefs about teaching mathematics, such as: giving students the knowledge they need, memorizing math facts, controlling the environment, and teaching the way they were taught. Even though all three also acknowledged certain student-centered beliefs, their traditional
beliefs were firmly embedded, and, with Ms. Red and Mr. Green, were predominantly displayed in their teaching practice. Table 16 summarize Theme 3:

<table>
<thead>
<tr>
<th>Instructional Beliefs</th>
<th>Ms. Blue</th>
<th>Mr. Green</th>
<th>Ms. Red</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional beliefs about mathematics instruction</td>
<td>Observed regarding memorizing math facts</td>
<td>Observed in instructional style and interviews</td>
<td>Observed in instructional style, written responses, and interviews</td>
</tr>
<tr>
<td>Student-centered beliefs about mathematics instruction</td>
<td>Observed in interviews, written responses, and observations</td>
<td>Observed in interviews, and part of written responses</td>
<td>Observed in interviews</td>
</tr>
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Table 16. Summary of Theme 3, Observed Traditional and Student-Centered Beliefs, by Teacher

Theme 4: Teachers Recognize Adolescents’ Individual Differences and Needs

Understanding individual children’s thinking is consistent with reform-based mathematics research (e.g. Ball, 1996; Beswick, 2006, NCTM, 2000). In order for teachers to assist individual students in a more constructivist process of learning, they need to have a good model of cognitive development in mathematics so they can understand each learner’s conceptions (Booker, 1996). Focusing on individual’s thinking may be unfamiliar to teachers, as this is an inquiry-based idea of teaching, as opposed to a more traditional method. Yet focusing on children’s thinking can cause teachers to re-conceptualize what they ‘know’ about children (Miller & Davis, 1992). This is not always easy for teachers, as Theme 3 in this research indicated, because teachers hold traditional beliefs about mathematics teaching. Beswick (2006) stated “it is perhaps not surprising that some teachers appear to believe that not all students
can learn mathematics and thus place the responsibility for learning firmly with the students” (p. 18).

In this study, the participants indicated that they recognized that adolescents differ. Evidence from the data showed teacher recognition of differences in students’ thinking and learning, maturity, reasoning, and intelligence. As indicated in Theme 2, each participant expressed or showed some level of inquiry-based practice. Hiebert (1997) indicated that this type of teaching calls for an understanding of where each individual child is functioning at any given time.

Mr. Green

I begin by examining how the teachers viewed individual differences in how their students thought or learned. Mr. Green indicated a perception of these individual differences when he was discussing his teaching methods and how certain students learn: “You know, the old, ‘show them how to do stuff and let them do it’ thing.” Then Mr. Green added: “But it doesn’t work for all kids, so they kinda feel left out” (Interview, December, 2008). This implied that Mr. Green’s acknowledged that his method of mathematical instruction did not work for all, and that he was aware, at least on some level, that there existed differences in his students’ learning needs. Mr. Green’s comments about students feeling left out showed an understanding of emotional development in adolescence. This also implied that Mr. Green is spending some time focusing on his students’ thinking, which could eventually assist him in understanding his students’ mathematical conceptions. Although I did not observe this, Mr. Green did indicate to me in an informal conversation that he did spend time
re-teaching or allow re-testing for some students who are struggling. This indicated that he did take some action with his observations and might modify his instruction (at least somewhat) based on his observations.

Mr. Green also discussed individual differences in regards to special education students, and how these differences affected the learning of these particular students. In this interview he talked about the advantage of having special education student in his class, and how he taught the “IEP” students in the same way he taught the “regular” students:

Some of these kids are pretty bright. Some of the kids who may have been stuck in special ed class are getting an A or B from me. I think the higher end special ed kids it’s been a benefit to them [to be in the regular mathematics classroom as opposed to the special education classroom] (Interview, December, 2008).

This quote from Mr. Green implied that he was thinking about the best learning environment for special education students. It also implied that he realized there are individual differences in reasoning, emotions, or intelligence, but even with those differences, children can be successful in mathematics.

My observations of Mr. Green did not necessarily match up with his comments regarding individual differences. His ideas about individual differences were noted in his words, both written and verbal, but from the time I spent in his classroom, his actions did not promote teaching toward individual needs.

Students are seated in rows of 7 desks across and 4 rows deep. All are seated facing the front of the room. Teacher is sitting in the front right corner of the room on a desk. He is going over the answers from a practice worksheet from yesterday. About half of the students are listening. Several are talking to each other, two are spaced off, one is reading a book, four girls in the back have
their heads together and are talking to each other, not paying any attention to teacher (Observation, November 2008).

Teacher does not appear happy with results from students’ tests from yesterday. He states that the students do not pay attention and are not looking at details. He is sitting at desk in front-right corner of room, and verbally goes over several topics very quickly: negative signs, negative slopes, dashed and solid lines. He emphasizes that he explained the ‘why’ and he will explain the ‘why’ again. He stressed the importance of memorizing these things (Observation, December 2008).

These observations were consistent with Mr. Green’s comments from earlier, “You know, the old, ‘show them how to do stuff and let them do it’ thing.” Even though he later stated that this method did not work for all individuals, indicating that some need a different type of instruction, my observations revealed that Mr. Green mostly utilized this one type of direct instruction. At least once during my observations, Mr. Green explicitly acknowledged individual differences, for example during an interview he talked about the different mathematics classes he taught, and how the students were placed in those classes:

Algebra I are brighter students, although there are some who shouldn’t be in there. I think there should be less, but there keep being more. They are put in there because of their test scores; I don’t believe in that. I think it should be teacher recommendation, the teachers know what they can do (Interview, December 2008).

Mr. Green’s comments indicate that the students need to be looked at individually as opposed to being grouped simply because of achievement test scores, showing of an understanding of adolescent cognitive development to some extent.

Ms. Red

In a written response from Ms. Red, she discussed differences in learning needs with different adolescents:
Adolescents need time to think and reason and process, a patient, observant teacher, some need much teacher modeling, some still need concrete manipulatives, and most need a sense of humor (Written responses, March 2009).

