ABSTRACT FOR A LOOK AT ATTITUDE AND ACHIEVEMENT AS A RESULT OF SELF-REGULATED LEARNING IN THE ALGEBRA I CLASSROOM

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Darin Craig Schroeder

The Graduate School
University of Kentucky
2007
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ABSTRACT OF DISSERTATION

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the College of Education at the University of Kentucky

By
Darin Craig Schroeder
Lexington, Kentucky

Co-Directors: Dr. Margaret Mohr, Assistant Professor of Mathematics Education and Dr. Truman Stevens, Associate Professor of Science Education
Lexington, KY
2007

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ABSTRACT OF DISSERTATION

A LOOK AT ATTITUDE AND ACHIEVEMENT AS A RESULT OF SELF-REGULATED LEARNING IN THE ALGEBRA I CLASSROOM

Not often do mathematics teachers instruct to improve students’ attitudes toward mathematics. The pressures to cover the state-mandated curriculum drive teachers to instruct for procedural understanding with few connections. The lack of real-life connections results in students with low motivation toward mathematics and results in poor mathematics attitude (Ma & Kishor, 1997). The purpose of this mixed-methods research is to examine self-regulated learning as an instructional technique aimed at increasing mathematical attitudes while also increasing achievement and to reveal barriers to its implementation in the classroom.

The research study involved an intervention in a Mid-South urban high school at the 9th grade level. All students who participated were enrolled in the middle track at the school, thus taking an Algebra I course. The intervention took place with four teachers in seven separate classes. Students were given the opportunity to regulate their own learning based on objectives for district and state requirements. In this pre/post design, students were surveyed for their mathematics attitude and achievement using the Attitude Toward Mathematics Inventory (Tapia, 1996) and a polynomial survey designed by the researcher. Teachers were surveyed and interviewed prior to the study to develop a sense of their teaching preferences. During the experiment classroom observations were conducted to assist in developing themes in the intervention. Following the study, extensive interviews took place with each participating teacher.
Data analyses revealed no statistically significant difference between the control and experimental group in regards to mathematics attitude and achievement. Qualitative analysis using constant comparative strategies (Denzin & Lincoln, 2000) revealed many teacher barriers and misconceptions. Teachers felt uncomfortable with the technique and were unable to allow the students to fully regulate their learning. The teachers imposed a timeline, quizzes, written tests, and direct instruction techniques on the students during the study. All of these created barriers to the students fully regulating their learning. Also, teachers’ perceptions of learning and attitude were not valid. Teachers believed the students achieved at a lower level than with a traditional approach and viewed their attitudes as worse than normal. This was in direct contrast to the quantitative results.

KEYWORDS: Self-Regulated Learning, Mathematics Education, Attitude Toward Mathematics, Teacher Perception, Barriers to Instruction

Darin Craig Schroeder

May 17, 2007
A LOOK AT ATTITUDE AND ACHIEVEMENT AS A RESULT OF SELF-REGULATED LEARNING IN THE ALGEBRA I CLASSROOM

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I would like to dedicate this work to the most important person in my life. This work is a testament to your ability to persevere. Your constant belief in me has resulted in all of my accomplishments.
ACKNOWLEDGMENTS

I would like to take this opportunity to individually thank people who made this achievement possible. To my family, Mom, Dad, Jori, Brian, Perry, Haley, Mackenzi, and Mandy, thank you for all the love and support you have given me throughout my life. I know that you always want the best for me and I can always look to you in time of need. This support has been invaluable to me over the years. I am indebted to you all more than I could ever hope to repay. Thank you for standing beside me.

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CHAPTER I
INTRODUCTION

Everyone involved in mathematics has a general purpose in their mathematics instruction, whether it is to further advance the mathematics ingenuity of the students, to share their love of mathematics with students, or simply to help guide students in life. No matter what the aim or purpose, it is generally assumed one wants to promote interest and positive attitudes about mathematics within students. Is this a proper goal of instruction? Is there a link between attitudes and achievement? These are burning questions in the mathematics community, and this mixed methods research study presents evidence as to the link between these factors and the strategies teachers can use to promote positive mathematics attitudes and achievement. The researcher proposes a further study on self-regulated learning in the mathematics classroom.

Statement of the Problem

While this area of research has gained popularity over the last decade, there still remains a vast array of knowledge to gain on attitude and achievement. It has been suggested the relationship between attitude and achievement in mathematics be further studied due to discrepancies found in the relationship between the two. More specifically, Meyer and Turner (2002) call for educational researchers to investigate the sociocultural perspective and its link to self-regulation through multiple research methodologies. Ma and Xu (2004) recommend

A longitudinal random experimental design with adequate improvement in measures of attitude toward mathematics and achievement in mathematics. With random assignment of students and careful manipulation of well-measured attitude and achievement, such a longitudinal random experiment is perhaps the best methodological approach for assessing the causal relationship between attitude and achievement. (pg. 278)

There is a need for research relating mathematical achievement, attitude, and instructional techniques (Ma & Xu, 2004).

Purpose of the Study

The general purpose of this convergent triangulation mixed methods study was to implement self-regulated learning as an experimental instructional design in a freshman

1
middle-track, Algebra I classroom. The research focused on the relationship between self-regulated learning and subsequent development of positive mathematical attitudes and achievement. The study also looked at teachers’ perceptions of self-regulated learning and its usefulness as an instructional method. In addition the research provided some insight as to the effects of the instructional technique in regards to student attitude toward mathematics.

Research Questions

This study initiated self-regulated learning as an experimental instructional technique to evaluate its influence on student attitude toward mathematics as well as subsequent mathematical achievement. There was also an investigation into the participating teachers’ perception of the technique and its usefulness in their classroom. Specifically, the following questions were investigated:

1. What is the relationship between attitude and achievement for beginning middle track secondary mathematics students?
2. How does attitude and achievement change due to the implementation of a self-regulated learning instructional technique?
3. How are mathematical attitudes impacted by self-regulated learning and its related instructional techniques as compared to normal instructional techniques?
4. How is mathematical achievement impacted by self-regulated learning and its related instructional techniques as compared to normal instructional techniques?
5. How do teachers perceive experimental instruction and in particular self-regulated learning and its related instructional techniques?
6. What are the barriers to instructing with self-regulated learning and its related instructional techniques?

Significance of the Study

Previous research has provided insights into mathematical achievement and attitudes (Ma & Xu, 2004). There has also been significant research on self-regulated learning in regards to instructional techniques (Ee, Moore, & Atpughtasamy, 2003). However there is a gap in the research relating attitude and achievement to self-regulated learning strategies and instructional techniques. There is also a need to intervene with freshmen, Algebra I students. Algebra is often viewed as the “gateway” course in
mathematics and it is therefore necessary to promote instructional techniques leading to higher achievement. Also, attitudes begin to decline at this age making it important to intervene and improve this situation. The design of this study was to allow for both a quantitative and qualitative look at these issues in a suburban Mid-South high school. This mixed methods research contributed to instructional design for current secondary mathematics teachers, further research with attitudes and achievement in mathematics, and has implications for teacher preparation programs.

Theoretical Framework

The most popular teaching strategies to promote self-regulated learning involve a constructivist approach to learning. Constructivists’ main tenet is the learner must construct all knowledge through the use of past knowledge. A popular faction of constructivism is the sociocultural approach. In this theory, laid out by Vygotsky (1978), students construct knowledge through social interactions and cultural exchanges. In the classroom this takes the form of cooperative learning, small-group instruction, inquiry, and the idea of the teacher as facilitator. Today’s U.S. classroom is dominated by seatwork and review. This gives little opportunity for students to perform inquiry and link mathematics to everyday life (Borasi, 1996). Inquiry helps promote self-regulation through collaborative and interactive discussions. It promotes social and individual development of metacognition, motivation, and self-regulating processes (Butler, 2003). “Self-regulated learners analyze task demands…select, adapt, or even invent strategic approaches to achieve task objectives…implement strategies…and monitor outcomes associated with strategy use” (Butler, 2002). While cooperative group learning can have both positive and negative social effects, the activity most closely models real-life situations of working with others (Mulryan, 1992). Students’ motivation can also be increased when teachers create instruction that focuses on creating meaning and mathematical relevance (Singh, Granville, & Dika, 2002).

Butler (2002) puts forth a strategic approach to instruction that focuses on promoting self-regulated learning. The approach contains the following elements:

a) Collaboration between students and teachers to complete meaningful work.

b) Teachers diagnose students’ strengths and challenges by listening carefully to students’ sense making as they grapple with meaningful work.
c) Teachers engage students in collaborative problem solving while working towards achieving task goals.
d) Teachers provide calibrated support given students’ areas of need to cue more effective cognitive processing.
e) The use of language in interactive discussions that students might employ to make sense of experience.
f) Teachers ask students to articulate ideas in their own words to promote distillation of new knowledge.

Teachers should use practical knowledge about students’ beliefs and tailor their instruction to influence the students in becoming self-regulated learners during instruction (Middleton & Spanias, 1999). They should also try to improve mathematics achievement in order to promote a positive attitude toward mathematics (Ma & Xu, 2004). In doing so, teachers should present activities that are challenging, can be solved by the students, and are related to real-life (Ma & Xu, 2004). Students should perceive the instruction they are receiving as being useful in immediate and future situations. The best way to accomplish this is by creating problems that have utility for students. This however, will not necessarily affect intrinsic motivation (Middleton & Spanias, 1999).

The theoretical framework for this study is based on the works of Vygotsky. Vygotsky (1978) employed previous research on animal behavior by Kohler and Buhler depicting similarities between higher primate and child development in their usage of tools. The use of tools, Buhler stated, was “the beginnings of practical intelligence in the child (he termed it ‘technical thinking’)” (Vygotsky, 1978, p. 21). Buhler summarized that a child’s degree of development is correlated to the degree of mastery in the use of tools. This is the beginning of cognitive development and precedes intelligent speech. However, Vygotsky (1978) disagreed that we are developmentally similar to apes before speech occurs. Vygotsky noted that the use of tools is an integral part of child development; however, he feels that Buhler and others in this area are underemphasizing the importance of speech in the cognitive development of a child. In fact, Vygotsky thinks the cognitive separation of child and ape actually begins when the child begins using speech. Once a child is able to use speech, then more complex mediated activities can occur.
Vygotsky explains mediated activity as a connection or bridge between stimulus and response. A tool is one form of a mediated activity. An example of the use of a tool to get to a response is when an individual uses a calculator. She uses an external object to get to a response. Vygotsky notes that the initial use of tools occurs in early childhood and precedes speech. Once speech occurs, a higher functioning mediated tool, signification, may be used. Signs prompt the individual to recall or internalize some bit of information. An example Vygotsky employs is the use of a knotted rope to help remind an individual of some event, or reality. “The most significant moment in the course of intellectual development, which gives birth to the purely human forms of practical and abstract intelligence, occurs when speech and practical activity, two previously completely independent lines of development, converge” (Vygotsky, 1978, p. 24). Vygotsky points out the profound ability of a human to combine speech and signs.

**Speech**

The tool of speech allows humans to distinguish themselves from other animals in its use in perception. No longer are we confined to our visual perception and the tools of the environment before us, but we can use speech and signs to revert to previous activities and knowledge. In this way we can develop a plan without actually executing the action. Therefore, we can run through many hypothetical practical applications of solutions or actions (synthesizing) that other animals may not (Vygotsky, 1978,). The tool of speech, therefore, integrates with practical thinking and knowledge to profoundly effect our development.

Speech, both internal and external, is essential throughout human life. Internally individuals are constantly having a conversation with themselves (internal dialogue). This could be a conversation about past, present, or future events. The one constant idea is we are always having this conversation. The language of speech is our way of organizing and thinking about events in our lives. Occasionally through social interaction, we verbalize these thoughts and use external dialogue to communicate with others. This information is discussed externally and then internally reprocessed as we make any changes necessary to our thoughts and knowledge. This process is continually occurring, and without the adaptability of speech to create a superficial environment it would not be possible.
Play

Vygotsky believed play is instrumental in the development of humans and in play the needs of the child are expressed. Play does not show up until the preschool years, when the child creates an imaginary situation to fulfill the unrealizable desires that cannot be fulfilled otherwise (Vygotsky, 1978). However, it is a mistake to think play is in an imaginary, unbound environment. Play always occurs in a rule-based situation. If the child is playing house, then the environment is a house and the events that can occur in that house are limited to those events that the child knows take place in a real house he has previously experienced. In this play situation, action is subordinated to meaning which is in direct contrast to real life where action dominates meaning. “Therefore to consider play as the prototype of a child’s everyday activity and its predominant form is completely incorrect” (Vygotsky, 1978, p. 101). However, play does allow the child to act as someone he is not. A child can play at being a mother, and in doing so, the play situation creates a zone of proximal development of the child. The zone of proximal development includes activities the child can do alone or with help from someone else and will be discussed further in this section. The child develops as she makes decisions as though she were the mother.

A unique feature of play is objects take on different meanings than those in real life. A piece of wood may become a doll and a stick a horse to ride on. The stick, however, retains its physical properties and therefore can be thought of as a horse. It would be impossible for the child to use a stapler as a horse because it doesn’t retain the necessary physical properties. This is a vital stage in that the child can now separate the word “horse” from the object that the word represents. In this case, the stick is called horse and for the child has the meaning of horse. The child may not know he has developed a separation of the two, but nevertheless this is an advancement in the stages of development.

As children get older, play takes the form of games and sports. A rule-based situation is set up and the children are asked to strive for some goal. In this situation, the desires are not immediate, but are suppressed until the end, i.e. winning the game, finishing the race, etc. Toward the end of the development, the rules get stricter and subsequently the play becomes more tense and acute (Vygotsky, 1978). To this effect, the
play has come full-circle. In the end, the play occurs in a rule-based world for delayed gratification whereas it started in an imaginary world for instant gratification. At the end, the child cannot determine his actions, but is bound to the meaning of things and must act accordingly. In this sense, play is directly linked to the development of abstract thought.

Interaction

According to Vygotsky the role of interaction is an essential part of the process of development and learning. Interaction occurs through the use of tools to solve a particular problem. These tools are not limited to, but may include, the use of speech or gestures in an attempt to communicate with those around the subject. This is one of the key elements to a child’s development; the understanding that interaction with those around the child is necessary to achieve a goal.

In his example, Vygotsky explains how a child, not yet developed to speak, can still communicate with a mother in an attempt to get what is wanted. This process starts as the child begins to grasp for an object out of reach. When the mother nearby sees this gesture, she understands that the child is trying to signal the need of something. Over time the child will take this grasping motion and evolve it to what we would call a simple pointing motion. Vygotsky explains that this is how “an object oriented movement becomes a movement aimed at another person, a means of establishing relations” (Vygotsky, 1978, p. 56). Once this process is started, the simple communication with another person to fulfill a need, the child will eventually come to a higher understanding that things can be obtained from those around them. As stated by Vygotsky, “signs and words serve children first and foremost as a means of social contact with other people” (Vygotsky, 1978, p. 28). An understanding of this becomes extremely useful when the child is at a speaking stage and can simply ask for what is needed.

As children develop, so does their understanding of the importance of interaction. Vygotsky explains that even after the use of language is mastered and “after completing a number of intelligent and interrelated actions that should help him solve a particular problem successfully, the child suddenly, upon meeting a difficulty, ceases all attempts and turns for help to the experimenter” (Vygotsky, 1978, p. 29). The child, though sufficiently developed, still shuts down when presented with a difficult task and turns to another for help. By this stage the child has realized that through interaction a process can
be made easier or be achieved at a faster pace—thus reiterating the importance of interaction.

Interaction becomes even more important as the child develops and begins to enter an age where learning begins to become more emphasized. In Vygotsky’s ZPD theory, interaction becomes one of the main factors in development. By this stage of learning a child should have the skills required to interact, at least to some extent, with those around him to achieve a particular goal or to obtain a particular piece of knowledge.