Ms. Red’s response implied that she recognized the individual differences in children’s reasoning or maturity. Some children need teacher modeling, a more traditional approach to teaching mathematics; some children need hands-on manipulatives, a more inquiry-based approach. The comments on humor and patience relate to Ms. Red’s understanding of social and emotional development in adolescents. Ms. Red’s words also implied that because there were individual differences in her students, there needed to be different teaching approaches. Understanding that individuals have different learning needs is consistent with social constructivist views, which states that each learner as a unique individual with unique needs and backgrounds. Wertsch (1997) noted, “Social constructivism not only acknowledges the uniqueness and complexity of the learner, but actually encourages, utilizes and rewards it as an integral part of the learning process” (p. 27).

At a later date, Ms. Red indicated again that there were individual differences in students’ reasoning:

There are some that never reach that abstract thinking level by the end of 4th grade. Some do. I can tell you Cody can think more abstract, even Tom can think more abstractly than most…. I think I see it [their abstract thinking] develop more because of their willingness to share…John asks the kind of questions that is an indicator to me that he thinks more abstractly (Interview, January 2009).

Ms. Red’s words are indicative of seeing a range of abilities and needs in her students. At times, observations of Ms. Red matched up with her comments regarding
individual differences. For example, the physical make-up of Ms. Red’s classroom show students seated in groups of four to five desks that are pushed together in groups, with the exception of three students who are seated in the middle of the room, not in any group (no explanation given for these three). At least for the students seated in groups, this grouping indicated that Ms. Red intends for students to work cooperatively. I need to comment, though, that during my four months of observations in Mr. Red’s classroom, I did not observe any group work occurring. Ms. Red’s comments regarding some students’ “willingness to share” is another indicator of an understanding of her students’ social or emotional development. In another observation I noted:

*Teacher writes problem on chalkboard 1/3 = / 15. She asks class how to solve this, several students raise their hand. Teacher calls on Patrick. Patrick explains how he would solve this, teacher re-explains Patrick’s thinking. She then puts 0.5 on the board and asks the class how to change this to a fraction. More than half the class raises their hand. Teacher calls on one student, who explains and gives the answer of 5/10. Teacher then asks, “Now, how do you reduce that?” Teacher calls on a boy in the front who does not have his hand raised, and she helps him through the explanation.*

From this observation, I noted that Ms. Red called on several students to keep more of them engaged; she also called on students who did not necessarily have their hands raised. This indicated an understanding of social development in her students. Ms. Red helped the male student though the fraction problem, which indicated that Ms. Red did realize there are individual differences in children’s reasoning and maturity and that there existed awareness from Ms. Blue that he might need more guidance.
Ms. Blue

In a written response from Ms. Blue, she talked about individual differences in regards to how children learn:

Some students need to “memorize” then understand. Some need to understand before they “memorize.” Some students need the direct approach and some need to explore. The only thing that is consistent is that all students learn at their own rate, have their own needs and reach developmental levels on their own time (Written responses, March 2009).

As with Ms. Red, Ms. Blue’s words indicated that she perceived there were individual differences in her students’ learning needs. Because she perceived these differences, I inferred that this might have affected her teaching, which was mostly inquiry-based or constructivist in nature, but still had some traditional aspects. I noted this in my observations:

*The students were seated in 3 long rectangular tables (each with their own desk). These tables were facing diagonally to the white board and smart board, which were in the front-center of the room. No student had his or her back to these boards. There were 6-9 students per table (Observation, December 2008).*

*Teacher told the students to turn to page 153 in their Everyday Math book. Teacher has prepared the questions to be projected onto the Smartboard. She turns it on and the students read the problem either from their book or on the board, “The profit from the book sale at Lincoln School was $725. The math club and 4 other clubs will share this amount equally. What will each club’s share be?” Teacher instructs the students to work with those around them to solve this problem.*

Ms. Blue’s room set-up allowed for social work to occur. The way that she presented mathematical problems indicated that she expected the students to work cooperatively to accomplish a goal. My observations of Ms. Blue’s teaching along with her expressed words in writing and during interviews are consistent with social
constructivist views, as well as with sociocultural views. One aspect of the sociocultural perspective is theorizing how children develop, and Ms. Blue appeared to consider this in the physical make-up of her classroom as well as her teaching approach. Development is often thought of as individual, which Ms. Blue seemed to perceive with her comments regarding the need to teach different children in different ways. Cultural research has also suggested that thinking involves interpersonal and community processes as well as the individual processes, which Ms. Blue apparently incorporated into her mathematical instruction, as illustrated in the above observation notes. Rogoff stated “the study of children’s cognitive development includes attention to how people come to understand their world through active participation in shared events with other people” (p. 17). My observations of Ms. Blue’s instructional methods were consistent with Rogoff’s theories on active participation.

To summarize this fourth theme, the three teachers indicated opinions on individual differences concerning how adolescents think or learn. Mr. Green realized that his method of teaching did not work for all students; Ms. Red indicated that different students need different methods of teaching. By listening to her students, she indicated that she was able to better understand their abstract thinking levels. Ms. Blue expressed that students learn at their individual rates and in different manners.

The teachers’ views on thinking were consistent with Fennema et al.’s (1996) research that provided evidence that knowledge of children’s thinking is a powerful tool that enables teachers to transform that knowledge and use it to change instruction. From their responses, Ms. Red and Ms. Blue commented that they used their students’
thinking to at least contemplate a change in their instruction. Mr. Green seemed to understand that he needed to use his students’ thinking, but my observations of his classes did not support that he used that thinking to change his instruction.

Research indicates that teachers’ ideas about individual differences in children’s learning, thinking, reasoning or intelligence come from several sources. Personal experiences with children could account for some of these ideas. This might include different parenting scenarios: parents versus non-parents, parents of one child versus multiple children. There are also potentially important experiences, such as babysitting, advice from their own parents, or visits to pediatricians (Miller, 1991) that might be sources of ideas regarding children’s individual differences in learning or thinking. Formal education in adolescent and child development through teacher education programs could also account for some ideas regarding differences in children’s thinking and learning, although none of the participants in this study recalled having specific training in adolescents in their undergraduate or graduate programs. These different theories shape teachers’ ideas about children’s’ development. Interestingly, Smith’s (1991) study about primary teacher beliefs, found that in response to developmental questions about children, teachers’ common response was to claim that their teaching was based on a self-made theory, which was due to past experience (Smith, 1991).

Summary

Chapter four proposed three themes that contributed to an understanding of middle grade mathematics teachers’ beliefs regarding adolescents, which were: 1)
Teachers’ expressed beliefs about adolescents’ mathematical learning were not necessarily borne out in their pedagogical practice; 2) Confronting their own folk beliefs about adolescents’ mathematical learning allowed teachers to consider alternatives to those beliefs, and could influence their teaching practice. In the absence of this confrontation or without impetus for change, teachers would be more likely to abandon thoughts of changing their pedagogical practice; 3) Teachers had firmly embedded traditional beliefs about mathematics instruction, although they may co-exist with student-centered views; and 4) Teachers recognize adolescents’ individual differences and needs, but do not necessarily act upon that recognition. The concluding chapter contains discussions based on the study’s findings, and offers implications and suggestions for future research.
CHAPTER 5: DISCUSSION

In this chapter, I first discuss the findings from the study. I then address the implications from each theme discussed in Chapter 4. In the third section, I discuss implications that this study offers for classroom teachers, mathematics teachers’ education programs, and curriculum developers. Limitations of this study are discussed in the fourth, and final, section.

The purpose of this study was to explore the intersection of middle grade mathematics teachers’ beliefs about adolescents and their teaching practice. The primary sources were observations, interviews, written responses, and document collection. The research questions in this study were:

- What is the intersection of middle grade mathematics teachers’ beliefs about adolescent and their teaching practice?
- What are teachers' beliefs about mathematics instruction, in particular reform-based mathematics instruction?
- What are teachers’ beliefs regarding adolescents?
- What pedagogical aspects of the teachers’ practices do I observe in the classroom?
- What is observed in the classroom or interviews that shows an intersection between the teachers’ beliefs about adolescents and their teaching practice?
This study depicted middle-grade mathematics teachers’ beliefs as traditional, yet complex, as supported by the literature, and revealed that expressed beliefs were not necessarily shown in teaching practices. Data also showed that when teachers challenge their folk beliefs, there could be an influence in teaching practice. Based on this study’s findings, teachers’ beliefs about adolescents or mathematics may influence their pedagogical practice.

Implications

When looking at research on teacher beliefs, there is not common definition as to what a belief is or how we should define it; thus Parajes (1992) asserted that a belief is considered a “messy construct.” The themes that emerged illuminated how complex and messy beliefs and practice look in the mathematics classroom. Expressed beliefs about adolescents and teaching can differ from what is observed in pedagogical practice. Even though teachers can have very traditional views and beliefs about teaching mathematics, they might still portray student-centered attributes, or vice versa. For example, in this study, all of the teachers expressed traditional mathematics views of some sort. Yet, I observed student-centered teaching often, especially with one teacher, Ms. Blue, who used student-centered instruction. Additionally, all of the participants expressed student-centered views, but observations indicated traditional teaching practices, especially from Mr. Green and Ms. Red.

Expressed Beliefs Differing from Observed Practice

The themes that did emerge from this study helped me to gain an insight as to the intersection of middle grade mathematics teachers’ beliefs about adolescents and
their teaching practice. First, I asserted that teachers’ expressed beliefs about adolescents’ mathematical learning are not necessarily borne out in their pedagogical practice. From this, three sub-themes were created from the data regarding this lack of consistency between beliefs and practice: 1) the lack of consistency may be due to social desirability from teachers; 2) the lack of consistency may be due to contextual factors, such as the achievement test, parents, students’ lack of motivations; and 3) the lack of consistency may be due to limited or improper theoretical understanding.

From observed findings, I identified inconsistencies between mathematics teachers’ expressed beliefs and their practices regarding teaching adolescence. All of the participants reported some level of agreement on reform-based or student-centered concepts, but at least in some part, the participants’ instruction was teacher-centered or traditional. Teaching is usually regarded as an intentional activity (Chen, 2008), but not all teaching activities are based on teachers’ intentions or beliefs because the contextual or external factors surrounding the teachers have a strong influence on teachers’ decision making (Lowyck, 2003). In other words, teaching is still intentional in a sense, but teaching practices may conflict implicitly with teachers’ beliefs.

Woolfolk Hoy, Davis, and Pape (2005) discussed these contextual factors regarding teacher beliefs. They noted that there could be many reasons why teachers do not always enact their beliefs. Similar to the results found in my study, the authors discussed that high-stakes tests are more likely than low-stakes tests to constrain teachers’ beliefs and practices: “The influences of state-mandated testing seem to
depend on how teacher interpret state testing policy and use it to guide their action” (p. 720). An example of how different interpretations affect practice follows: Ms. Blue appeared to teach in an inquiry-based manner, despite, or possibly, because of the achievement tests; her students have done well on these tests while she has implemented a more reform-based style, so she finds no reason to change (Interview, December, 2008). In contrast, Ms. Red appeared to teach in a more traditional manner because she believed the achievement test left her no other choice; if her children were to be prepared for the achievement test she needed to give up project-based work and cooperative grouping (because these take too much time) and concentrate on building their skills (Interview, November, 2008).

According to Ball and Cohen (1996), teachers’ decisions about instructional strategies are based on different information and concerns, including: 1) information about students; 2) teachers’ beliefs; 3) the characteristics of the curriculum; and 4) the constraints and support of the instructional situations. In this study I focused on #2 (teachers’ beliefs) and to a lesser extent, #4 (the constraints and support of the instructional situations). For example, the participating teachers indicated that the achievement test, parents, the students’ motivation levels, and time, were all constraints on their practice.

An implication that grew from this theme was that teachers might compromise their ideal pedagogical approach to meet the needs and expectations of parents, administration, or even the state. Chen (2008) suggested that teachers might have been torn between their ideal instructions, and covering the content that might be
related to items on the achievement tests. I found data suggestive of the same phenomenon in my study. For example, Ms. Red indicated verbally that she knew cooperative work and mathematics-based projects helped children to learn and she admitted that she did not use those methods any longer because they took too much time away from preparing for ‘the test’. Ideally, she would like to employ more student-centered mathematics, but she opted for the pragmatic approach of using her time to do achievement test preparation, thus, showing a compromise between her ideal pedagogy and actual practices.