To reiterate, a child’s development of interaction starts with an object oriented movement, such as the reaching for an unreachable object, to a stage where “the path from object to child and from child to object passes through another person” (Vygotsky, 1978, p. 30). When this stage of development is achieved, the child should be able to interact with those around them, either through hand motions or speech, to achieve a goal or a need.

Zone of Proximal Development (ZPD)

In *Mind in Society* (1978), Vygotsky attacks the misconception that students showing achievement on the same grade level or “are the same age mentally” (MA) should be pedagogically approached in the same way (Vygotsky, 1978, p. 85). From this he discussed the notion of a child’s level of actual development and zone of proximal development (ZPD). The ZPD refers to “the distance between the actual level of development as determined by independent problem solving [with social interaction] and the level of potential development as determined by problem solving under adult guidance or in collaboration with more capable peers” (Vygotsky, 1978, p. 86). Vygotsky frames this concept by comparing two students’ chronological age (10 years old) to their mental age (8 years old).

Two children achieve on the same level. Given a set of tasks to be performed without guidance, both children would perform at the same level. A common pedagogical practice, therefore, has been to handle their education in the same ways. However, Vygotsky states that circumstances leading up to these children’s current “mental age” could be more complex causing this end result of achievement. For example, a student, he says, could have missed school which resulted in a loss of education and therefore has
fallen behind his peers. The other student could have been present in class the entire time but still fell short of the average achievement of his peers.

Given similar tasks to be performed with guidance, the child that has missed school may achieve more than the second child receiving the same guidance. Vygotsky says the achievement level for the first child could jump from an MA of 8 to 12, for example, and the second child may only achieve an MA of 9 which is 3 levels below the first child. The area where the child is independent of guidance and where the child could be with help is the ZPD. The zone, Vygotsky says, is defined by the level of maturation developing but not quite developed, and he refers to this as “buds” or “flowers” of development. We should, therefore, provide different guidance along the identified ZPD for each child to help them mature. Arguably, Vygotsky is really referring to the differences between a child’s achievement level and Intelligence Quotient. Also, the concept of the ZPD has become a foundation for the current notion of scaffolding and the notion of a spiral curriculum (Bruner, 1996).

Contemporary Research in Mathematics

Paul Cobb has been a prominent leader in the implementation of Vygotsky’s ideas toward mathematics education research. While not always incorporating or agreeing with Vygotsky wholly, Cobb, Boufi, McClain, and Whitenack (1997) analyzed the ideas of constructivism and sociocultural theories. Cobb has made several contributions to the field including editing Theories of Mathematical Learning (1996), a compilation of articles on mathematical learning theories that present the reader with very differing views.

Cobb presents several theoretical ideas in his works. The first is that a constructivist researcher is a teacher and a model builder (Cobb & Steffe, 1983). Cobb states that it is essential the researcher be active in the classroom, making observations and testing theories of learning, in order that he might construct a view of mathematical thinking. From these observations, the researcher can then develop and mold his model of mathematical learning. Also, this interaction privileges the researcher to the interaction between adults and children which influences the child’s construction of mathematical knowledge (Cobb & Steffe, 1983). In addition, within the constructivist view, teachers must continually view both their own and children’s actions from the children’s point of
view. Cobb emphasizes that qualitative data must be collected in order to understand how children develop mathematical ideas. In this way, teachers are constructing their understanding of children’s mathematical knowledge and thus using Vygotsky’s ideas.

In addition, Cobb (1994) was quick to note the constructivist viewpoint is not the only theory of learning; other viewpoints should be considered and respected. He particularly points out that sociocultural theory has relevance within mathematical research.

In my view, both these perspectives are of value in the current era of educational reform that stresses both students’ meaningful mathematical learning and the restructuring of the school while simultaneously taking issues of diversity seriously. (Cobb, 1994, p. 18)

This awareness of others’ theories and ideas has helped further research and understanding of mathematical learning and has placed Cobb in high regard among his peers.

The impact of Vygotsky’s ideas on mathematics teaching, learning, and curriculum can be found in the ZPD and spiraling curriculum. Vygotsky’s (1978) notion of building knowledge from previous knowledge and that there is a limit to what can be learned at any given time influences our current mathematical curriculum greatly. The current reform movement attempts to promote a spiral curriculum (Bruner, 1996) in that topics are taught within a whole and previous constructs are continually revisited as depth and complexity are added to the material. It is important to note the implementation of a spiral curriculum is difficult given the numbers of students and their varying levels of knowledge. Students are guided through the material in an effort to build their knowledge of mathematics as a whole. This is in contrast to the strict curriculum of the past in which topics were taught as separate entities with no real connections provided.

The framework for this mixed methods study is that of social-constructivism. This is evident in the use of the teacher as a facilitator and the students’ abilities to learn at their own pace. This allows the students to interact with others, both in the classroom and via resources, and construct new knowledge from existing knowledge structures. This provides students with an opportunity to be successful even though their MA may be quite different from their peers. With this approach remediation can occur for those students in need, and advanced learning can take place simultaneously for those with
higher-level understanding. This will create many opportunities for students to engage in discussion and mathematical learning.

**Definition of Terms**

The following definitions are provided for terms having special applications to this study. These terms and definitions will be extensively reviewed in Chapter 2.

*Attitude* – one’s feelings and emotions toward mathematics including interests and motivation

*Affective domain* – the realm of attitudes, emotions, and beliefs.

*Alternate group* – a group of students receiving a teacher’s normal instruction during the duration of the study. This group was used in contrast to the experimental group during the study.

*Constructivism* – the building of knowledge from previous knowledge structures.

*Experimental group* – a group of students receiving the treatment of self-regulated learning during the duration of the study.

*Motivation* – the intrinsic or extrinsic drive to complete a task.

*Self-regulated learning* – learning in which the learner has autonomy (choice) over subject, method, motivation, or assessment or any combination of these areas.

**Assumptions**

1. The participants provide accurate information

**Delimitations**

1. It is not possible to test all beginning secondary mathematics students. Thus, the study is limited to the number of students and teachers available to the researcher.

2. The students were confined to their classrooms and the materials located in those classrooms. This did not include internet or other electronic resources. The researcher provided hard copies of internet resources and other electronic resources when possible.

3. Study was limited to one unit of study (15 instructional days).

4. Could not use SES as a covariate due to IRB restrictions.

**Organization of the Study**

The goal of the study was to produce two separate articles for publication. The first article gives a qualitative analysis of the participating teachers’ perceptions of self-
regulated learning and its utility at the beginning secondary level as well as the barriers encountered. The second article is a mixed-methods design focused on the relationship between attitude and achievement in secondary mathematics for beginning students and the teachers’ implementation of self-regulated learning. To complete the dissertation, this first chapter presented an introduction to the mixed methods study while justifying the need for this study. The second chapter presents a comprehensive literature review for the study. The third chapter describes the methodology for the study. The two articles are present in Chapters IV and V. The final chapter brings together all the results and discussion, and gives implications that can be drawn from the study.

I. Introduction
II. Literature Review
III. Methodology
IV. Article 1
V. Article 2
VI. Discussion, Conclusions, and Implications
Chapter II
REVIEW OF LITERATURE

Chapter II contains a review of literature on mathematics attitude, achievement, motivation, and interest. It also provides a review of teacher impact and self-regulated learning. This provides a foundation for the study.

**Attitude**

A student’s attitude will be defined in this research to include one’s feelings and emotions toward mathematics including interests and motivation. Attitudes, emotions, and beliefs make up the affective domain in mathematics education (McLeod, 1992). Students typically display a dislike for mathematics as well as waning beliefs of the social importance of mathematics as they increase in age (Wilkins & Ma, 2003). This effect is even seen among students who claim to enjoy mathematics. The decline in attitude could be explained by the ever-increasing diversity of choices available to today’s youth. As options available to students increase with age, the attitude those students have towards mathematics could be negatively affected, in that it is replaced by a different activity. For example, as a student enters secondary school they often have a choice of career paths that dictate the choice of mathematics courses. If they choose a tract with few mathematics courses, then they will view mathematics as being irrelevant or not important to their needs. Past instruction promotes in mathematics students’ attitudes (1) the value of speed of computation, (2) following the example of the teacher, and (3) right answers are more important than learning and understanding (Kloosterman, 1993).

The influences on students’ attitudes are many. Teachers, peers, and parents, as well as the environment, all have influence on an individual’s attitude. Wilkins and Ma (2003) found teachers’, peers’, and parents’ positive support helped create positive attitudes and beliefs about the social importance of mathematics and thus helped curb negative beliefs and attitudes. Hon and Yeung (2005) tell us when students are surrounded by positive influences, they will be affected in a positive way. Environmental factors including students’ home life and access to instructional materials as well as entertainment measures can all have an affect on attitude and achievement (Ames, 1992).
Attitude and Achievement

All schools strive to have students achieve at a level of proficiency. However, this does not always equate to instruction that takes into account the students’ attitudes toward mathematics. Although attitudes decrease over time, Ma and Xu (2004) reported an increase in mean achievement across time. This study, performed through analysis of LSAY data on students in grades 7-12, highlights that even though students’ attitudes decreased they still performed well. It could be that attitude does not have an effect on achievement, or that attitude and achievement have an inverse relationship. This begs the question, is there any link between attitudes and achievement?

This particular issue needs to be studied further. It has been found that students who value and enjoy mathematics have a higher level of achievement (Gottfried, 1985). On the flipside, poor achievement has been linked to a decline in mathematics attitude (Ma & Xu, 2004). We do know that attitudes about mathematics develop over time (Ma & Kishor, 1997). During the elementary grades students are introduced to concepts slowly and repetitively, resulting in positive attitudes and achievement for most students. As the material gets more diverse and abstract, students’ attitudes and achievement levels begin to decline (Hiebert et. al, 2003). Prior attitude has an affect on later attitude and prior achievement has an affect on later achievement, with the affect of prior achievement being stronger (Ma & Xu, 2004). As for the relationship between the two, at a statistically significant level, prior achievement predicted later attitude for grades 7-12. However, prior attitude did not predict later achievement (Ma & Xu, 2004). Therefore, achievement leads to a positive attitude, but having a positive attitude does not necessarily lead to achievement. While this study argues for a one-sided effect, most authors conclude attitude and achievement influence one another in a cyclical fashion (Schiefele & Csikszentmihalyi, 1995).

Attitude and Achievement Outcomes

The outcomes of attitude, interest, motivation, and achievement are far-reaching. The most significant is course selection and career paths. Maple and Stage (1991) found students’ attitude toward mathematics was a significant predictor of selecting a mathematics major, but not achievement. On the other hand, achievement at the middle school level determines the curricular choices of students in higher-level mathematics
Armstrong and Price (1982) found usefulness of mathematics was the most important item influencing the decision to take more mathematics courses. Interest has been linked to the choice of courses in high school. While it cannot account for grades, interest does contribute significantly to the level of mathematics proficiency students attempt (Schiefele & Csikszentmihalyi, 1995). Along with these factors, lower levels of achievement in mathematics courses restrict students’ career choices involving mathematical skills (Oakes, 1990). As an instructor, one hopes to guide students into taking higher-level mathematics classes which allow them an opportunity for entering careers involving mathematics.

Interest

Students often become interested in a subject because it evokes some intrinsic motivation within them. They may see a challenge in the subject, be curious about an event, or have a fantasy involving a particular topic. “When a student first encounters an academic activity, she will tend to evaluate the stimulation it provides and the personal control the activity affords” (Middleton & Spanias, 1999). When stimulation and control are available, the student is likely to become engaged. Students who have high interest tend to have instruction that is student-centered and stimulating, complete their homework regularly, and have fewer distracting objects in their home environment (Horn & Walberg, 1984). The student-centered learning approach develops the student’s sense of control of the activity and the ability to explore interesting topics.

Interest and Achievement

Interest and achievement have also been found to be interrelated. Interest has been shown to account for a significant, yet small portion of achievement variance as well as predicting grades (Schiefele & Csikszentmihalyi, 1995). They also found evidence interest is not just an outcome of successful performance. While this research shows support for the correlation of interest and achievement, there are contradictory findings. Schiefele and Csikszentmihalyi state that the attitude of the student has no effect on interest and has no meaningful practical implications. Also, the effect of interest on achievement is insignificant. This viewpoint is supported by Horn and Walberg (1984) who found “[interest] is nearly uncorrelated with achievement, which surprisingly
suggests that students who pursued mathematics voluntarily achieve little more on average than those who do not.”

These confounding arguments call for more research in the area of interest and its link to attitude and achievement. However, there have been pertinent findings as to the timing and significance of interest research. Middleton and Spanias (1999) reported that students who like math started to do so around seventh grade while those who disliked math started to do so at the same time. Links have also been shown between the quality of experience in mathematics classes and interest (Schiefele & Csikszentmihalyi, 1995). In order to make use of interest and its affects on achievement and attitude, the material must be difficult enough to hold the students interest, but allow for successful completion by the student (Middleton & Spanias, 1999). The good news is this is not an unreachable goal for instruction. However, instruction must undergo radical change in order to hold the attention of the student, and it must do so consistently to be effective (Middleton & Spanias, 1999).

Motivation and Math Anxiety

Students who are not motivated in some way often tend to perform poorly in the classroom. Motivation can be defined as the reason individuals have for behaving in a given way in a given situation (Ames, 1992). Motivation can take two forms, intrinsic and extrinsic. Often teachers and schools focus on providing extrinsic rewards, i.e. grades, treats, and college entrance, in order to motivate students. It would be more effective for teachers to promote intrinsic motivation. Intrinsic motivation removes the need for outside incentives for learning. Rather than receive a gift, the student learns in order to fulfill an internal desire and receives satisfaction and praise from himself. Results show that motivational patterns are learned, and more importantly students learn to dislike mathematics (Middleton & Spanias, 1999). Of great importance to educators is the strong effect of motivation, attitude, and engagement on success in mathematics (Singh et al., 2002). Each student has different motivations and it is key that instructors are able to help build and tap into these personalized constructs. Since over time these motivations are relatively stable regardless of success or failure, it is important to help form positive attitudes and intrinsic motivations during early adolescence (Middleton & Spanias, 1999).
Math anxiety is a term used to describe individuals who view mathematics as difficult and their mathematical abilities as poor. Math anxiety often leads students to avoid mathematics if at all possible (Hilton, 1981; Otten & Kuyper, 1988). Math anxiety has often been shown to have a significant relationship with achievement. Ma (1999) was able to quantify the potential improvement in academic achievement when anxiety was reduced. Nakamura (1988) found that gifted children who had high levels of achievement were often less anxious than lower achieving students. Anxiety and motivation are just two more factors that can affect the achievement and attitudes of students in mathematics classrooms.

Teacher Influence

Teachers can have a profound influence on students’ attitude, motivation, interest, and achievement in the classroom. As previously mentioned, most teachers tend to “stimulate” their students through the use of extrinsic rewards (Middleton, 1995). While this can be successful, it often makes the student continually dependent on the rewards to perform mathematical tasks. Students can be prompted to view the mathematical problems as interesting and useful through discussions of their relationship to the students’ current and future endeavors (Good & Brophy, 2003). Teachers can affect students through very different means. Through a teacher’s choice of activity, students’ view of mathematics and its usefulness can be impacted (Wilkins & Ma, 2003). A teacher who is supportive and authoritative, as well as both a model and peer, can help produce feelings of self-worth in students in the mathematics classroom (Covington, 1984).

The students, through proper modeling of the instructor, can also learn intrinsic motivation. Intrinsic motivations affect the choices teachers make in the activities they choose for their classroom (Middleton, 1995). However, teachers tend to have little knowledge as to how students view mathematics and the students’ motivations (Middleton & Spanias, 1999). Therefore, teachers are continually making instructional decisions that do not take into account the students’ motivations for mathematics. Those who account for student motivations and do use students’ motivations to guide their instruction have been shown to better motivate their students toward work in mathematics (Middleton & Spanias, 1999). Good and Brophy (2003) also suggest that social factors such as peer interaction can influence positive student motivation. In what
they refer to as “co-regulated learning” students combine their own skills and interests with those of peers to move past their own limitations. Teachers who do not currently employ this practice can be helped through professional development. By teaching them to recognize and adjust to differing student motivations, these teachers can be helped to provide an atmosphere that helps promote intrinsic motivation (Middleton & Spanias, 1999).