Challenging Folk Beliefs

The second theme that was established from the data concerned teachers challenging their folk beliefs, that is, those ideas that we think are true because of past experience or because of cultural influences. From this study, I found evidence that: confronting their own folk beliefs about adolescents’ mathematical learning allows teachers to consider alternatives to those beliefs and can influence their teaching practice. In the absence of this confrontation or without impetus for change, teachers may abandon thoughts of changing their pedagogical practice.

Research indicates that teachers’ beliefs do not change much from the time they begin and to the time they complete pre-service education training programs, and these beliefs are generally not influenced by readings or by being asked to apply findings from educational research (Stipek et al., 2001). Changing beliefs is extremely difficult and occurs over long periods of time. Pajares (1992) commented that, “people are adept at using evidence that would appear contradictory to a belief to
support that same belief” (p. 307). In other words, teachers will change their interpretation of a situation to fit their belief, rather than change their belief.

Within the *Principles and Standards for School Mathematics* (2000) the NCTM contended that teachers should allow students to construct their own knowledge about mathematics. This is a vastly different belief system for many teachers of mathematics. From past reform movements, it is evident that teachers do not change their beliefs simply because it has been recommended; a powerful reason for change must be present for change to occur (Pajares, 1992). One reason for change may be dissatisfaction with what is occurring in the classroom. An important cognitive factor in most models of conceptual change is that “some level of metacognitive awareness seems to be necessary for change” (Patrick & Pintrich, 2001, p. 130). In particular, teachers must have some discontent about their mathematical content knowledge, pedagogical knowledge, or child development knowledge.

Beliefs are changed in the same way that conceptual change is induced, through cognitive dissonance (Woolfolk Hoy, et al., 2006). Researchers (e.g. Ball, Hill, & Bass, 2005) suggest, therefore, that professional development aimed at changing beliefs should be geared toward creating dissonance by offering experiences where the teachers’ new understandings from a teacher perspective conflict with their experiences as a student. Additionally, research has shown that in order to accomplish a lasting change, professional development should be long-term and job-embedded.

Of course, this change in teacher beliefs does not happen quite the way researchers may have intended it. Gregoire (2003) commented, “changing practices
alone does not seem to ensure belief change” (p. 150). Gregoire further commented on possible explanations as to why teachers, who positively value the reform and believe they are employing it in their classroom, actually lack the implementation of constructivist-oriented reforms, such as NCTM’s *Principles and Standards for School Mathematics*. One idea from Fennema and colleagues (1992, 1998) was that teachers’ pre-existing subject-matter beliefs constrain them from adopting practices that conflict with those beliefs. Another reason why teachers may not actually be implementing constructivist reforms, even when they believe that they are, might be related to “ill-structured situations” (Gregoire, p. 149) such as teaching a classroom of students of widely varying intellectual, social, and affective differences.

What appears to be needed is a greater understanding of the processes involved in belief change and how beliefs affect teachers’ interpretations of reforms. The research of Gregoire (2003) adds this significant piece to the “belief changing” research, and is important in my research in that it might explain why the teachers in this study expressed reform-based beliefs but did not enact those beliefs. Gregoire’s Cognitive-Affective Model of Conceptual Change (2003) explains that when teachers do not change their beliefs, even when presented with a convincing reform message, it is because they may not be systematically processing reform messages. This route of heuristic processing, or lack of it, explains why many teachers who believe they have changed their beliefs, have actually not “accommodated the new ideas about learning math implicit in the standards and similar constructivist-oriented reforms. They did
not have the motivation or ability to process such reform messages systematically” (p. 168). Additionally, teacher may lack the support for change.

Researchers have studied how teachers’ frameworks for human development, curriculum, and mathematics influenced how they interpreted children’s mathematical thinking. One particular project (Bright & Bowman, 1998) showed that after implementing Cognitively Guided Instruction (CGI) during long-term, job-embedded professional development, there was a substantial amount of teacher change that might have reflected changes in teachers’ philosophy of mathematical teaching. For example, after two years in the project, teachers put more emphasis on students’ demonstration of understanding math content, rather than on the generic stages of problem solving. The Bright and Bowman study has implications for my study because it helps to show the relationship between teachers’ mathematical practice and their understanding or beliefs about student’s cognitive development.

With regards to Theme 2, these past studies, as well as my current study, have shown that a challenge of beliefs opens a door to consider alternative beliefs. Considering those alternative beliefs could indeed lead to an influence on teacher practice. Of course, the opposite could also be affirmed: in the absence of a confrontation regarding beliefs, or without motivation for change, teachers are more likely to abandon those thoughts of changing their pedagogical practice.

Findings from other researchers (Stipek, et al., 2001) indicate that teachers have a fairly coherent set of beliefs, and those beliefs can predict their instructional practice. For example, a teacher who believes in controlling instruction, through direct
instruction and modeling also likely believes that students can only learn a mathematical procedure after being shown the steps. These kinds of beliefs leave little room for her students to understand the concept being taught, how an algorithm was derived, why it works, or other ways that it could be done. When mathematics teachers who have traditional beliefs about mathematics use a more traditional approach, and have no desire to change or have no impetus to change, they likely will not change. It is clear from a body of research (e.g. Beswick, 2006; Carter, 1997; Stipek et al., 2001) that teacher beliefs influence what occurs in the classroom, therefore, if beliefs do not change, the instructional approach is apt to not change as well.

_Traditional Beliefs about Mathematics Instruction_

The third theme that was identified within the data dealt with the traditional beliefs that mathematics teachers were observed to have, specifically, that teachers have firmly embedded traditional beliefs about mathematics instruction, although they may co-exist with student-centered views. By “traditional,” I suggest a belief system that indicates teachers, positioned as the mathematical authority in the classroom, should _give_ students the mathematical knowledge, usually by telling them what they need to know and how to do it.

One apparent implication regarding this theme is that traditional beliefs foster traditional teaching practices. Other researchers have found that teachers who had more traditional mathematical beliefs (for example, beliefs that telling children procedures to memorize was an appropriate way for children to learn mathematics) did
indeed have traditional math practices (e.g. Stipek, et al., 2001). Those traditional beliefs emphasized student performance (i.e. getting the correct answer or getting good grades) and speed rather than mathematical processes. Even though researchers, mathematics educators, and other experts in mathematics instruction, such as NCTM (2000), promote a constructivist view of learning mathematics, what is occurring in school continues to be dominated by the traditional transmission of knowledge (Stipek, 2001).

Another implication that this theme conveys is the vulnerability of teachers. When mathematics teachers attempt a new conjecture or belief, they are taking a risk. This requires the admission that their previous assumptions were flawed, that their insights may have been limited, or that their conclusions may have been inappropriate (Lampert, 1990). This suggests that teachers are vulnerable when they are learning mathematics and teaching mathematics, because they may not always be correct.

Again, Gregoire’s (2003) research helps to give a possible explanation to this phenomenon. Her Cognitive-Affective Model of Conceptual Change begins with a presentation of a reform message; in other words, teachers are presented with a strong message about mathematical reform, such as the NCTM’s Standards. For those who are traditional instructors, this message is difficult to hear because it suggests that traditional mathematics instruction is detrimental to students’ comprehension. This threat is not necessarily adverse, as Gregoire stated, “For many traditional instructors, the message received threatens their professional identity and such a threat can motivate attitude change to occur” (p. 164). Additionally, Gregoire commented that
the lack of this threat can actually lead to no change; if teachers believe they are not threatened, in other words that they believe they are already implementing the standards, then there is no need to process the new information any further and they stop any future change in beliefs.

It is a traditional, underlying assumption that the teacher is the all-knowing, giver of knowledge. These teachers went to school in the same pre-standards systems in which they are teaching. The curriculum and teaching methods used in their own schooling, and in the setting in which they are now teaching, often overwhelm students with skills and procedures without allowing them to develop an appreciation for the power of mathematics as a system of human thought (Ball, Lubienski & Mewborn, 2001).

Therefore, to teach in a more traditional manner is more comfortable, because teachers believe it will work and they experienced it themselves; teaching in a traditional approach also feels safer. These teachers believe they do not have time for something more constructive, they believe that parents want them to teach this way, and they believe that the achievement tests adhere to a more traditional style of mathematics instruction. The Mr. Green, in my study, summarized this quite well for me: “There were good aspects about it [teaching a more constructivist manner], except it takes time and it’s non-traditional, and parents had a problem with that” (italics added, interview, December 2008). Similarly, Ms. Red stated, “So much is dictated what we teach and when we teach it, you know that I’m just really fighting hard to slug through it all and make sure that they are prepared as they can be for that
achievement test when March or April comes (italics added, interview, November 2008). It appears from the data, at least from two of the teachers, that traditional mathematics instruction was most comfortable, it was safe, it took less time, the parents wanted it, and it helped in getting through the content for the achievement test.

**Teachers’ Recognition of Adolescents’ Individual Differences and Needs**

The final theme in this study pertained to teachers recognizing adolescents’ individual differences and needs. I asserted from observations and interviews that the teachers spent some time focusing on their students’ thinking. This implied that when teachers listen to their students or use their students thinking, that they might take action with their observations and might modify their instruction based on observation.

Using student thinking in mathematics instruction is definitely supported by research (e.g. Ball, 1999; Ball & Cohen, 1999; NCTM, 2000; Shayer & Adhami, 2007). Ball (1999) commented that teachers “need ways to expand the interpretive frames they likely bring to their observations of students so that they could see more possibilities in what students could do” (p. 8). This also means that teachers would need to expand their ideas about what it means to learn, what helps children learn, and how to interpret children to know more about what they are learning and thinking.

Teachers’ recognition of individual differences applies not only to cognitive development in adolescents, but also to emotional and social differences as well. The teachers in this study made comments related to social and emotional development such as: students appreciate a teacher with a sense of humor; some students need more patience than others; some students need to be prompted along in order to share;
students need to work cooperatively; and students learn at different rates and in
different manners. The implications of the teachers identifying emotional and social
differences in children relate to Vygotsky’s sociocultural theory. Vygotsky believed
that knowledge is not individually constructed but was socially co-constructed
between people as they interact. He alleged that knowledge is not located in the
children or in the environment; rather, knowledge is situated in a particular social or
cultural context (Meece & Daniels, 2008). In the classroom, this would possibly be a
small group of heterogeneous students working together on a rich mathematical task,
where there is discourse, negotiation, and justification occurring. This type of setting
was observed somewhat in Ms. Red’s classroom and especially in Ms. Blue’s
classroom, with students mostly seated in tables working cooperatively on
mathematics.

When teachers reflected on their students’ individual differences and needs, as
the teachers in this study were observed doing, another implication was that they
might be reflecting on their own teaching. Schulman (1987) stated:

Reflection is what a teacher does when he or she looks back at the teaching and
learning that has occurred, and reconstructs, reenacts, and/or recaptures the
events, the emotions, and the accomplishments. It is that set of processes
through which a professional learns from experience” (p. 19).

Teaching in a manner recommended by researchers and mathematics educators
requires teachers to stand back from and analyze their own teaching, to ask such
questions as: What is working? What is not working? For whom are certain things
working or not working? I especially noted this type of reflection in Ms. Blue, with
comments such as “Kids are more open to different ways of thinking, so I need to
teach them in different ways” (Interview, January 2009), and “I just try to present material in many different ways and help students find their own comfort zone” (Written response, March 2009). Ball and Cohen (1999) summed up reflection in teaching: “To teach well, given reformers’ ambitions and the situational and uncertain nature of teaching and learning, teachers would need to use what they learn to correct, refine, and improve instruction” (p. 10). Teachers’ reflection on their own learning is as important as teachers’ reflection on their students’ learning.