Assignment Choices

A novel idea not often used is to allow students to have choices for their assignments and learning. With strict standards to meet both at the state and national levels, teachers are often rushing students to learn the proposed curriculum. These students can often benefit from choices within this curriculum. Whether it is in choice of assignment, topic, instructional materials, or evaluation method, giving the students autonomy in their learning can produce increased intrinsic motivation (Good & Brophy, 2003). Often it is thought older students and those of higher-ability are the students that need choice in their instruction. However, low achievers and younger students also need choice.

Intervention

The good news is that even though students may not be motivated, have good attitudes, or have any interest in mathematics, teachers can still have a positive influence on all of these factors. Ma and Xu (2004) suggest teachers work to improve attitude and achievement early in junior high school. Their research found teachers’ efforts to improve attitude and achievement during late junior and early senior high school can have far-reaching effects. This is the most effective time to use achievement to promote attitude. This intervention is particularly useful with nonelite students (Ma & Xu, 2004). This intervention could take the form of increased academic time and new curricular strategies to enhance interest in mathematics (Singh et al., 2002).

Teaching Strategies

The teaching strategies that can promote attitude, interest, motivation, and achievement are the same strategies that make for effective instruction. Teachers in the past have focused on a small number of students (usually less motivated ones) or the “average,” and focus instruction on this group in an attempt to reduce the complexity and
feeling of failure in instruction (Middleton, 1995). Even when they use this strategy, they often do not know how students are intrinsically motivated due to the reality of having to teach 30 students. This is a challenge all teachers face today. The classroom is becoming increasingly more diverse and different learners present various challenges. Even when learners are having difficulty with the same task, they may need different interventions (Butler, 2002). In a twins study, Fouzder and Markwick (2000) found all the attitudes and general behavior of a set of twins were similar, but their personalities and self-perceptions were very different. If twins do not have similar traits, then non-related students will have very different needs.

Regardless of the approach used, it is documented that instructional practices influence achievement motivation, and if these methods are consistent over time, students learn, enjoy, and value mathematics (Middleton & Spanias, 1999). While a self-regulated approach has been promoted here, it is important that each teacher find an approach that matches his or her theoretical beliefs about mathematics education.

**Self-regulated Learning**

In 2000 the National Council of Teachers of Mathematics (NCTM) released the *Principles and Standards for School Mathematics*. This document updated the 1989 NCTM document, suggesting teachers take on different roles in the classroom. Teachers are now being asked to engage students in rich mathematical experiences and to challenge them to reason through problem solving and inquiry. This requires a shift from direct instructional methods that promote transfer of perceived facts and memorized procedures, to methods that promote actual student understanding of the reasoning behind chosen procedures.

Since the release of the 2000 NCTM Standards, there has been an initiation of self-regulated learning research within mathematics education. This influx of new research can be traced to a bridging of educational psychology and mathematics education. Academic self-regulation refers to the processes by which learners maintain cognition, affect, and behavior in order to achieve personal goals (Zimmerman, 2000). Pintrich (2000) defines self-regulated learning as “an active, constructive process whereby learners set goals for their learning and then attempt to monitor, regulate, and control their cognition, motivation, and behavior, guided and constrained by their goals.
and the contextual features of the environment” (p. 453). This is similar to the definition used by Pape, Bell, and Yetkin (2003). In mathematics the typical emphasis tends to be on effective problem solving procedures and the tasks that are associated with this process. This often results in direct instruction which does not take into account students different learning preferences.

There are several cyclical steps self-regulated learners follow in order to learn effectively, the first of these being an analysis of the task demands. A self-regulated learner examines cues from the question or the teacher in order to determine what is required for the specific outcome. This analysis requires that the student discern the necessary information from the verbal or written instruction and then compare it with previous knowledge (Butler, 2002). For example, if asked to write an open-response answer the student would link this requirement to previous experiences where student was required to not only solve the problem at hand, but also to give a written explanation of his logic in solving the problem adding extensions for the solution to the problem.

A self-regulated learner would then choose, select, adapt, or invent a strategic approach to solving the problem (Butler, 2002). This requires that the learner compare the problem to previously encountered problems as well as taking inventory of the facts and ideas surrounding the task. In doing so, the learner chooses an appropriate method, combines two methods, or creates a new unique approach. This type of learner, a self-regulated learner, is much more efficient and effective then a learner who often has difficulty if the problem does not match a schema for problem solving they have previously encountered.

The most important step is that self-regulated learners evaluate their strategy after implementation (Butler, 2002). Since they understand the goal of the task, they are able to judge whether their strategy was effective in finding a proper solution. If not successful, they are then able to develop and implement another strategy that can be used to solve the problem. Either way, the results are recorded by the learner for future reference in relation to newly encountered problems. This differs from a deficient learner who is more apt to simply stop whether the correct or incorrect solution has been reached.

While there is some research into self-regulated learning specific to the mathematics field, there is a large area yet to be explored. A search of ERIC database
revealed approximately 30 hits relating self-regulation and mathematics, with several of
the studies applying across content areas; however, most of these articles have been
helpful in generating ideas for future researchers.

Research has been primarily limited to the implementation of individual
instructional strategies aimed at promoting self-regulation within the classroom (Pape,
Bell, & Yetkin, 2003). Most studies relate to teachers who promote self-regulation
through the modeling of mathematical behaviors. This is often completed through a
variety of approaches. One may ask the students to study, report their learning and
understanding, and then provide the student with feedback and guidance as to any
misunderstandings or misconceptions held (Travers & Scheckley, 2000; Zan, 2000). This
process of learning, self-evaluating, and then entering the process again promotes self-
regulation. The goal is to reduce the teacher’s role in the process and have the learner
implement the stages. The key seems to be giving students a task that builds from rote
knowledge, to engaging exercises, to problems that embed previous learning (Zan, 2000).
This building of students’ success leads to higher self-efficacy. Self-efficacy refers to
one’s belief in his capability to perform at a designated level (Bandura, 1997). By
increasing a student’s belief in his ability to perform, it is more likely the student will
persevere when a solution is not attained rapidly. A high degree of self-efficacy has been
linked with high academic performance, use of self-regulation strategies, and delay of
gratification (Bembenutty & Karabenick, 1998). While the research is limited, there have
been positive correlations found between self-regulated learning, performance, and self-
efficacy (Malpass, O’Neil, & Hocevar, 1999). More specifically, self-efficacy is
moderately and positively related to self-regulation and positively related to math
achievement.

When implementing an instructional strategy for developing self-regulated
learning there are two distinct schools of thought based on the learning theory in which
the researcher focuses. One can see the individual as the means for implementation or
one can see the group as a social constructor of knowledge. Each theory has its own
unique approach to developing self-regulated learning. Sociocultural approaches assume
self-regulation occurs through social interaction and produces results that are both
academic and nonacademic (Meyer & Turner, 2002). This is in contrast to instruction
which only looks at the individual’s ability to identify the task, choose a strategy, implement the strategy, and reflect on the process. Socioculturalists add the idea that the goal of the task is both individual attainment and social change (Yowell & Smylie, 1999). Therefore, instruction has the added component of group discussion and problem solving. This allows students to discuss their thinking and develop not only self-reflection but also peer-reflection. One must be careful though as the group dynamic can also affect participation of those with low self-efficacy.

These differences in approaches, individual and sociocultural, need to be addressed. By taking the individual approach and focusing on the learner only, we can isolate the variables of instruction that lead to self-regulation. This will allow researchers to best hone the technique of promoting self-regulation within the classroom. It does, however, leave out a large variable. Peers and teachers themselves have a large impact on the learning of others.

Peers can be both the best promoters as well as the worst enemies of motivation and self-regulation. Positive effects include peer-to-peer scaffolding, promoting positive attitudes, and peer pressure that leads to increased achievement. Students often are able to better reason with other students due to their similar cognitive levels. This can be very beneficial as students are much more likely to bridge between concepts with their peers than with the instructor. Peers can model the behavior necessary to solve problems, and they can also have a positive effect through peer pressure and positive attitudes. Often seeing peers solving a problem and/or hearing encouragement from their peers can influence a student’s self-efficacy. These are all positive influences that social context has on self-regulated learning.

On the contrary, social interaction can also have a negative effect. Negative attitudes from peers along with peer pressure to “fit in” can persuade students to give up, especially in the context of mathematics. It is often considered normal not to “get” mathematics in formal schooling. If a student constantly worries about making a mistake in front of others, they are less likely to engage in self-regulated learning and are more likely to simply follow formal procedures regardless of the results.

The reasons for the two viewpoints, individual and social, are linked to the researcher’s view of learning. If the researcher is a social constructivist who believes that
all learning occurs through social interaction and that knowledge is constructed, then he must include the social context in self-regulation strategies. If one subscribes to an approach that does not rely on social context, then the strategy will focus upon the individual learner and will not include social aspects. Both approaches are beneficial to teaching implementation, but it is virtually impossible to leave social interaction out of any approach to formal schooling.

There is a small amount of research that analyzes self-regulation across disciplines. In 1998, Wolters and Pintrich researched mathematics, English, and social studies classrooms. Their findings showed that self-regulation and academic performance were similar across the fields of study. Wolters and Pintrich (1998) also concluded that

*From a social cognitive and self-regulated learning perspective, interest and value can help a student choose to become involved in a task…but once involved, the self-regulation process of strategy use and adaptive efficacy beliefs are more important for “steering” and controlling actual performance. (pg. 42)*

No matter what the subject, self-efficacy and strategy use are most important when promoting academic achievement.

There are several ideas that have emerged from this research on self-regulation. Most of these in mathematics education, including the NCTM (2000), link successful mathematics with choosing and implementing proper strategies and then reflecting upon those strategies. Although there is not a plethora of data to support the position that teaching techniques implemented are the sole cause for improved achievement, it is important for teachers to promote self-regulation in their classroom nonetheless. The first issue is whether classroom processes have any control over achievement and self-regulation. Classroom control does have a positive effect on self-regulation strategies and achievement (Eshel & Kohavi, 2003). A higher math score was positively correlated with self-efficacy for self-regulated learning, intrinsic value, and cognitive strategies. While perceived classroom control is subjective and can vary among students in the same classroom, research suggests that within the same classroom, opportunities for both individual and group instruction can lead to greater self-regulation and achievement (Eshel & Kohavi, 2003).

Another emerging issue is the role of affective domains on the selection of self-regulation strategies. Often, repeated failure within mathematics leads to negative
emotions such as anxiety and panic as well as negative attitudes and fatalism (Zan, 2000). This may prove to be a large barrier to successful completion of mathematics tasks. A Student’s failure to complete examinations may not be due to the student’s lack of knowledge, but the influence of “loser” beliefs and the subsequent mismanagement of student’s knowledge. Therefore, it is not only important to research what instructional strategies are successful in promoting self-regulation, but it is also important to analyze and remedy negative attitudes and beliefs that can block the use of self-regulation strategies that currently exist within the students. In a secondary school experiment, Bembenutty and Zimmerman (2003) found, through instruction designed to promote self-regulation, they were able to improve intrinsic interest and the delay of gratification. In doing so, they were able to improve self-regulation since their research data supported the idea that both intrinsic interest in a course and the delay of gratification have a direct effect on self-regulation.

The third emerging belief is that self-regulation can have a direct effect on students’ achievement in and outside of school. Cognitive self-regulation strategy proved to be a significant predictor of course grades in mathematics in the high school and subsequent course grades and examinations at the university level (Nota, Soresi, & Zimmerman, 2004). They were also able to show that the self-consequences strategy (students’ arrangement of imagination of rewards or punishment for success or failure) was the best predictor of student’s intentions to further their education. The student’s ability to set a long-term goal, delay gratification, and grasp the consequences of success within school was directly linked with the choice of further schooling. Higher levels of schooling can be directly linked to both job satisfaction and an improved society.

While all of these issues have emerged, there is very little solid research within this domain of mathematics education. Most of the studies followed the same line of research. Instructional strategies were used to promote self-regulation strategies and self-efficacy in an effort to improve achievement. It was difficult to discern the particulars of the instructional strategies promoting self-regulation and how they differed from instructional strategies teachers currently possess. For example, Pape, Bell, and Yetkin (2003) never discuss the particulars of their intervention more than the fact that they used professional development sessions to promote instructional strategies aimed at improving
self-regulation. Most strategies focused on some main ideas within the field. First, students need to be successful in mathematics in order to improve their self-efficacy. The theme within the research is to break the tasks into smaller, more manageable tasks so students will most likely succeed (Pape, Bell, & Yetkin, 2003; Zan, 2000). The hope is by creating success, students will build their ability to delay gratification and proceed with problem-solving when failure does occur.

The second strategy is that students need to be instructed how to self-regulate their learning. This can be completed through various forms of modeling. Whether it is individual, small group, or classroom instruction, there are various techniques that can be useful in promoting self-regulated learning (Butler, 2002). Individualized instruction relies on the instructor tutoring the student to evaluate the metacognitive processes occurring in solving problems. The teacher must guide the student in identifying the task, choosing the appropriate strategy, and then reflecting on the outcomes. In small-group instruction, the tasks and outcomes may be different for varying groups or even individuals within the groups. Peers can help develop strategies for others even when they will not be a part of the implementation (Butler, 2002). This peer interaction brings a new level of engagement and is more in line with the sociocultural perspective. Whole-class instruction usually involves the discussion of task goals and strategy choices. A teacher may give an assignment and then have the class analyze the goals of the assignment and the strategies that will be useful. The students would then be allowed to choose their own strategy and subsequently control the implementation. The class would then discuss their individual outcomes and reflect on the different strategies in relation to the goal of the task (Butler, 2002).

Conclusions

This area of mathematics research regarding self-regulation is still in its infancy. It is important to merge the fields of educational psychology and mathematics education so that educators may provide students with the best opportunities to learn within the classroom. The opportunities and branches from this point are endless. Suggestions are immense throughout the current research. There is a call for future research to find models that represent how motivation, meta-cognition, and self-regulation interact (Kuyper, van der Werf, & Lubbers, 2000). There is a need to inquire as to how one
defines self-regulation in the content of collaborative and interactive discussions, while also uncovering the roles of social and individual processes in students’ development of metacognition, motivation, and self-regulating processes (Butler, 2003).

Schunk (1996) lists three goals for future research. The first emphasis should include finding the role of self-evaluation in self-regulated learning. Finding students’ current evaluation techniques and researching their origins and effects will allow researchers to better understand the processes and develop instruction designed to promote effective procedures. Second, self-regulated learning should be evaluated across content areas (Miller, 2000; Schunk, 1996). It may be that skills that are advantageous in one content area are not as pertinent in another. There may also be a link across the disciplines. While some research has been conducted in this area, a more in-depth analysis is needed. The third area recommended by Schunk (1996) is research in the environmental context of the self-regulated learning. Insight as to how environment and specific feedback received affects self-regulation is needed in order to move forward in the production of effective instructional strategies.

There is also a need for a study of methods that can capture the inter-relationships among self-regulation variables (Travers & Scheckley, 2000). Another area of interest is how student’s self-regulation processes change over time. Is there a staging process in the development of self-regulation? Are there specific qualities that are found in the teaching of effective self-regulation strategies?
CHAPTER III
METHODOLOGY

The purpose of this quasi-experimental convergent triangulation mixed methods study was to analyze the mathematics attitude and achievement of Algebra I students. The researcher was interested in implementing a new instructional strategy in the classroom and finding the affects of this strategy on student attitude, interest, motivation, and achievement as well as its utility for practicing secondary mathematics teachers. The study was a mixed-methods design with data being analyzed both quantitatively and qualitatively. The quantitative analysis was used to study the relationship between attitude and achievement as well as the relationship of the instructional technique to student attitudes and achievement. Qualitative analysis was used to understand the utility of the method and the barriers to its implementation from the teachers’ perspectives. The quantitative and qualitative analyses compliment each other in providing an in-depth analysis of most factors contained in the study.