Limitations

I recognize several limitations in this study. First, this study cannot be generalized to all middle grade teachers due to the fact that this was a multiple-case study of only three teachers. Another limitation results from classroom set-ups; some middle grade-level teachers teach only mathematics, and some are self-contained and teach all subjects. Because of these structural differences, the possibilities open to teachers who have self-contained classrooms as opposed to mathematics-only teachers may differ in significant ways, such as the amount of flexibility in their scheduling to work on long-term projects or work in a certain subject area for a longer duration of time. Third, the participants’ views can be representative of only their school cultures. Their beliefs and practices may correspond to their school culture and not be generalized to other schools’ cultures. Next, observations and interviews were completed during certain times of the year, during a certain year. The results, even for the same teacher, would not necessarily occur in the same manner at a different time or in a different setting.
Finally, this study aimed to gather information regarding mathematics teachers’ beliefs regarding adolescents and the intersection of those beliefs on their teaching practice. I observed several aspects of the teachers’ beliefs (beliefs about adolescents, beliefs about mathematics); there are other factors and beliefs that affect teaching practice. Additionally, I only observed and interviewed teachers over a span of about four months and thus, their retrospective memories of their teaching and beliefs cannot be independently documented. This was not a long-term longitudinal study in which changes over time might have been observed.

Recommendations

This study’s findings have implications for teachers, college-level education departments, and curriculum developers. First, the findings from this research could be useful to teachers or teacher educators of middle grades who have an interest in better understanding adolescents and how they could be taught to better match their developmental stages. The data from Theme 4 showed that the teachers in this study did recognize individual differences in adolescents. They were observed recognizing cognitive, emotional, social, and maturational differences. There were times when the participants acted on these recognitions, but this did not necessarily happen every time. This study could help teachers and teacher educators to better recognize that there are a plethora of individual differences in adolescents. Recognition is the first step, but then that needs to be acted upon. In order to assist their learners to construct their own mathematical knowledge, teachers need to have a good understanding of
mathematical cognitive development in adolescents so that they can look at each individual’s conceptions.

As Scales and McEwin’s (1994) research indicated, the most important recommendation for strengthening middle grade teachers’ practices is for the teachers to have a greater understanding of early adolescents. When there is a match between teachers’ understanding about adolescents and the child’s actual ability, the child’s development is more appropriate for that individual child (Eccles et al., 1993). Booker (1996) commented that in order for teachers to assist in the constructivist process of learning, they need to have a good model of cognitive development in the specific area of mathematics so that they can understand the learner’s conceptions.

Second, the findings from this research can help middle-grade mathematics teacher educators in illustrating the connection between understanding adolescents and reform-based mathematics. With national and state standards recommending inquiry-based, student-centered teaching, more teachers are apt to be interested in understanding more about changing beliefs and/or teaching practices. Research (Ball, Hill & Bass, 2005; Fennema & Carpenter, 1996) has shown that when teachers move towards a more inquiry or reform-based practice they are opening themselves to learning and growth in their teaching. Teachers of adolescents could use the information provided from this study to better understand the importance of how the correlation between understanding adolescents and reform-based mathematics is so relative. Specifically, the data that was used to establish Theme 3 could help in this process. Theme 3 illustrated that with a confrontation and/or an impetus for change,
as was shown with Ms. Blue, teachers could change their beliefs about adolescent mathematical learning, and could change their teaching practice.

Additionally, the findings from this research could be useful to curriculum developers who prepared material for middle-grade mathematics classrooms. Traditional mathematics teaching leaves little room for an examination of student thinking. Those in charge of mathematics curriculum might take an interest in what this study has to offer in terms of the fit or match between reform-based practices, student-centered teaching, and an examination of teacher beliefs. For example, taking an inventory of teacher beliefs in a school can give the school or district administration an idea of what professional development needs to be offered.

Third, the results from this research could help in answering questions about what teachers should know and understand. Theme 3 illustrated that teachers have firmly embedded beliefs about mathematics instruction. Teacher educators are able to teach their future educators what they should know and understand from researchers such as Eccles and Roeser (2003), Steinberg (2008), and NCTM (2000), who highlight the importance of a classroom culture, including elements such as having high, well-defined standards for behavior and academic work, and allowing students to make decisions and have autonomy. These researchers also recommend constructivist pedagogical aspects such as giving students opportunities to see connections between related ideas, asking students to construct or produce knowledge rather than reproducing or repeating facts, and using material that is relative to the students’ community and culture. But, teacher educators could learn from this research, that
without somehow helping their students face their folk beliefs (Theme 2) about firmly embedded mathematics instruction (Theme 3), all of these recommendations may not be utilized, even if the future teachers express that they will utilize them (Theme 1).

Therefore, the results from this study could be useful to college-level education departments as they are developing programs for in-service and pre-service middle-grade educators. As previous research (Gregoire, 2003; Pajares, 1996; Patrick & Pintrich, 2001) indicated, beliefs are difficult to change. Past reform movements have shown that teachers do not change their beliefs simply because it has been recommended, a powerful reason must be present for change to occur and they must have a desire to change. One reason for this is that students of teaching are insiders, the have spent the last twelve or more years in a classroom, and it is familiar to them; therefore, they believe that they already understand the classroom and do not need to discover what it is all about (Woolfolk & Murray, 2001). Pajares (1993) stated, “In learning to be teachers, they simply return to places of their past, complete with memories and preconceptions of days gone by, preconceptions that often remain largely unaffected by higher education...” (p. 46). The classroom is familiar to teachers because of the amount of time they have spent there as students; the need to learn about their environment does not exist for most teachers because of this.

These preconceptions of teachers are very familiar, and therefore become powerful influences, “because in learning to teach, as in all learning, what prospective teachers already know determines to a great extent what they will pay attention to, perceive, learn, remember, and forget (Woolfolk & Murray, 2001, p. 7-6). Preservice
education programs need to consider prospective teachers’ beliefs and the examination of those beliefs. By using the results from this type of research, programs could present teachers coursework aimed more at creating conflict within themselves. For example, Ms. Blue indicated that her traditional mathematics beliefs were powerful influences; her two years in a job-embedded professional development program helped her examine and change her beliefs about teaching mathematics. In regards to teacher education preparation, Woolfolk and Murray suggested,

Some class activities should be designed to create cognitive conflict. Using this conflict, teacher educators can help students identify their own beliefs and explore why certain beliefs resist change. All beliefs should be examined and challenged, not just those that conflict with the beliefs of the teacher educator or the education curriculum (p. 7-25).

Programs that allow prospective teachers to examine their folk beliefs can offer experiences that may differ from their previous experiences as students.

To summarize, in this study I examined the intersection between middle grade teachers’ beliefs regarding mathematics and adolescents. From observations, interviews and written responses, I found four overarching themes. The implications from these themes could assist teachers, teacher educators, and administrators of school districts, especially as they look at middle-grade mathematics instruction. For instance, most teachers have an ideal classroom in their mind, but what is actually implemented appears to stem from the need to cover content or preparation for achievement tests, or other contextual factors such as parental involvement or time. Second, there needs to be a better understanding of the process of teacher change. Simply asking teachers to change their pedagogies and presenting them with reasons
why, does not insure lasting change. A reform message actually “threatens professional identity [and can] motivate attitude change to occur” (Gregoire, 2003, p. 164). Finally, teachers need to be taught to recognize individual differences in students, including cognitive, emotional, social, and maturation differences. This recognition will assist teachers not only in the modification of their instruction, but also in reflecting on their teaching. The detection of these themes from the observations and interviews helped me to begin to connect middle-grade teacher beliefs regarding mathematics and adolescents.
References


NVivo qualitative data analysis software; QSR International Pty Ltd. Version 8, 2008.


Appendix A: Support Letters from Principals
To Whom It May Concern:

I would like to offer this letter for <School Name> participation in the research project entitled “The Intersection of Middle Grade Teachers’ Beliefs Regarding Mathematics and Adolescents.”

I acknowledge that this research will involve 5-15 hours per week of mathematics classroom observations by the researcher, and up to 5 teacher interviews lasting 30-60 minutes each. The researcher will be observing for teaching practices that will help lead to a better understanding of teacher beliefs about adolescents. The researcher will also be observing for teacher beliefs about adolescents that will help lead to a better understanding of teacher practices. The interviews will pertain to teacher beliefs about adolescents and teacher beliefs about mathematical teaching practice (specifically inquiry-based). Both the observations and the interviews may be audio or video tapes, with information gathered on only the teachers’ participation.

I recognize that there is minimal anticipated risk of this study. Finally, I acknowledge that the teacher may withdraw from the research at any time with no repercussions.

Sincerely,

<Principal Name>
Appendix B: Informed Consent Letter from Participants
The Ohio State University Consent to Participate in Research

**Study Title:** The intersection of middle grade teacher beliefs and adolescents

**Researcher:** Lisa Douglass

This is a consent form for research participation. It contains important information about this study and what to expect if you decide to participate.

Your participation is voluntary. Please consider the information carefully. Feel free to ask questions before making your decision whether or not to participate. If you decide to participate, you will be asked to sign this form and will receive a copy of the form.

**Purpose:** You are being asked to participate in this study to help the researcher discover the intersections between middle grade mathematics teachers beliefs and adolescents in their classrooms.

**Procedures/Tasks:** In this research I will ask you to participate in a 30-60 minute interview in the Fall of 2008 regarding your beliefs about teaching mathematics and adolescents. I will then observe your mathematics classroom for up to 15 hours per week from November 2008 through February 2009. In this time I will take notes pertaining to the mathematics teaching, classroom setup, pedagogies used, and adolescents; I may also take digital pictures of your classroom setup (without students or you in the pictures). During that time, I may ask for up to four more 30-60 minute interviews. I will send home an informational letter to your students’ parent, I will be sure to inform them that the students are not being studied. I will also audio or videotape your teaching, only to help me look for information that may help me understand beliefs about mathematics instruction or beliefs about adolescence.

**Duration:** This study will begin in November of 2008 and end in February of 2009. Your time commitment will consist of up to five 30-60 minute interviews, and allowing me to observe your classroom for up to 15 hours during this time.

You may leave the study at any time. If you decide to stop participating in the study, there will be no penalty to you, and you will not lose any benefits to which you are otherwise entitled. Your decision will not affect your future relationship with The Ohio State University.

**Risks and Benefits:** You have minimal risk in this research project. Some risks may result from an effect of being observed or interviewed. Other risks may result from your students’ participation in class due to the fact than an observer is present. I will take precautions to minimize any risks that I foresee to you. The benefits you will receive pertain to the information you and I will share about adolescence and mathematics. Your participation will help add to a body of research regarding teacher beliefs and teacher practices.
Confidentiality:
Efforts will be made to keep your study-related information confidential. However, there may be circumstances where this information must be released. For example, personal information regarding your participation in this study may be disclosed if required by state law. Also, your records may be reviewed by the following groups (as applicable to the research):

- Office for Human Research Protections or other federal, state, or international regulatory agencies;
- The Ohio State University Institutional Review Board or Office of Responsible Research Practices

Incentives:
There will be no incentives offered to participate in this research.

Participant Rights:
You may refuse to participate in this study without penalty or loss of benefits to which you are otherwise entitled. If you are a student or employee at Ohio State, your decision will not affect your grades or employment status.

If you choose to participate in the study, you may discontinue participation at any time without penalty or loss of benefits. By signing this form, you do not give up any personal legal rights you may have as a participant in this study.

An Institutional Review Board responsible for human subjects research at The Ohio State University reviewed this research project and found it to be acceptable, according to applicable state and federal regulations and University policies designed to protect the rights and welfare of participants in research.

Contacts and Questions:
For questions, concerns, or complaints about the study you may contact Lisa Douglass at 740-704-1975 or Dr. Lucia Flevares at 614-247-4270.

For questions about your rights as a participant in this study or to discuss other study-related concerns or complaints with someone who is not part of the research team, you may contact Ms. Sandra Meadows in the Office of Responsible Research Practices at 1-800-678-6251.

If you are injured as a result of participating in this study or for questions about a study-related injury, you may contact Lisa Douglass at 740-704-1975 or Dr. Lucia Flevares at 614-247-4270.
Signing the consent form:
I have read (or someone has read to me) this form and I am aware that I am being asked to participate in a research study. I have had the opportunity to ask questions and have had them answered to my satisfaction. I voluntarily agree to participate in this study.
I am not giving up any legal rights by signing this form. I will be given a copy of this form.

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Investigator/Research Staff
I have explained the research to the participant or his/her representative before requesting the signature(s) above. There are no blanks in this document. A copy of this form has been given to the participant or his/her representative.

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Appendix C: Parent Information Letter
December 10, 2008

Dear Parents:

I am a graduate student in the College of Education and Human Ecology at The Ohio State University. For my dissertation I am studying middle grade mathematics teachers’ instructional practices and beliefs.