Mixed Methodology Research Design

Mixed methods research uniquely combines both quantitative and qualitative methodologies to gain a better understanding of the research problem. For the purposes of this study Creswell and Clark’s (2006) definition of mixed methodology will be utilized.

Mixed methods research is a research design with philosophical assumptions as well as methods of inquiry. As a methodology, it involves philosophical assumptions that guide the direction of the collection and analysis of data and the mixture of qualitative and quantitative approaches and many phases in the research process. As a method, it focuses on collecting, analyzing, and mixing both quantitative and qualitative data in a single study or series of studies. Its central premise is that the use of quantitative and qualitative approaches in combination provides a better understanding of research problems then either approach alone. (p. 5)

Both qualitative and quantitative approaches have been successful in broaching the topic of self-regulation in mathematics classrooms. Qualitative methods have included the usual surveys of student attitudes and performance. Quantitative analyses have relied heavily on survey results and academic achievement to monitor self-regulation, which has made it difficult to isolate the procedures that are effective within the implemented behavior. Qualitative research on self-regulated learning (Travers &
Scheckley, 2000) on the other hand has relied heavily on observation and description of student-teacher and student-student interactions. It has also included reflections from the instructor as to the effectiveness of instruction and difficulties of the instructional strategy. By combining both quantitative and qualitative methods one might see a more complete view of the importance and development of self-regulated learning.

This quasi-experimental study employed a convergent triangulation mixed methods strategy in order to answer the above research questions. The triangulation model is the most familiar of the six major mixed methods models (Creswell, 2003). The convergence triangulation strategy uses separate quantitative and qualitative methods to give strength to the research in areas where one method alone would be inherently weak. In this strategy it is ideal for quantitative and qualitative approaches to be given equal treatment with the integration of the results of the two methods happening at the interpretation phase of the study (Creswell, 2003). The following (figure 1) gives a more detailed picture of the concurrent triangulation strategy being used in this study.
Figure 1. Mixed Methods Design for the Study (adapted from Creswell, 2003; Tashakkori & Teddlie, 1998).
Population

The researcher used an experimental instructional strategy implemented at the 9th grade level in Algebra I classrooms at one local high school for a duration of fifteen instructional days (one instructional unit on polynomials) with 96 students participating in the experiment. Due to restraints a convenience sample was employed putting a limitation on the study. The teachers enrolled in the study on a voluntary basis and with the approval of the local school board, principal, and mathematics department chair. The targeted population was freshman students enrolled in Algebra I. These students were ability grouped and this population represented the middle track. Advanced students were enrolled in Geometry and lower-level students were enrolled in Algebra I part 1. The total enrollment of the school was over 1800 with approximately 500 freshman students enrolled in a math course.

Instrumentation

To assess students’ attitudes, interest, motivation, and achievement the students were given an attitude survey prior to the start of the experiment as well as a polynomial survey (the topic of the instructional unit). The researcher administered these surveys to prevent any management differences among classes. In addition the researcher distributed the assent forms to students and reviewed these documents to ensure safety and consistency. Students were given the same surveys at the end of the experimental instruction, once again by the researcher. A control group (n = 17) received typical instruction consisting of lecture, seatwork, and various small group activities and was used to compare to the experimental data.

The teachers participating in this study were interviewed and surveyed for their perceptions of the experiment and its usefulness in their classroom. Extensive interviews were conducted with all of the participating teachers prior to and after the study was completed. The teachers were interviewed prior to the research study to reveal their current teaching methods and their motivations as teachers (see Appendix F). Following the initial questioning, the researcher performed a member check (Denzin & Lincoln, 2000). This assured the responses were accurate and not prone to recording error. In order to save time on the interviews, the teachers were also given survey questions to answer prior to the study (see Appendix G). An initial and brief qualitative analysis of these data
provided the researcher with the knowledge necessary to improve the experimental technique and monitor its effectiveness and utility throughout the study. In addition, these data were used to help construct the post-interview questions for the teachers.

The teacher interview questions and survey questions administered prior to the research were developed by the researcher. These questions were designed to give the researcher an insight into the teacher’s motivation for teaching mathematics. In addition these instruments developed an understanding for the teacher’s participation in the research, the teacher’s typical classroom instruction, and the teachers’ motivation for participating in the research. The interview questions also probed the teacher’s thoughts about students’ likely success or failure with self-regulated learning and their concerns before starting the study.

In addition to the interview and survey questions, teachers were asked to journal during the experiment and their thoughts were typed and emailed to the researcher during this time.

Interview questions for the teachers following the intervention (see Appendix H) focused on the teachers’ day-to-day activities during the research and subsequent successes and failures within the instruction. The questions revisited their prior assumptions about self-regulated learning and developed many themes that became apparent during the study. The focus was on the barriers teachers encountered and improvements that could be made for future implementations of self-regulated learning.

The student attitude survey was developed by Martha Tapia of Berry College. The Attitude Toward Mathematics Inventory (ATMI) is a 40-item, Likert scale survey measuring four areas relating to mathematics attitude including self-confidence, value, enjoyment, and motivation. The ATMI was developed for use with high school students and has evolved through item analysis and exploratory factor analysis. The assessment has been validated through studies involving high school and college students, as well as students from Mexico and the United States. The instrument has a coefficient alpha of 0.97 with standard error of measurement of 5.67 (Tapia, 1996). Written permission was granted by Tapia for the use of the instrument in this study.

The student polynomial survey was developed by the researcher in conjunction with the teachers involved in the study. The content was outlined by the school
curriculum map developed by the secondary mathematics curriculum specialist for the school system. The researcher developed a list of student objectives for the unit in order to develop the survey. The survey instrument contained questions found on the district-wide assessments which aligned with the list of objectives. This survey used a multiple-choice format. For those questions which were currently used on the district assessment but were not multiple-choice, the researcher developed distractors based on common mathematical misconceptions. It is important to note that district-wide assessments align with the Program of Studies and Core Content for Assessment 4.1 from the Kentucky Department of Education. Therefore, this survey measured objectives at both the district and state levels. A standardized assessment would not have closely monitored the students’ knowledge in relation to the teaching objectives for this specific school.

Collection of the Data

The self-regulated learning instructional strategy involved the students having a choice in all aspects of learning except assessment due to the teachers’ pre-study decision to use a written assessment. The students had multiple methods of instruction available, including but not limited to lecture notes, textbooks, Internet access, peer collaboration, inquiry, teacher facilitation, and discovery activities in which the students were guided through questions and prompts to discover a proof or theorem or general idea. In order to monitor the teaching method, the teachers went through an orientation with the researcher. These orientations took place prior to the research study and were conducted by the researcher. At this time the researcher used sample materials to introduce the self-regulated learning technique to the teachers. The researcher emphasized to the teachers it was not about the students “teaching themselves.” It was about the students managing their own instruction. The researcher discussed with the teachers how they wanted to assess the students for their classroom grades and a decision was made to use two district-wide assessments. It was important the teachers felt comfortable with the techniques they were using. If the teachers felt uncomfortable or had negative attitudes toward the research it would have an effect on the outcomes. The focus was on the objective of the students controlling or managing their learning. To monitor the self-regulated learning instruction techniques, the researcher conducted random observations of the teachers during the study. Field notes were recorded and used for analysis.
The students were required to learn the specified topics but were not required to approach them in any specific order or in any given timeframe (outside of the time allotted for the unit in the curriculum guide). In order to identify these topics the researcher and teachers developed a list of objectives for this unit of study. This list was distributed to students as a guideline for their study. Topics that required previous constructs would naturally lead the learner back to those objectives. For example, a student trying to factor a polynomial would need to have the prerequisite knowledge of multiplying polynomials. In addition to the list of objectives, students were given a timeline as well as a resource sheet. The timeline provided students with the minimal amount of material to be covered each day (a direct regulation of the students’ learning). This timeline was developed by the researcher, and teachers and followed the timeframe set forth by the district curriculum map. The resource sheet was developed by the researcher to assist students in learning the objectives. Students did not have ready access to a variety of resources (computers, books, tutorials); they needed to be provided for the students. These resource sheets referenced materials to be found in the classroom such as printed websites, other textbooks, open-response items, and other teacher provided materials. These three items gave the students guidance through the unit. In addition students had access to algebra tiles for this polynomial unit. Materials explaining their use were located in the resource notebooks for students and the teachers were provided with sets of tiles for classroom use.

In this approach the students were not responsible for displaying their new knowledge through experimental results, tests, art projects, or any other form they chose as is sometimes utilized in self-regulated learning instructional techniques. The teachers, due to their comfort with the assessment, made a decision to use a district-wide assessment for the research. The teachers were fully in charge of the instruction and grading and were able to make choices in these areas. The researcher was unable to convince the teachers to employ an assessment method that allowed students a choice. The teachers also incorporated a series of quizzes designed by the researcher in order to monitor students’ progress in meeting objectives. These were designed to be used as self-checks for the students. This self-regulated learning approach allowed students to research topics they were interested in, as well as develop motivation for new learning.
The researcher hoped to show that through choice and independent learning, students could develop a better attitude, more interest and motivation, and higher achievement in mathematics.

As previously described, data were collected through an attitude survey, polynomial pre- and post-survey, and teacher surveys, interviews, and classroom observations. Students completed a pre- and post-survey to evaluate their knowledge of polynomials. The researcher administered this survey to the students to assure uniformity in the assessment. At the same time students completed an attitude survey to assess their mathematics attitudes. In an effort to reduce test anxiety the students were reassured the surveys did not affect their grade in the course and the teacher would not see individual data. These data were then stored by the researcher in his office under lock and key to assure the safety and rights of the research participants. The instructors completed a survey, and then were involved in extensive interviews with the researcher both prior to the research and immediately following the study. For the interviews the researcher used the two-column method to record responses. Following the initial questioning, the researcher performed a member check (Denzin & Lincoln, 2000). This process assured the researcher the responses were accurate and not prone to recording error. These interviews were also kept under lock and key by the researcher. In addition, classroom observations took place randomly throughout the study. The researcher was a participant-observer, interacting with the students and recording the events that occurred during the class time. During the intervention a meeting was held near the middle of the study. This meeting addressed several topics that were developing as barriers to self-regulated learning. The researcher and teachers discussed and developed changes to be implemented during the remainder of the study at this time.

Analyses of the Data

The purpose of this convergent triangulation mixed methods study was to study the impact of self-regulated learning on mathematics attitude and achievement as well as provide insight into barriers to the implementation of this technique. The data were analyzed both qualitatively and quantitatively. The quantitative data were analyzed using univariate statistics. The researcher used these statistics to explain changes in attitude and achievement over the course of the study. Specifically, the attitude survey was scored
using a 5-point system to generate a score for each of the four specified areas of mathematics attitude (self-confidence, value, motivation, and enjoyment). The pre- and post-scores were compared and a difference score was obtained for each student. Changes in the data were analyzed and compared to the control group.

The polynomial survey was scored for correct responses. Item-response theory was used to analyze each individual question, determining its discrimination, difficulty level, and distractors. The researcher then decided whether to retain or discard each item in the composite score. Each student was then given a composite score that was compared on pre- and post-test items thus giving a difference score. The researcher analyzed gains as well as ending knowledge in comparison with the control group. To analyze reliability, a split-half comparison test was used. The survey was developed using district assessments and teacher input. The items directly corresponded with the objectives in the student rubric, giving the survey content validity in this specific instance.

The survey included demographic questions. These were used as independent variables in the analyses of data for both the attitude and polynomial surveys. Possible links among gender, class, age, previous course and grade information, and ethnicity were analyzed.

Research Question 1

To analyze the relationship between attitude and achievement for beginning secondary mathematics students the researcher used Pearson correlations.

Research Question 2

To analyze how attitude and achievement changed during the implementation of the self-regulated learning instructional technique the researcher compared the pre- and post-surveys of both attitude and polynomials using an ANOVA.

Research Questions 3 and 4

To explore the impact of self-regulated learning on attitude the researcher looked for a statistically significant change in the pre- and post-survey scores for attitude using univariate analysis, specifically a linear regression model. Similarly, statistically significant changes in the polynomial pre- and post-survey scores were examined in the analysis of achievement during the study using a linear regression model. Once again
relationships were analyzed by gender, class, age, previous course and grade information, and ethnicity.

Research Questions 5 and 6

The qualitative data were analyzed using the constant comparative strategy (Denzin & Lincoln, 2000). The data were categorized and assessed to provide answers as to the utility of the method and the barriers to its implementation in the secondary classroom. These two questions were also answered using descriptive statistics and representative participant responses from data analysis based on content, teacher interviews, and classroom observations. The categories that emerged from the analysis of the written explanations were identified and unifying commonalities were grouped into metacategories (Denzin & Lincoln, 2000).

Summary of Research Procedures

Data were collected from 96 Algebra I students enrolled in the middle track at a Midwest urban high school. The pre/post design included the Attitude Toward Mathematics Inventory (Tapia, 1996) and a polynomial survey developed by the researcher. The ATMI included 40 questions on attitude using a 5-response Likert scale. The polynomial survey consisted of 43 multiple-choice items. Data were also collected through interviews, surveys, and classroom observations. The data were analyzed both quantitatively and qualitatively. The quantitative data were analyzed using univariate statistics. The qualitative data were analyzed using a constant comparison strategy (Denzin & Lincoln, 2000).
ABSTRACT. This paper presents an inquiry into teachers’ perceptions of self-regulated learning instructional techniques and the barriers to its implementation in the secondary mathematics classroom. The focus was on four teachers who participated in a six-week (15 instructional days) study. The analysis is in terms of reflective thinking about the themes that were developed throughout the study. Through multiple documentation practices including interviews, journals, observations, and surveys, the researcher explored the barriers to implementing self-regulation as an instructional strategy and the perceptions of these teachers. These ideas should be considered in future developments of self-regulated learning instructional techniques.

KEYWORDS: self-regulated learning, barriers to instruction, mathematical learning, mathematical attitude, social constructivism

The purpose of this paper is to explore teachers’ perceptions of experimental instruction, exclusively self-regulated learning, and its related instructional techniques. The paper is an analysis of an experimental intervention using self-regulated learning as an instructional technique in an Algebra I classroom. Social-constructivism along with self-regulated learning strategies provided a framework for the analysis. In addition it also analyzes the barriers to instructing with self-regulated learning and its related instructional techniques. The experiment involved four mathematics teachers implementing a self-regulation instructional technique during instructional time involving a unit on polynomials.

Theoretical Framework

Social Constructivism

Social constructivism was first outlined by Vygotsky (1978). In this framework students construct knowledge through social interactions and cultural exchanges in and out of the classroom. In the classroom social constructivism is evident in cooperative learning, group work, and facilitation by the instructor. It is imperative that students are able to connect their current knowledge with new knowledge. Teachers must be able to help facilitate this construction within the zone of proximal development, or ZPD (Vygotsky, 1978). This zone describes the area of knowledge the student can obtain with the help of others and based on their current knowledge. Within a classroom, the zones of
proximal development for many students may overlap. However, it is more likely that
students have ZPD’s which do not overlap. The impact on instruction in a typical direct
instruction approach is the necessity of review of previous concepts and procedures for
the lower-level students followed by the introduction of new material. This creates a
serious time issue for any classroom instructor.

Self-regulated Learning

Self-regulated learning is defined as “an active, constructive process whereby
learners set goals for their learning and then attempt to monitor their cognition,
motivation, and behavior, guided and constrained by their goals and the contextual
features of the environment” (Pintrich, 2000, p. 453). While the classroom goals are set
forth by state legislatures and departments, the students can be allowed to control their
learning. It is important to note self-regulated learning is synonymous with allowing the
students choices in how they learn, rather than having the students learn on their own
without any guidance or assistance being available. Within self-regulation there are
several cyclical steps students must engage in to be successful. Students must be able to
examine the task or goal and its specific requirements. Usually this is presented in the
form of objectives for the day, developed by the teacher from state and local
requirements. In doing so students must match this goal with their previous experiences
and knowledge in order to properly assess the task (Butler, 2002). An example is a
project to develop a budget. A student would link this to his previous experiences with
budgets or money and also his knowledge of bill payments, other financial obligations,
and wants in his life. The next step is to develop, select, modify, or create a strategy to
achieve the objective or task and to implement this strategy (Butler, 2002). This can be
accomplished by combining strategies or using previous strategies. However, in
mathematics this often requires the student to learn a new strategy or technique. Through
self-regulation a student can choose to learn through direct instruction (notes, text), social
interaction (groups), or through experts (teacher) to name a few. Finally the student must
evaluate the results in accordance with the specified task or objective (Butler, 2002). This
is the most important step in regulation. Determining whether the solution is correct and
feasible is often lost within the mathematics classroom. In the budget example, the
evaluation would include asking whether the budget included all financial obligations and
allowed for money to remain at the end of the month or in the worst case for the student to “break even.”

Social Constructivism and Self-regulated Learning

These two ideas combine to create a classroom with many different attributes than what is typically considered normal. No longer is the teacher responsible for regulation; time management, responsibility, motivation, and evaluation now rest with the student. Social constructivism realizes this occurs within a community of learners. Students have the opportunity to interact with each other in order to develop their knowledge and understanding of mathematics. While a student may choose to work individually, she must demonstrate her knowledge to the expert for evaluation, making even this process a social interaction. The underlying construct is that all knowledge is socially constructed and agreed upon.

The advantages of using this approach in a classroom are many. Students are able to work at their own rate, eliminating the teachers need to “teach to the middle.” In turn this saves students’ time, allowing them to always focus on the topics and ideas they need to master rather than ones they might have already mastered. This approach allows lower-level students to review previous concepts and build knowledge where they may have previously been left behind due to lack of prerequisite skills and abilities.

Students are also able to choose their method of instruction. Learning preferences vary from student to student (Gardner, 1983). A teacher can differentiate instruction in a normal classroom, but this is not effective practice every day for each student. Through self-regulation a student may choose his preferred method of learning, whether it be taking notes and reading the text, viewing video resources online, asking a peer, or questioning an expert. This promotes metacognition within the students and can lead to more efficient instructional time.

Another advantage of the self-regulated learning technique is the students’ development of evaluation strategies. The teacher is not responsible for continuously assessing the students’ knowledge. It is the responsibility of the student to reflect upon their learning and current knowledge, a major goal of the NCTM Standards (2000). This develops metacognition that can help improve a student’s learning efficiency.
Self-regulation instruction promotes students’ development of intrinsic motivation. Motivation is defined as the reason individuals behave in a given way in a certain situation (Ames, 1992). Students develop their own motivations for learning and their own connections to the mathematical knowledge. More importantly, as a facilitator, the teacher can more effectively tap into these personalized constructs. Over time motivational patterns are learned (Middleton & Spanias, 1999). Giving students the opportunity to build intrinsic motivation will better prepare them for learning outside the classroom.

**Research Methodology**

The research took place at an urban Mid-South high school with seven, Year 9, Algebra I classes including 96 student participants. The researcher was involved as a participant-observer (Atkinson & Hammersley, 1994), observing class and facilitating work with individual students during the 90-minute courses as well as mentoring the teachers in regards to the instructional approach. The mentoring took the form of two different sessions in which the teachers were provided with guidance for self-regulated learning. During this time the teachers asked questions about the technique and decisions were made regarding the assessments. The sources of data for this paper include teacher interviews (both before and after the intervention), teacher surveys, teacher journals, meeting notes, and classroom observations by the researcher (see Appendices A, B, C).

The interviews ranged from thirty minutes to an hour and half. The researcher used member checks (Denzin & Lincoln, 2000) during the interviews to ensure the integrity of the responses. The questions for the interviews were developed from the research questions as well as classroom observation data collected during the experiment. Teachers were asked to journal during the experiment and their thoughts were typed and emailed to the researcher during this time. The researcher held a meeting to discuss implementation issues at the midpoint of the experiment and these notes have also been used to guide this analysis. The survey questions were directed towards the teachers’ normal teaching routine.

Constant comparative strategies (Denzin & Lincoln, 2000) were used to qualitatively analyze the data. Themes were developed by coding the transcripts available to the researcher. Notes were written alongside each comment during a second read,
followed by coding and then categorization into the main themes. The themes that follow
guide the results section of this article, answering the research questions of the barriers to
implementation of self-regulated learning instructional techniques and the teachers’
perceptions of the technique.

Results and Discussions

Implementations

The purpose of this study was to explore barriers to the implementation of self-
regulated learning strategies as well as explore the teachers perceptions of the strategy.
The teachers were asked to use a teaching strategy based on self-regulation research to
explore the possibilities of increasing both attitude and achievement in the mathematics
classroom. To this end the teachers needed to give up management of the daily activities
in the classroom to their students and assume the role of expert/facilitator in their
classroom. In the analysis of the data, regulation and roles emerged as major themes
when talking about teacher implementation of self-regulated learning strategies.

Regulation

Regulation occurs constantly in a typical classroom. The three teachers (Ms.
Batts, Ms. Price, and Ms. Marple) and one student teacher (Ms. Newcomer) participating
in this research showed high levels of regulation in their normal instruction. Ms. Marple
describes her normal class,

Class begins with a warm-up. A warm-up will usually consist of 5 questions over
the concepts learned in the previous class period. Students have about 5-10
minutes to complete. Then I go over the answers and we discuss any problems.
Next, we go over the homework problems. Grades are taken several different
ways – no credit, effort and accuracy. After collecting the homework, I give notes
and do example problems for the students. After several of these, I ask the
students to try some similar problems. After the lecture, students work in pairs to
complete “partner problems”. These consist of about 10 questions from the book
or a worksheet over that day’s topic. Students may talk to each other and share
ideas. They are to check each other’s answers and come to a consensus if they
have different results. Then, they staple their work together and turn in. After this
is done, the homework assignment is given. (E. Marple, personal communication,
December 18, 2006)

The other teachers provided similar descriptions of their classes. At no time did the
teachers mention that students were given any choice or management of their learning.
While differentiation was incorporated by Ms. Price, this technique did not allow students to choose the method they wished to use.

From the beginning of the experiment it was very evident the teachers had full control and regulation of their classrooms. It was difficult for the teachers to give up this control and change their teaching style. This became apparent at the first meeting the researcher had to present the new instructional technique. A basic notion of self-regulated learning is the students’ ability to regulate their own learning. Within a social-constructivist framework it is also necessary for the student to share this knowledge socially. Combining these two ideas results in the method of sharing the learned knowledge being chosen by the students. The researcher suggested students be able to choose the method in which they shared their knowledge and the teachers were opposed to this and decided to use a standard written assessment. When questioned on the subsequent use of a standard written test Ms. Marple stated, “I don’t know how else I could assess their learning” (E. Marple, personal interview, March 14, 2007). Ms. Batts and Ms. Price commented that outside pressures including the principal and district personnel led them to use the written assessment. After the experiment when the researcher suggested the written test could have been an option to the students along with any other form both the student and teacher agreed upon, Ms. Batts agreed this would have been more appropriate with the self-regulated approach.

The teachers were involved in two sessions prior to the experiment in which they were introduced to self-regulated learning, and specifically the ideas that were to be implemented. During these sessions group decisions were made as to how the techniques would be implemented. While the researcher could have been strict in his implementation, he felt it was important to allow teachers to assess the students and more importantly determine grades in a manner they deemed feasible. Another result of this process was the implementation of a quizzing system. Students were given the objectives for the unit on polynomials (see Appendix C). The teachers developed quizzes to accompany each individual section. Rather than use these as self-checks for students as they were originally intended, teachers used these items as a strict quizzing system. The researcher was able to manipulate this by having students complete the quizzes until they had 100% mastery of the topic in order to encourage the students to evaluate their
learning, make adjustments, and not move to the next topic before they had mastery. In the first half of the experiment, the teachers had a quiz rotation during class. Students were constantly taking quizzes, waiting for the teacher to grade them, and then returning them so the student could study more and then take the quiz again.

The teacher begins by grading quizzes that students have completed at the front of the room. This is the system that she has designed for herself. This limits her role of walking around the room and facilitating. However, this is giving her an opportunity to see student errors and call them to the front of the room for individual corrections on their papers. This is fine, but she is not giving the student the opportunity to evaluate their own mistake or even figure out their error. This will affect their self-management abilities. (Field Notes, January 17, 2007)

This iteration took place three times during this particular 90-minute block class period. The students were also forced to take notes in one teacher’s class and provide them to the teacher prior to taking the quiz, another regulation strategy. Not only were the students being informed how they were to learn, and how they would be assessed, the teacher was also evaluating the students’ work and informing them what they knew and did not know. This was teacher regulation and does not adhere to the principles of self-regulation. Two of the teachers did not view these quizzes as a form of regulation when interviewed; rather they viewed it as a self-check for the students. Not only was this quiz process regulating the students learning, but it was also filling a lot of the students’ in-class time. Three teachers reported the quizzes only taking 10-25% or 10-20 minutes out of the class. However, the student teacher reported this process taking 60% of the class time. The researcher’s classroom observations show this last figure to be much closer to reality. Realizing this was a huge problem, the researcher intervened at the midpoint of the experiment and met with the teachers to change this structure. The result was the teachers allowed the students to check their own quizzes, thus making them learning checks (interestingly none of the teachers changed the title on the paper). This freed the teachers to spend more time with the students, but more importantly allowed the students to evaluate their own learning, an essential component of self-regulated learning. The quizzes were still graded, making them mandatory and important to the students; a direct contrast with self-regulated motivation strategies.
Regulation also occurred in the form of direct instruction by the teachers. All four teachers reported using opener problems in their normal classrooms, a common approach for most classroom teachers. The researcher found upon his observations this was still the case in all classes.

The class starts with a warm-up exercise based on the previous day’s minimal work. This is similar to the activity that Ms. Marple is using to start her day. Once again after the students work the problem the teacher is working the problems and using questioning techniques to have the students respond. This is not what we want or need. The students are not evaluating their work and the teacher is regulating their learning with this technique. The teacher is instructing with direct instruction. (Field Notes, January 22, 2007)

It seems the teachers were unable to let go of this control over the students. This process was also tweaked by the researcher during the midpoint meeting. The teachers modified the technique by simply providing the answers to the questions in written form rather than going over them as a whole-class and asking questions of individual students. This was an improvement, but students were still required to complete the activity and in Ms. Price’s class she gave participation points for doing so.

Another large regulation technique was the implementation of a timeline for students. To be successful in self-regulation the student must work at their chosen rate. The timeline was introduced as a minimum requirement for the students due to the time constraints of the experimental intervention. The researcher hoped this would be used as a tool for the students to see their reasonable progression. However, the teachers held the students to the timeline and forced students to take the assessment before the students had completed all of the necessary pre-requisites to do so.

The teacher starts the class by reminding the students of the timeline and the end date for this experiment. She then goes to each student and gives them a progress report of scores she has for their quizzes. This shows she doesn’t trust her students to discern what they have completed and what they have left to complete. It has been hard for the teacher to let go of her management strategies and allow the students to be accountable for their work. (Field Notes, February 12, 2007)

The teachers also found it important to keep students on task. Ms. Batts commented,

It drove me crazy that they weren’t on task and were wasting time. They weren’t getting anything out of it. I feel like it’s my job to keep them on task. Yes it’s a form of regulation. I have pressures from the principal to keep them on task. It
was very difficult seeing the kids not on task. I didn’t mind them talking to friends about math as long as it was only math. It wasn’t organized (I like to be organized). (M. Batts, personal interview, March 16, 2007)

The teachers were under pressure for the students to work, and they did not feel comfortable allowing the students to choose when, how, and what they did to learn.

All of these forms of regulation were present prior to the experiment. All teachers had their own timeline, used quizzes extensively, assessed through tests, and used openers and direct instruction techniques. Even though all teachers could define self-regulation and sometimes recognized they were regulating the students’ learning, it was difficult for them to change their behaviors. They repeatedly regulated the students’ learning throughout the experiment thus putting results in jeopardy.

Roles

The self-regulated learning strategy was implemented in various ways by teachers. This implementation highlighted both the advantages and disadvantages of the strategy.

The teachers were asked to take on a facilitation role within the classroom. No longer were they to lead whole-class discussions, instruct directly, or evaluate the students learning. Instead they were asked to take on the role of an expert in the classroom who could be viewed as a facilitator. The researcher instructed teachers to have students ask questions and not to interfere or circulate around the room asking questions of the students. For the most part the teachers complied with this request. When asked to describe a typical interaction with a student during this time, Ms. Newcomer stated,

I was comfortable. I would sit beside the student and talk the student through how to do it. I would show an example. Then I would give a couple problems to try from the book. Then they could ask further questions. Sometimes I would write down notes for them. Most of the time I would wait for the students, but sometimes I would go to the students specifically, if I could tell they were frustrated. (J. Newcomer, personal interview, March 15, 2007)

This highlights both the correct approach and the struggles with facilitation encountered by all of the teachers. Ms. Newcomer was able to comfortably approach students on an individual basis and would mostly wait for them to ask questions. However, when talking with them she was unable to ask them questions or probe their knowledge to help the
student construct the knowledge they needed. Instead she would show them an example and talk them through the problems. This technique did not help to guide and promote self-regulation.

Others encountered the same difficulties, often saying they worked through examples while the students watched or just explicitly explained the method for solving the problem. While this is not a bad approach, the problem lies in the teachers’ inability to link the new knowledge to the previously constructed knowledge. Ms. Price had a different experience. Rather than work through problems she greeted the students with a series of questions.

I would ask the students which resources they had used. If they hadn’t used any I would encourage them to find some other resources. The students had to ask specific questions. I would model the procedure or idea. Then I would go back after they had worked two or three problems. (S. Price, personal interview, March 28, 2007)

The telling part here is her first question to the students; it was directed at what they had tried on their own. If they had not made sufficient effort or asked a specific question then she tried to help guide their regulation by directing them to other resources. This is an important concept in self-regulated learning. While the teacher is viewed as an expert, she is not the only expert in the room. The students had access to textbooks, and other printed materials from the internet that contained expert knowledge.

Ms. Price was by far the most comfortable in the role of a facilitator. She moved about the room constantly and her students were willing to ask her questions. However, as she noted, the students’ questions had to be direct and show an effort on their part to learn before she would offer any assistance. She had built a good rapport with her students and just as she felt comfortable, they were comfortable in having her as a facilitator.

Another advantage of self-regulated learning is the students’ ability to proceed at their own pace. This is also demanding on the teacher due to the differing levels of knowledge each student possesses at any given time. As a facilitator the teacher must be able to quickly assess the individual student’s knowledge and then provide feedback and questions that help to stimulate the student within their ZPD. This puts a demand on the teacher to understand the material completely but more importantly to be able to question
effectively. The teachers in the study did not show expertise in this area and this was evident in their descriptions of their interactions. Only one teacher stated that she would ask the students questions about what they already knew.

The research materials were an integral part of this research. Due to financial and resource restrictions students could not research topics on their own during school time outside of the contained classroom. The researcher developed notebooks to be placed in the classroom that provided several alternate resources for each objective. The lack of computers made video and other computing technology non-accessible during this time. Web links to computerized models were provided to the students for use at home or after school in the computer lab. In addition each student had a textbook with each objective, examples, and practice problems for his/her use. This did not exhaust all of the possible resources thus limiting the study.