My study focuses on how teachers think and teach. I will interview participating teachers and will observe their mathematics instruction from November 2008 through February 2009 for up to 15 hours per week. Although I will be observing in your child’s class, I will not interview your child or collect any data that would identify your child. Because I will be audio or video taping the teacher, incidental information may be gathered from the children. I will not use or transcribe that information, and all audio and video taped will be destroyed after my study. I will only observe regular classroom instruction and will not ask your child’s teacher to change his or her teaching in any way.

The purpose of this letter is to inform you of my presence in your child’s mathematics classroom, and to assure you that I will not interfere with the teaching of your children, or use them in my study. I am simply looking at the teacher’s instructional practices with them.

If you have any questions or concerns, please feel free to contact Dr. Lucia Flevares at 614-247-4270, or me at 740-704-1975.

Thank you,

Lisa Douglass
Appendix D: Observation Protocol
Model of teaching adolescents: Developmentally appropriate middle grade mathematics teaching (based on suggestions from Eccles and Roeser, 2003; National Council of Teachers of Mathematics, 2000; Steinberg, 2008)

## Developmentally appropriate middle grade mathematics teachers should:

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<th>(Classroom Culture)</th>
<th>(Pedagogical Aspects)</th>
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<td>Provide clear feedback and expectations about performance</td>
<td>Help the students to think flexibly in their <strong>problem solving and reasoning</strong></td>
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<td>Give ample praise to students when they perform well in effort, process of thinking, correctness of answer</td>
<td>Give the students opportunities to see <strong>connections</strong> between related ideas</td>
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<td>Be supportive and responsive, but firm and demanding</td>
<td>Integrate the mathematics (e.g. algebra and geometry) so students can understand the <strong>interconnectedness</strong></td>
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<td>Have high, well-defined standards for behavior and academic work</td>
<td>Engage the students in interesting and challenging problems (<strong>multiple process standards</strong>)</td>
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<td>Spend a high proportion of their time on lessons, rather than on setting up equipment or on discipline</td>
<td>Ask students to construct or produce knowledge rather than reproduce or repeat facts (reinforce <strong>representations</strong>)</td>
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<td>Begin and end on time (respect students’ time)</td>
<td>Encourage students to engage in deep cognitive work that requires them to rely on a field of knowledge, searching for understanding (<strong>problem solving/connections</strong>)</td>
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<td>Have high expectations that all students can learn</td>
<td>Provide active instruction in metacognitive skills (<strong>reasoning</strong>)</td>
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<td>Have strong and clear norms and rules (for discipline)</td>
<td>Use material that is relative to students’ community and culture (<strong>connections</strong>)</td>
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<tr>
<td>Build a sense of community in their classrooms</td>
<td>Provide abundant opportunities to rethink one’s work and understanding (<strong>reasoning</strong>)</td>
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<td>Show a positive, caring attitude toward their students</td>
<td>Provide multiple ways for students to learn new material and demonstrate their learning (<strong>representations</strong>)</td>
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<td>Create a positive, caring peer climate for all students</td>
<td>Provide highly interactive and cooperative learning activities that allow students to work with and tutor each other without the class getting out of control (<strong>communication/problem solving</strong>)</td>
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<tr>
<td>De-emphasize comparison and competition, and emphasize effort and improvement</td>
<td>Provide hands-on activities (<strong>multiple process standards</strong>)</td>
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<td>Allow for students to make decisions and have autonomy</td>
<td>Be sure that <strong>all</strong> students participate fully in learning activities</td>
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<tr>
<td>What is the physical set–up of the classroom?</td>
<td>Help students understand the importance and larger meaning of what they are being taught (connections)</td>
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• NCTM process standards

Outside the classroom, developmentally appropriate middle grade mathematics teachers should:

• Be involved in on-going professional development related to mathematics content, pedagogies, and adolescents

• Have clear curricular goals

• Involve administration for support
Appendix E: Interview Questions
Initial Interview Questions

This research study is looking at the intersection of teacher beliefs regarding adolescents and mathematics teaching. I would like to ask you some questions pertaining to your teaching background, your beliefs about adolescents and your beliefs about mathematics. If at any time during this interview you would like to stop, you may do so. This interview will take approximately 30 minutes.

The purpose of this interview is to gather teachers’ views about their beliefs about adolescents and mathematics. After conducting initial interviews, I will contact a small set of teachers about participating in classroom observations and follow-up interviews. By participating in this initial interview, you are not committing to be part of the entire study. If you have any questions, you may ask them at any time.

Background questions:
Years teaching? What subjects and grades? Where? Other experience? Where? Materials or curriculum used? What are the demographics of your school/your students?

How would you assess this year’s class (or specific period) in terms of where they are mathematically and/or with their thinking skills?

What background, experience and/or expertise do you think influences your teaching?

How would you characterize your pedagogical or instructional approach to teaching mathematics?

Questions related to adolescents:
What is the secret of working with adolescents?

What do you know or believe about adolescents based on your experience, not necessarily what you learned in courses?

Picture a typical adolescent student. How do you reach him/her? What gets in the way?

If you could teach an adolescent in any way you thought would work best, how would you?

What coursework and/or additional training have you taken in adolescent or child development?

As compared to elementary-aged children, how do you think it is different to teach to
adolescents?

What teaching approaches (pedagogies) do you use that you feel is effective for adolescents?

What feelings/emotions/thoughts come to mind when you think of ‘adolescents’?

**Questions related to inquiry-based mathematics:**

What coursework or training have you had in inquiry-based/reform-based/constructivist approach (or other similar) mathematics? Describe this.

Do you find any correlation between what you know or have learned about adolescence and what you know or have learned about inquiry-based mathematics teaching?

**Follow up questions:**

What are students ready to learn and why?

How are these students different from younger students?

How does development change from younger children to adolescents? Or even from your own children throughout the year?

What are the learning needs of adolescents?

What are they ready for?

What are the changes in their thinking, especially abstractly? What evidence do you have of that?

Teachers have a special kind of knowledge. What can you tell me about what you really believe about adolescent’s minds and what is the basis for this?

What is hard/easy for adolescents? Why?