The researcher’s observations revealed little use of resources outside of the textbook. The teachers often recommended students use other resources, but the students failed to do so. There were, however, some instances of the students using the materials successfully. A positive finding involved three of the four teachers adding materials they thought would be helpful to the resource notebooks. The teachers gave varying outlooks on reasons students did not use the outside resources (other than the text). “They have never had to go to outside sources. Even though we talked about them, they weren’t accustomed to this process. They haven’t learned there are other resources for learning (other than the teacher and text)” (J. Newcomer, personal interview, March 15, 2007). On the other hand Ms. Batts had different ideas. “They were not motivated and didn’t want to put forth the effort. When we told them they had to do it they did but when we didn’t it was extra work” (M. Batts, personal interview, March 16, 2007). Interestingly these two teachers are talking about the same students. Ms. Marple added that “I told them to go to the resource packets…but students don’t like to read” (E. Marple, personal interview, March 14, 2007). The implementation of outside resources requires the student to be able to research and read about a given topic rather than having the teacher provide all the information needed. This skill was either lacking in most of the students, or they lacked the motivation and effort needed to use other resources.
Attitudes

The teachers’ perceptions and attitudes toward the self-regulated learning technique played a vital role in the results of the study. During the qualitative analysis, several themes developed. The following themes emerged from the analysis: teacher comfort, teacher understanding, student ability, teachers’ perceptions of learning, and teachers’ perceptions of learning.

Teacher Comfort

The four teachers involved in this study displayed varying degrees of comfort during the experiment. Three of the four teachers displayed personalities that demanded order and organization within their classrooms. These three had the most difficulty implementing the self-regulation techniques and allowing their students to have control over their learning. Ms. Marple stated, “I like to have control of the classroom” (E. Marple, personal interview, March 14, 2007). When asked what was hardest about giving up control Ms. Batts commented, “Not being able to teach. Not having class discussions and explaining it as a whole. This is very important. I feel like I reach more kids this way” (M. Batts, personal interview, March 16, 2007). Later when asked about the most challenging part of the study she stated,

It was very difficult seeing the kids not on task. I didn’t mind them talking to friends about math as long as it was only math. It wasn’t organized (I like to be organized). I wasn’t able to do whole-class instruction. The research didn’t fit my personality. (M. Batts, personal interview, March 16, 2007)

The control issues spread even to the student teacher. Classroom observations revealed Ms. Newcomer was constantly telling the students they needed to be working on mathematics. “It really bothers me (when students are off task). It’s my responsibility to keep them on task” (J. Newcomer, personal interview, March 15, 2007). Meanwhile Ms. Price showed signs of some control. On one hand the most challenging thing for her was “keeping my mouth shut. I like to have class control for the first part of class to settle them down” (S. Price, personal interview, March 28, 2007). When asked about her comfort level in class she stated, “The setting was okay and I felt comfortable with the class” (S. Price, personal interview, March 28, 2007). This was indeed true. The researcher’s classroom observations showed Ms. Price to be very comfortable in the role of a facilitator. She moved about the room purposefully during class and was able to offer
individual help as well as conducting small group discussions. Despite her concerns she was not able to reach all the students, it was evident she was able to provide more meaningful one-on-one direction than in her normal classes. She was also able to target those students who needed her help and did not display any negative attitudes toward the instruction during her classes.

The comfort level was exhibited through the teachers’ control of the learning processes within their classrooms. The previously discussed quizzes, timeline, and assessment all allowed the teachers to retain control over their students. Structure was developed by each teacher in their own way. All four used an opener to keep students on track to finish their studies by the end of the study. Ms. Price employed a point system for crediting students who were actively working on mathematics and an exit slip system to hold the students accountable for learning. Ms. Batts and Ms. Newcomer were continually prodding their students to be on task. Ms. Marple used note taking procedures in order to control the students’ method of learning. A telling comment came from Ms. Batts’ discussion at the end of the research project. “I wanted my kids back. I wanted to be back in control…they are back where I want them now” (M. Batts, March 16, 2007).

**Teacher Understanding**

The teachers’ understanding of self-regulated learning was excellent. All four came up with definitions that fit the researcher’s definition of self-regulation. Responses included “the students are responsible to find their own way to learn the material” (S. Price, personal interview, March 28, 2007); “students are in control of what they are learning” (E. Marple, personal interview, March 14, 2007); and “students are in control of the learning environment and pace they learn” (M. Batts, personal interview, March 16, 2007). These responses were consistent over time in all instances.

More importantly the teachers understood the implementation of the strategy was aimed at improving the attitudes of the students. When asked why the researcher suggested this study, Ms. Batts responded with “to help students with their attitudes” (M. Batts, personal interview, March 16, 2007). This idea to increase attitudes also related to the teachers’ philosophy of teaching. Ms. Price’s goal for teaching involves helping the students to “understand the curriculum so they are not afraid of mathematics and are not uncomfortable with it” (M. Price, personal interview, December 18, 2006). Ms.
Newcomer’s goal is for “students to enjoy math and like it” (J. Newcomer, personal interview, January 5, 2007) and Ms. Batts added she “hopes to develop in students a love of learning and mathematics. I want students to see that math is exciting and easy” (M. Batts, personal interview, January 3, 2007). All teachers seemed genuinely enthusiastic about their jobs and wanted to help students understand and enjoy mathematics.

The teachers’ reoccurring reason for entering their profession was their belief that a student must possess good knowledge of mathematics in order to be successful in life. Ms. Newcomer reported her reason for teaching mathematics was “to convey that it is important for society and life. I believe if students can’t complete Algebra I they won’t be successful in life” (J. Newcomer, personal interview, January 5, 2007). Ms. Price commented “I hope students are comfortable enough to perform mathematics and are prepared for life” (S. Price, personal interview, December 18, 2007), and Ms. Marple added “students don’t understand that they need to learn now so they can be successful later” (E. Marple, personal interview, December 18, 2007). This need to prepare students for life was not evident in the teachers’ implementation of the self-regulated learning technique.

There is a district-wide open response question for each mathematical unit. The researcher included this problem in the resource materials. However, none of the teachers or students ever used the open-response items. Even more importantly, no teacher was ever observed helping the students make connections between the mathematical topic and the students’ everyday lives. A fundamental idea of constructivism is the new learning must be related to previous knowledge and understanding. Included is the motivation the student has to learn this new information. The teachers never encouraged the students to develop these connections despite their statements that they wished for students to learn mathematics so they could be successful in life. Real-life problems can help motivate students to understand and make connections in their life. When asked about real-life problems Ms. Marple responded that this “wouldn’t have helped with the students’ motivation since they don’t like them” (E. Marple, personal interview, March 14, 2007), and Ms. Newcomer also added “it would not help the students with their motivation” (J. Newcomer, personal interview, March 15, 2007). Ms. Price stated “I’m not sure how it would have (helped)” (S. Price, personal interview, March 28, 2007). The teachers did
not make the connection that motivation could be improved through making connections to the students’ lives.

The teachers were also able to make the connection between self-regulated learning and learning outside of the classroom. Self-regulated learning is a construct that is used extensively to learn outside the classroom. Its basic tenets of analyzing a problem, implementing a solution, and evaluating that decision occur daily for most people. This is all completed without the help of a teacher in most cases, although an expert may be consulted. The teachers stated they did view self-regulated learning as something their students needed to be able to do.

Definitely, the higher you go the more you need it. It is valuable and I can see trying to make it a normal part of my instruction. The maturity level is not there at this level. Subtle or gradual integration would be more effective. This is perfect for home-schooling. Yes, self-regulation is how people learn. (E. Marple, personal interview, March 14, 2007).

Interestingly Ms. Marple does not believe the students can do it at the freshman level and goes on to say it would be great for home-schooling. This shows her inability to see it as a viable way to learn for students and may stem from her inability to give up control in the classroom. Ms. Price had similar ideas.

Yes, students need to know how to learn outside of the whole-group instruction world. After school, students will need to know how to find answers when a teacher isn’t there. I am trying in my classroom to incorporate cooperative learning as much as possible. This simulates how someone in a new job would learn new things by asking co-workers for help and not just the boss. (S. Price, personal interview, March 28, 2007)

In this instance Ms. Price expresses the idea that it is important to learn how to learn in this manner and cites her use of cooperative learning as working toward self-regulated learning. Ms. Batts’ thoughts on the topic were similar.

Yes it is something students need to learn how to do. They are going to encounter this in life, especially in college. I hope that my higher-level classes are doing some of their own regulation. The non-advanced classes are not prepared for this. Yes I view it as real life. I learned (self-regulation) in college. It was trial by fire.” (M. Batts, personal interview, March 16, 2007)

The telling statement is she does not view it as viable for lower-level students. However, she states they are going to need to regulate their own learning in college. From her
statements it seems as though she thinks students will learn in college how to regulate their learning. All of the teachers recognized the importance of self-regulation and its use after high school, both in college and in the non-academic world. However, they did not view it as something the students could accomplish on their own at this level.

**Student Ability**

A recurring theme in the interviews was the students’ abilities to regulate their own learning. This experiment was a radical change from the teacher’s normal teaching routine. Subsequently the students were asked to make choices in situations where previously the choices had been made for them. The teachers had various perceptions on the students’ ability to participate and why they lacked these abilities. Maturity was often mentioned as a reason the students were unable to regulate their learning. “They aren’t mature enough to handle it. There isn’t enough motivation. There isn’t enough intelligence (cognitive level). This might be possible in different subject area” (M. Batts, personal interview, March 16, 2007). “All of it (isn’t feasible). Immaturity is the problem. This might work with seniors but not freshman” (E. Marple, personal interview, March 14, 2007). She also added,

> I truly feel that it would be wonderful if students could develop their own understanding of mathematics. In the “real-world”, I see this as being virtually impossible for several reasons. First and foremost, 14 year old students are extremely immature. Of course I am speaking about the majority of the students I have taught in the past. Most students lack the self-motivation and maturity to independently do the work to “discover” the mathematical knowledge they need to be successful in future math classes. Secondly, most 14 year olds are “social” animals. They really don’t consider the “big picture” and cannot see 4 years down the road. They are mainly worried about what is happening Saturday night. So when I discuss college and their futures, it doesn’t sink in with most of them. Lastly, most of these students have had their hands held through the middle school years. High school is very new and scary situation for many of them. They often don’t handle the freedoms they get at this level well, resulting in failing grades for many of them. (E. Marple, personal communication, January 12, 2007)

Maturity and motivation play a role in the students’ abilities to regulate their learning. While these are viable explanations, the students’ inability to regulate may be due to another construct Ms. Marple mentioned, teacher dependence.

Teacher dependence seemed to pervade throughout the teachers comments and in most cases they were more than happy to accommodate this dependence. “The students
want me to hand it to them. They don’t want to do work. This is okay with me because that is the way I like to instruct” (M. Batts, personal interview, March 16, 2007). She even went as far as to say “the students developed a new appreciation for the teacher (during this experiment)” (M. Batts, personal interview, March 16, 2007) when asked about what the students learned. Ms. Price was a little more positive in her outlook.

They learned they don’t have to have everything spoon-fed to them. They learned how to read the textbook better. (Previously) they didn’t really read the textbook…(they were) used to the teacher telling them. The students don’t want to be out of their comfort zone. This is how they have learned previously. (S. Price, personal interview, March 28, 2007)

Ms. Newcomer had a level approach also. When questioned on why the students often commented they wanted the teacher to teach them she stated,

The students are lazy. They were used to the teacher teaching. They mean direct instruction or that the teacher organizes what they are doing…management. (We) tell them how to do the work, giving them examples and guidance. They didn’t know how to learn on their own. They need to be taught how to learn on their own.

Ms. Newcomer has great insight in that the students have been taught to learn from direct instruction and they must be taught how to learn through self-regulation. The researcher did not have time to have the teachers slowly implement the self-regulation strategy. Instead they were thrown into it fully and left to manage their learning explicitly where they had been guided previously by the instructor.

A telling summary of this situation is found in the field notes from an observation of Ms. Marple.

The teacher mentioned to me that she had a “revolt” in the first period of the day. She stated that the students said they were “tired of teaching themselves” and that “they wanted her to teach.” While this is disheartening, it also gives light to the fact that the students are dependent on the teacher for learning. From a larger perspective we’re developing students who aren’t responsible for their own advancement and who won’t be able to learn once outside of the classroom in the absence of an authority figure managing their learning. (Field Notes, January 17, 2007)

The students did not have the skills to regulate their learning. This is due to the fact that the students have become dependent on the teachers to manage their learning in our current educational system.
Teachers Perceptions of Learning

The teachers’ perceptions of learning varied greatly throughout the study. Before the study started most prophesized the instruction would be successful for some and some would struggle, mirroring typical instruction results. A representative response was given by Ms. Batts,

I think those students with good grades and that are repeaters will “love it” since they will know the content and there will be no specific homework. I think those that are struggling will find it difficult and that I will need to hold their hand. A few will fail no matter what since it is new to them and they will have new responsibilities. (M. Batts, personal interview, January 5, 2007)

The researcher had a more positive perception. He thought the students would be highly successful because they could choose the method they liked and the teacher would be able to help more students individually.

The teachers decided to split the unit into two “chapters” and gave a written assessment for a grade after each chapter. The researcher asked the teachers to compare student learning at this point to learning of previous years’ classes and also to the students’ performance in the first semester of school (the research began as the second semester started). Ms. Marple reported that the students had equal achievement levels when compared to the previous semester as well as previous years’ classes. Ms. Price added,

As a whole class they did what I thought they would have done (using a traditional method). A few of my top students did not score well. If they had been taught in the traditional way they would have done “A” work. (S. Price, March 28, 2007)

The chapter tests were created for the research, therefore each teacher used the same instrument. Ms. Batts was skeptical about the student performance. Although it was similar to the students’ previous grades she stated, “They would not have been able to pass my test” (M. Batts, personal interview, March 16, 2007).

After the midpoint of the experiment, these views were quite different. When asked about the students’ learning after the study was complete three of the four teachers viewed it as less achievement than a “traditional” class.

- “They learned less than in previous years” (E. Marple, personal interview, March 14, 2007).
- “Their knowledge was below average after chapter 5, but after chapter 4 it was average” (J. Newcomer, personal interview, March 15, 2007).
- “I don’t think they know as much as if I would have taught them (direct instruction)” (M. Batts, personal interview, March 16, 2007).
- “I feel their knowledge was comparable to what it would have been after a traditionally taught unit” (S. Price, personal interview, March 28, 2007).

Interestingly, Ms. Batts (with Ms. Newcomer) and Ms. Marple were so certain the knowledge was less they incorporated two days of review to go back over the objectives using direct instruction. When asked about their students’ knowledge level when they reviewed they had two different responses. Ms. Marple reported that “some of the students understood and some didn’t” (E. Marple, personal interview, March 14, 2007). Ms. Batts on the other hand was pleasantly surprised. “It was different than what I thought when I started to review. I didn’t think they got it, but when I reviewed with them they got more than I thought and maybe more than they thought they got” (M. Batts, personal interview, March 16, 2007).

These perceptions are quite interesting. Three of the four teachers displayed an obvious dislike for the research at the end of the study. They viewed it as ineffective for student learning, a main goal of their teaching. However these perceptions of learning are in contrast to the quantitative findings. Using a pre/post test design with a 43-item polynomial survey, no statistically significant difference was found in the learning of the experimental and control group. These attitudes and views were possibly a product of the teachers’ comfort with the technique and their inability to constantly assess the students as they do in their traditional approach.

*Teachers Perceptions of Attitudes*

Each teacher stated a goal of their instruction was for their students to like and enjoy math. Their instruction, however, failed to work toward these aims in both their traditional approach and during this study. None of the teachers used the open-response questions (which related math to real life) available to them and no one implemented any real-life problems in their interactions with the students. There was also no observed discussion with students relating the mathematics to the students’ personal lives outside of the mathematics classroom. Understandably, three of the four teachers viewed the
students’ attitudes at the end of the study as comparable to their attitudes at the beginning.

- “Their attitudes did not change much” (E. Marple, personal interview, March 14, 2007).
- “Their attitudes were the same as they were before. Their ideas toward the research are worse” (J. Newcomer, personal interview, March 15, 2007).
- “Students seemed to like the approach at first but grew weary of it after they fell behind on the timeline. It seemed they were more annoyed at the end of the study” (S. Price, personal interview, March 28, 2007).

These teachers mentioned the students’ attitudes toward the research and methodology were worse. This was an interesting comment given the students had probably not encountered self-regulated learning and so there was no baseline from which to form an opinion. The focus of the study was actually on their attitudes toward mathematics. To this end Ms. Batts believed the attitudes declined. She stated, “I don’t think they like math” (M. Batts, personal interview, March 16, 2007). This is a fascinating result given Ms. Batts and Ms. Newcomer were referring to the same students. Even more interesting were the results of the attitude survey. Using the Attitude toward Mathematics Inventory (Tapia, 1996), it was found that student attitudes were not statistically significantly different than those of the alternate group (did not receive the treatment of self-regulated learning). This finding was not abnormal given the teachers did not foster in the students any type of motivation to learn mathematics.

Conclusions and Implications

The teachers in this study had a firm understanding of self-regulated learning and its approach to instruction. Their current teaching practices and their teaching philosophies presented many barriers to the SRL approach. For future studies in the classroom these barriers and perceptions need to be addressed.

While it is difficult to control the grading and assessment process, it is imperative students be allowed to choose their sharing of knowledge (assessment) within a self-regulated learning instructional approach. The teachers were aware that a written test did not align with the research, but were unable to or, in this case, did not know any other way to assess their students. Along these lines any form of quiz, test, or timeline is not conducive to this instructional technique; these are regulation strategies. Teachers must be willing to relinquish control of evaluation and time management to their students in
order for true self-regulation to occur. Explicitly stating this to the teachers is not enough. The researcher must be firm in declaring the necessities of the approach and ensuring these occur during the study. When the quizzes were no longer graded by the teachers, the teachers expressed that they no longer knew what the students understood. Teachers must be equipped with the ability to assess students verbally and through multiple assessment forms. This inability inhibits the teachers’ ability to properly guide self-regulation in a one-on-one situation.

All four teachers stated they wished for their students to enjoy and like mathematics. They also thought it was very important for the students to be able to learn mathematics in order to be successful in their lives after schooling. The researcher assumed the teachers used instructional techniques to motivate their students toward this goal. This was not the case and since it was not addressed prior to the study the teachers did not implement any motivational strategies as was desired. An underlying assumption for self-regulated learning is the students are motivated to learn. Often this is not the case in a school setting where objectives are dictated to the students, so it is imperative teachers be given the skills needed to help guide the student to learn intrinsic motivation in this environment.

The students’ ability and maturity level were often stated as perceived barriers to student success in self-regulated learning. Any future study needs to take the students’ self-regulation skill set into account. The best possible solution is to slowly integrate self-regulated learning into a typical classroom. Systematic implementation of the technique over time will give the students the chance to adjust to the process and develop the regulation strategies they need to be successful. This is not impossible for students at this level, but they have been trained to learn via direct instruction in our current school structure. Breaking this dependence on the teacher and training them for real-life learning situations will not be an easy or quick endeavor.

To this end the teachers must have positive attitudes toward the instruction. They must be willing to try new approaches and not give up on them. They must also be comfortable in giving up control of the classroom to the students. If the teacher demands control then they will not be able to implement the approach effectively. Three of the four instructors made assumptions about the effectiveness of self-regulated learning before the
students had completed the study. It is highly probable this attitude impacted the students’ efforts and attitudes also. The teachers’ perceptions of learning were not correct. This was most likely due to the teachers’ unfamiliarity with the technique and the lack of multiple structured assessments. Researchers must constantly communicate with their teachers to ensure the teacher does not “give up” on the technique. Rather they should be in constant communication with the researcher in order to address problems that arise or concerns they may have.

The study revealed many barriers and perceptions. Regulation and roles emerged as major themes when talking about teacher implementation of self-regulated learning strategies. It has also provided information to develop and implement further studies. With all of the difficulties encountered, and despite the teachers’ perceptions, the students’ attitudes and learning were not statistically significantly different from the control group. With a better design and more preparation, SRL can be more effective in developing mathematical learning as well as increasing mathematics attitudes. A year long study that slowly introduced the students to self-regulated learning, thus building their skills and abilities to manage their own learning, is a possible next step in developing self-regulated learning as a viable instructional strategy aimed at improving mathematical attitudes. The researcher will need to work closely with the teachers to address the previously mentioned concerns in order for the treatment, self-regulated learning, to be successful. This should include many sessions prior to the research to design and discuss day-to-day classroom interactions. There must not be a timeline and students must be able to choose their form of knowledge sharing (i.e., assessments). Slowly removing teacher regulation and developing student regulation should be the main focus of these discussions. This research on using self-regulated learning as a treatment will provide teachers with insights into developing students that are intrinsically motivated and better prepared for learning outside of the classroom. The focus should not just be on learning during the schooling years, but developing lifetime learners through self-regulation.
ABSTRACT. This mixed-methods article describes the results of a study incorporating self-regulated learning instruction in Midsouth urban high school Algebra I classroom. Analysis of student attitude and achievement data showed no statistically significant difference compared to an alternate group. Qualitative analysis revealed many barriers related to implementing self-regulated instruction and suggestions for future research designs.

KEYWORDS: self-regulated learning, mathematics education, attitude toward mathematics, teacher perception, barriers to instruction

The field of mathematics attitude and achievement has gained popularity over the last decade, but there still remains a vast array of research to be conducted to explain these two topics. It has been suggested the relationship between attitude and achievement in mathematics be further studied due to discrepancies found in the relationship between the two. More specifically, Meyer and Turner (2002) call for educational researchers to investigate the sociocultural perspective and its link to self-regulation through multiple research methodologies. Ma and Xu (2004) recommend

A longitudinal random experimental design with adequate improvement in measures of attitude toward mathematics and achievement in mathematics. With random assignment of students and careful manipulation of well-measured attitude and achievement, such a longitudinal random experiment is perhaps the best methodological approach for assessing the causal relationship between attitude and achievement. (pg. 278)

There is a need for research relating mathematical achievement, attitude, and instructional techniques.

Attitude

A student’s attitude will be defined in this research to include one’s feelings and emotions toward mathematics including interest and motivation. Attitudes, emotions, and beliefs make up the affective domain in mathematics education (McLeod, 1992). Students typically display a dislike for mathematics as well as waning beliefs of the social importance of mathematics as they increase in age (Wilkins & Ma, 2003). This effect is even seen among students who claim to enjoy mathematics. The decline in
attitude could be explained by the ever-increasing diversity of choices available to today’s youth.

The influences on students’ attitudes are many. Teachers, peers, and parents, as well as the environment, all have influence on an individual’s attitude. Wilkins and Ma (2003) found that teachers’, peers’, and parents’ positive support helped to create positive attitudes and beliefs about the social importance of mathematics and thus helped to curb negative beliefs and attitudes. Hon and Yeung (2005) reported when students were surrounded by positive influences, they were affected in a positive way. Environmental factors, including students’ home lives and their access to instructional materials as well as entertainment measures, could all have an affect on attitude and achievement (Ames, 1992).

**Attitude and Achievement**

All schools strive to have students achieve at a level of proficiency. However, this does not always equate to instruction that takes into account the students’ attitudes toward mathematics. Although attitudes decreased over time, Ma and Xu (2004) found there was increase in means of achievement across time. This study, performed with analyses of LSAY data on students in grades 7-12, highlighted that even though students’ attitudes decreased they still performed well. It could be the case that attitude does not have an effect on achievement, or that attitude and achievement have an inverse relationship.

Students who value and enjoy mathematics have a higher level of achievement (Gottfried, 1985). On the flipside, poor achievement has been linked to a decline in mathematics attitude (Ma & Xu, 2004). We do know how attitudes about mathematics develop over time in students (Ma & Kishor, 1997). During the elementary grades students are introduced to concepts slowly and repetitively, resulting in positive attitudes and achievement for many students. As the mathematics gets more diverse and abstract, students’ attitudes and achievement levels begin to decline (Hiebert et. al, 2003). Prior attitude has an affect on later attitude and prior achievement has an affect on later achievement, with the effect of achievement being stronger (Ma & Xu, 2004). As for the relationship between the two, at a statistically significant level, prior achievement predicted future attitude for grades 7-12. However, prior attitude did not predict later
achievement (Ma & Xu, 2004). Therefore, achievement leads to a positive attitude, but having a positive attitude does not necessarily lead to achievement. While this study argues for a one-sided affect, most authors conclude attitude and achievement influence one another in a cyclical fashion (Schiefele & Csikszentmihalyi, 1995).

**Attitude and Achievement Outcomes**

The outcomes of attitude, interest, motivation, and achievement are far-reaching. The most significant are course selection and career paths. Maple and Stage (1991) found students’ attitude toward mathematics was a statistically significant predictor of mathematics major but not achievement. On the other hand, achievement at the middle school level determined the curricular choices of students in higher-level mathematics (Singh et al., 2002). Armstrong and Price (1982) reported usefulness of mathematics was the most important item that influenced the decision to take more mathematics courses. Lower levels of achievement in mathematics courses restricted students’ career choices involving mathematical skills (Oakes, 1990). Mathematics educators hope to guide students into taking higher-level mathematics classes allowing them the opportunity for careers involving mathematics.

**Interest**

Students often become interested in a subject because it evokes some intrinsic motivation in them. “When a student first encounters an academic activity, she will tend to evaluate the stimulation it provides and the personal control the activity affords” (Middleton & Spanias, 1999). When the stimulation and control are available, the student is likely to engage herself. Students who have high interest tend to have instruction that is student-centered and stimulating, complete their homework regularly, and have fewer objects in their home environment (Horn & Walberg, 1984). The student-centered learning approach develops the student’s sense of control of the activity and the ability to explore interesting topics.

**Motivation and Math Anxiety**

Students who are not motivated in some way often tend to perform poorly in the classroom. Motivation can be defined as the reason individuals have for behaving in a given way in a given situation (Ames, 1992). Motivation can take on two forms, intrinsic and extrinsic. Often teachers and schools focus on providing extrinsic rewards. Results
show that motivational patterns are learned, and more importantly students learn to
dislike mathematics (Middleton & Spanias, 1999). Of great importance to educators is the
strong effect of motivation, attitude, and engagement on success in mathematics (Singh et
al., 2002).

Math anxiety is a term used to describe individuals who view mathematics as
difficult and their mathematical abilities as poor. Math anxiety often leads students to
avoid mathematics if at all possible (Hilton, 1981; Otten & Kuyper, 1988). Math anxiety
has often been shown to have a statistically significant relationship with achievement. Ma
(1999) was able to quantify the potential improvement in academic achievement when
anxiety was reduced. Nakamura (1988) found gifted children who had high levels of
achievement were often less anxious than lower achieving students. Anxiety and
motivation are just two more factors that can affect the achievement and attitudes of
students in the mathematics classroom.

Teacher Influence

Teachers can have a profound influence on students’ attitude, motivation, interest,
and achievement in the classroom. Students can be prompted to view mathematical
problems as interesting and useful through discussions of their relationship to the
students’ current and future endeavors (Good & Brophy, 2003). Through a teacher’s
choice of activity, students’ view of mathematics and its usefulness can be impacted
(Wilkins & Ma, 2003). A teacher who is supportive and authoritative, as well as both a
model and peer, can help produce feelings of self-worth in students in the mathematics
classroom (Covington, 1984).

Students, through proper modeling of the instructor, can learn intrinsic
motivation. Intrinsic motivations affect the choices teachers make in the activities they
choose for their classroom (Middleton, 1995). Those teachers who use the students’
motivations to guide their instruction have been shown to better motivate their students
toward mathematics (Middleton & Spanias, 1999). Good and Brophy (2003) have a term
called “co-regulated learning,” where the students combine their own skills and interest
with those of peers to move past their own limitations. They suggest social factors, such
as peer interaction similar to co-regulated learning, can influence positive student
motivation.
Assignment Choices

A novel idea not often used in today’s classrooms is to allow the students choices for their assignments and learning. With strict standards to meet both at the state-level and nationally, teachers are often rushing their students to learn the proposed curriculum. These students can often benefit from choices within this curriculum. Whether it is a choice of assignment, topic, instructional materials, or evaluation method, giving the students autonomy in their learning can produce increased intrinsic motivation (Good & Brophy, 2003). Often it is perceived older students and those of higher-ability are the students that need choice in their instruction. However, low achievers and younger students also need choice (Good & Brophy, 2003).

Intervention

The good news is even though students may not be motivated, have good attitudes, or have any interest in mathematics, as teachers we can still have a positive influence on all of these factors. Ma and Xu (2004) suggested teachers work to improve attitude and achievement early in junior high school. Their research found teachers’ efforts to improve attitude and achievement during late junior and early senior high school could have far-reaching effects. Late junior and early senior high school is the most effective time to use achievement to promote attitude. This intervention was particularly useful with nonelite students (Ma & Xu, 2004), and could take the form of increased academic time and new curricular strategies to enhance interest in mathematics (Singh et al., 2002).

Teaching Strategies

The teaching strategies that promote attitude, interest, motivation, and achievement are the same strategies that make for effective instruction. The classroom is increasingly becoming more diverse and different learners present various challenges. Even when learners are having difficulty with the same task they may need different interventions (Butler, 2002). In a twins study, Fouzder & Markwick (2000) found that all the attitudes and general behavior of the set of twins were similar, but their personalities and self-perceptions were very different.

Regardless of which approach is used, it is documented that instructional practices influence achievement motivation, and that if these methods are consistent over time,
students learn, enjoy, and value mathematics (Middleton & Spanias, 1999). While a self-regulated approach has been promoted here, it is important each teacher find an approach that matches his theoretical beliefs about mathematics education.

**Self-regulated Learning as a Theoretical Framework**

In 2000, the National Council of Teachers of Mathematics (NCTM) released the *Principles and Standards for School Mathematics*. This document updated the 1989 NCTM document, suggesting teachers take on different roles in the classroom. Teachers are now asked to engage students in rich mathematical experiences and to challenge them to reason through problem solving and inquiry. This requires a shift from direct instructional methods promoting transfer of perceived facts and memorized procedures, to methods promoting actual student understanding of the reasoning behind chosen procedures.

There has been an initiation of self-regulated learning research within mathematics education. This influx of new research can be traced to a bridging of educational psychology and mathematics education. Academic self-regulation refers to the processes by which learners maintain cognition, affect, and behavior in order to achieve personal goals (Zimmerman, 2000). Pintrich (2000) defines it as “an active, constructive process whereby learners set goals for their learning and then attempt to monitor, regulate, and control their cognition, motivation, and behavior, guided and constrained by their goals and the contextual features of the environment” (p. 453). This is similar to the definition used by Pape, Bell, and Yetkin (2003). In mathematics education, the emphasis tends to be on effective problem solving procedures and the tasks associated with this process.

There are several cyclical steps self-regulated learners follow in order to learn effectively; the first of these is an analysis of the task demands. A self-regulated learner examines cues from the question or the teacher in order to determine what is required for the desired outcome. This analysis requires the student discern the necessary information from the verbal or written instruction and then compare it with previous knowledge (Butler, 2002). For example, if asked to write an open-response answer the student would link this requirement to previous experiences where the student was required to not only
solve the problem at hand, but also was required to give a written explanation of his logic in solving the problem and to add extensions for the solution to the problem.

Second, a self-regulated learner would choose, select, adapt, or invent a strategic approach to solving the problem (Butler, 2002). This requires the learner to compare the problem to previously encountered problems as well as taking inventory of the facts and ideas surrounding the task. In doing so, the learner chooses an appropriate method, combines two methods, or creates a new unique approach. This type of learner is much more efficient and effective then a learner who often has difficulty if the problem does not match a current schema for problem solving they have previously encountered.

The last and most important step is self-regulated learners evaluate their strategy after implementation (Butler, 2002). Since they understand the goal of the task, they are able to judge whether their strategy was effective in finding a proper solution. If not successful, they are then able to develop and implement another strategy that can be used in another attempt to solve the problem. Either way, the results are recorded by the learner for future reference in relation to newly encountered problems. This differs from a deficient learner who is more apt to simply stop whether the correct or incorrect solution has been reached.

Research has been primarily limited to the implementation of instructional strategies aimed at promoting self-regulation within the classroom (Pape, Bell, & Yetkin, 2003). The mainstay is the teacher promotes self-regulation through the modeling of mathematical behaviors. This is often completed through a variety of approaches. One may ask the students to study and report their learning and understanding. Then the teacher provides the student with feedback and guidance as to any misunderstandings or misconceptions (Travers & Scheckley, 2000; Zan, 2000). This process of learning, self-evaluating, and then entering the process again promotes self-regulation. The concept is that eventually the teacher can be removed from the process and the learner can implement the stages himself. The key is giving the students a task that builds from rote knowledge, to engaging exercises, to problems that embed previous learning (Zan, 2000). This building of students’ success leads to higher self-efficacy. Self-efficacy refers to one’s belief in his capability to perform at a designated level (Bandura, 1997). By increasing a student’s belief in his ability to perform, it is more likely the student will
persevere when a solution is not attained rapidly. A high degree of self-efficacy has been linked with high academic performance, use of self-regulation strategies, and delay of gratification (Bembenutty & Karabenick, 1998).

Sociocultural approaches assume self-regulation occurs through social interaction and has results that are both academic and nonacademic (Meyer & Turner, 2002). This is in contrast to instruction which only looks at the individual’s ability to identify the task, choose a strategy, implement the strategy, and reflect on the process. Socioculturalists add the idea that the goal of the task is both individual attainment and social change (Yowell & Smylie, 1999). Therefore, instruction has the added component of group discussion and problem solving. This allows students to discuss their thinking and develop not only self-reflection but also peer-reflection. One must be careful though as the group dynamic can also affect participation of those with low self-efficacy.

Cognitive self-regulation strategy proved to be a significant predictor of course grades in mathematics in the high school and subsequent course grades and examinations at the university level (Nota, Soresi, & Zimmerman, 2004). The self-consequences strategy (students’ arrangement of imagination of rewards or punishment for success or failure) was the best predictor of student’s intentions to further their education. Therefore, the student’s ability to set a long-term goal, delay gratification, and grasp the consequences of success within school was directly linked with the choice of further schooling. Higher levels of schooling can be directly linked to both job satisfaction and an improved society.

Students need to be instructed how to regulate their learning. This can be completed through various forms of modeling. Whether it is individual, small group, or classroom instruction, there are various techniques that can be useful in promoting self-regulated learning (Butler, 2002). Individualized instruction relies on the instructor tutoring the student to evaluate the metacognitive processes that occur in solving problems. The teacher must guide the student in identifying the task, choosing the appropriate strategy, and then reflecting on the outcomes. In small-group instruction, the task and outcomes may be different for varying groups or even individuals within the groups. Peers can help to develop strategies for others even when they will not be a part of the implementation (Butler, 2002). This peer interaction brings a new level of
engagement and is more appropriate in the sociocultural perspective. Whole-class instruction usually involves the discussion of task goals and strategy choices. A teacher may give an assignment and then have the class analyze the goals of the assignment and the strategies that will be useful. The students would then be allowed to choose their own strategy and subsequently control the implementation. The class would then discuss their individual outcomes and reflect on the different strategies in relation to the goal of the task (Butler, 2002).

While all of these issues have emerged, there is very little research within the domain of mathematics education on self-regulation. For most studies instructional strategies were used to promote self-regulation strategies and self-efficacy in an effort to improve achievement. It was hard to discern from the discussions the particulars of the instructional strategies promoting self-regulation and how they differed from instructional strategies teachers currently incorporate. For example, Pape, Bell, and Yetkin (2003) never discussed the particulars of their intervention more than the fact that they used professional development sessions to promote instructional strategies aimed at improving self-regulation. This area of mathematics research regarding self-regulation is still in its infancy. It is important to merge the fields of educational psychology and mathematics education so that we may provide students with the best opportunities to learn within the classroom.

**Purpose of the Study**

The general purpose of this quasi-experimental convergent triangulation mixed methods study was to implement self-regulated learning as an experimental instructional design in a freshman middle-track Algebra I classroom. The research focused on the relationship between self-regulated learning and the subsequent development of positive mathematical attitudes and achievement. The study also looked at the teachers’ perceptions of self-regulated learning and its usefulness as an instructional method. In addition the research provided some insight as to the effects of the instructional technique in regards to student attitude toward mathematics. Specifically, the following questions were investigated:

1. What is the relationship between attitude and achievement for beginning middle track secondary mathematics students?
2. How does attitude and achievement change due to the implementation of a self-regulated learning instructional technique?
3. How are mathematical attitudes impacted by self-regulated learning and its related instructional techniques as compared to normal instructional techniques?
4. How is mathematical achievement impacted by self-regulated learning and its related instructional techniques as compared to normal instructional techniques?
5. How do teachers perceive experimental instruction and in particular self-regulated learning and its related instructional techniques?
6. What are the barriers to instructing with self-regulated learning and its related instructional techniques?

Mixed Methodology Research Design

Mixed methods research uniquely combines both quantitative and qualitative methodologies to gain a better understanding of the research problem. For the purposes of this study Creswell and Clark’s (2006) definition of mixed methodology was utilized.

Mixed methods research is a research design with philosophical assumptions as well as methods of inquiry. As a methodology, it involves philosophical assumptions that guide the direction of the collection and analysis of data and the mixture of qualitative and quantitative approaches and many phases in the research process. As a method, it focuses on collecting, analyzing, and mixing both quantitative and qualitative data in a single study or series of studies. Its central premise is that the use of quantitative and qualitative approaches in combination provides a better understanding of research problems than either approach alone. (p. 5)

Currently in the field of self-regulated learning, quantitative analyses have relied heavily on survey results and academic achievement to monitor self-regulation, which has made it difficult to isolate the procedures that are effective within the implemented behavior. Qualitative research (Travers & Scheckley, 2000) on the other hand has relied heavily on observation and description of student-teacher and student-student interactions. It has also included reflections from the instructor as to the effectiveness and difficulties of the instructional strategy. By combining both quantitative and qualitative methods we see a complete viewpoint of the importance and development of self-regulated learning.

This study employed a convergent triangulation mixed methods strategy in order to answer the above research questions. This model is the most familiar of the six major
mixed methods models (Creswell, 2003). The convergence triangulation strategy uses separate quantitative and qualitative methods to give strength to the research in the areas where one method alone would be inherently weak. In this strategy it is ideal for quantitative and qualitative approaches to be given equal treatment with the integration of the results of the two methods happening at the interpretation phase (Creswell, 2003). The figure below gives a more detailed picture of the concurrent triangulation strategy being used in this study.

Figure 2. Mixed Methods Design for the Study (adapted from Creswell, 2003; Tashakkori & Teddlie, 1998).
Population

The researcher used self-regulated learning as an experimental instructional strategy implemented at the 9th grade level in Algebra I classrooms at one local Midwest urban high school for a duration of fifteen instructional days with 96 students participating in the experiment. Due to restraints a convenience sampling was employed putting a limitation on the study. The teachers were enrolled in the study on a voluntary basis and with approval of the local school board, principle, and mathematics department chair. The targeted population was freshman students enrolled in Algebra I. These students were ability grouped and this population represented the middle track. The advanced students enrolled in Geometry and the lower-level students enrolled in Algebra I part 1. The total enrollment of the school was over 1800 with approximately 500 freshman students enrolled in a math course.

Instructional Strategy

The instructional strategy involved the students having a choice in most aspects of learning except assessment. The students had multiple methods of instruction available, including but not limited to lecture notes, textbooks, Internet access, peer collaboration, inquiry, teacher facilitation, and discovery activities in which the students were guided through questions and prompts to discover a proof or theorem or general idea, concept and/or skill. In order to monitor the teaching method, the teachers went through an orientation with the researcher and observations of the classes were performed in a random manner during the study. Teacher questionnaires were used to compare with these observations. During the orientations the researcher used sample materials to introduce the self-regulated learning technique to the teachers. The researcher emphasized to the teachers that the student was not “teaching themselves,” but instead the student was managing their own instruction. At this time the researcher discussed with the teachers how they wanted to assess the students for their classroom grades and the decision was made to use two district-wide tests. Although this was a direct violation of self-regulated learning, it was important the teachers felt comfortable with the techniques they were using. For this study and because of the constraints on the assessment techniques, the focus was on the objective of the students controlling or managing their learning.
The students were required to learn the specified topics but were not required to approach them in any specific order or in any given timeframe (except the duration of the study). In order to identify these topics the researcher and teachers developed a list of objectives for this unit of study (see Appendix C). This list was distributed to the students as a guideline for their learning. Topics that required previous constructs naturally lead the learner back to those constructs. In addition to the list of objectives, the student was given a timeline as well as a resource sheet (see Appendices E & D, respectively). The timeline provided the student with the minimal amount of material to be covered each day. This timeline was developed by the researcher and teachers and followed the timeframe set forth by the district curriculum map. A resource sheet was developed by the researcher to assist the students in learning the objectives. The students did not have ready access to a variety of resources (computers, books, tutorials); they needed to be provided for the students. These resource sheets referenced materials to be found in the classroom resource notebooks such as printed websites, other textbooks, open-response items, and other teacher provided materials. These three items gave the students guidance through the unit.

Although it is common to allow the students to display their knowledge through a variety of different assessment techniques, especially performance assessments, in this approach the students were not responsible for displaying their new knowledge through experimental results, tests, art projects, or any other form they choose. The teachers made a decision to use a district-wide assessment for the research. The teachers were fully in charge of the instruction and grading, and were therefore able to make choices in this area. The teachers also incorporated a series of quizzes designed by the researcher in order to monitor the students’ progress on the objectives.

Overall, this self-regulated learning approach allowed students to research topics they are interested in, as well as develop motivation for new learning. The researcher hoped to show through choice and independent learning, students can develop a better attitude, more interest and motivation, and higher achievement in mathematics.

Instrumentation

To assess the students’ attitudes, interest, motivation, and achievement the students were given an attitude survey prior to the start of the experiment as well as a
polynomial survey. These two surveys were administered again following the intervention. A control group received typical instruction consisting of lecture, seatwork, and various small group activities and was used to compare to the experimental data.

The teachers participating in this study were interviewed and surveyed for their perceptions of the experiment and its usefulness in their classroom. Extensive interviews were conducted with all of the participating teachers prior to and after the study was completed. The teachers were interviewed prior to the research study to reveal their current teaching methods and their motivations as teachers (see Appendix F). Following the initial questioning, the researcher performed a member check (Denzin & Lincoln, 2000). This assured the responses were accurate and not prone to recording error. In order to save time on the interviews, the teachers were also given survey questions to answer prior to the study (see Appendix G). An initial and brief qualitative analysis of this data provided the researcher with the knowledge necessary to improve the experimental technique and monitor its effectiveness and utility throughout the study. In addition, these data were used to help construct the post-interview questions for the teachers.

The teacher interview and survey questions were developed by the researcher. These questions aimed to give the researcher an insight into the teacher’s motivation for teaching mathematics. In addition these instruments developed an understanding for the teacher’s participation in the research, the teacher’s typical classroom instruction, and the teacher’s motivation for participating in the research. The interview questions also probed the teacher’s thoughts about the students’ likely success or failure with self-regulated learning and their concerns prior to starting the study.

The interview questions (see Appendix H) for the teachers following the intervention focused on the teachers’ day-to-day activities during the research and subsequent successes and failures within the instruction. The questions revisited their prior assumptions about self-regulated learning and developed many themes that become apparent during the study. The focus was on the barriers the teachers encountered and improvements that could be made with future implementations of self-regulated learning.

The attitude survey had been developed by Martha Tapia of Berry College (see Appendix B). The Attitude Toward Mathematics Inventory (ATMI) is a 40-item, Likert scale survey that measures four areas relating to mathematics attitude: self-confidence,
value, enjoyment, and motivation. The ATMI was developed for use with high school students and has evolved through item analysis and exploratory factor analysis. The instrument has a coefficient alpha of 0.97 with standard error of measurement of 5.67 (Tapia, 1996).

The polynomial survey was developed by the researcher in conjunction with the teachers involved in the study. The content was outlined by the school curriculum map developed by the curriculum specialist for the school system. The researcher created a list of the student objectives for the unit in order to develop the survey. The survey instrument contained questions found on the district-wide assessments which aligned with the list of objectives. This survey was in multiple-choice format. For those questions which were currently used on the district assessment but were not multiple-choice, the researcher developed distractors based on common mathematical misconceptions. It is important to note the district-wide assessments align with the Program of Studies and Core Content for Assessment 4.1 from the Kentucky Department of Education. Therefore, this survey measured objectives from both the state and district. A standardized assessment would not have closely monitored the students’ knowledge in relation to the teaching objectives for this specific school.

The polynomial survey was scored for correct responses. Item-response theory was used to analyze each individual question and determining its discrimination, difficulty level, and distractors. The Spearman-Brown prediction formula was used to calculate the reliability of the assessment. The coefficient alpha for the pre-survey was .804 and the coefficient alpha for the post-survey was .745. Due to the design the researcher could not remove items, however the analysis shows only minimal gains in alpha for the removal a few items on the pre-survey and post-survey. The researcher analyzed gains as well as ending knowledge in comparison with the control group. The items directly correspond with the objectives in the student rubric, giving the survey content validity in this specific instance.

The survey included demographic questions. These were used as independent variables in the analysis of data for both the attitude and polynomial surveys. Links among gender, class, age, previous course and grade information, and ethnicity were analyzed.
Analysis

The purpose of this convergent triangulation mixed methods study was to study the impact of self-regulated learning on mathematics attitude and achievement as well as provide insight to the barriers to implementation of this technique. The data were analyzed both qualitatively and quantitatively. The quantitative data were analyzed using univariate statistics. The researcher used these statistics to explain changes in attitude and achievement over the course of the study. Specifically, the attitude survey was scored using a 5-point system to generate a score for each of the four specified areas of mathematics attitude (self-confidence, value, motivation, and enjoyment). The pre- and post-scores were compared and a difference score was obtained for each student. Changes in the data were analyzed and compared to the control group.

In order to use parametric analysis it is necessary to first guarantee the fit of the data to a normal curve. The first step is to test for skewness and kurtosis on all four measures. A lack of extreme skewness and kurtosis was noted. The fit of the total content scores to a normal distribution through a Kolmogorov-Smirnov Test for each measure, pre-ATMI ($z = .563$ with $N = 96$, $p = .909$), post-ATMI ($z = .855$ with $N = 96$, $p = .458$), pre-Polynomial ($z = .865$ with $N = 96$, $p = .443$), and post-Polynomial ($z = .688$ with $N = 96$, $p = .730$) revealed no statistical significance. Therefore, the normality assumption was met and further analysis could be performed.

Analysis for research question 1 about the relationship of mathematics attitude and achievement was performed through two correlations: pre-ATMI with the pre-Polynomial survey and the post-ATMI with the post-Polynomial survey. The Pearson correlation coefficient for was $r = .317$ ($\alpha < .01$) for the pre-tests and $r = .246$ ($\alpha < .05$) for the post-tests. This revealed only a small correlation between attitude and achievement scores. Because of this magnitude, univariate, rather than multivariate, analysis was performed for attitude and achievement scores.

To analyze the effectiveness of the self-regulated learning technique in impacting attitude and achievement a regression approach to analysis of variance (ANOVA) was performed with polynomial post-survey scores as the dependent variable and polynomial pre-survey scores as the independent variable in order to determine if statistically significant differences were found between the two scores. However, the data failed to
meet the homogeneity of variances requirement and therefore no further analysis could be completed. Using a regression approach to ANOVA, the variable ATMI pre-survey was regressed on the variable ATMI post-survey as independent variable, the overall model yielded $R^2 = .840$ for the ATMI Survey for summary data (see Table 1). This model accounted for 84% percent of the variance in the difference of the scores. The ATMI pre-survey had a statistically significant ($p < .05$) contribution to the post-survey ATMI total. Effect sizes were large.

Table 1
Univariate Regression on ATMI Survey
Dependent Variable: Post-ATMI Survey Total

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta Squared</th>
<th>Noncent. Parameter</th>
<th>Observed Powera</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>19105.964b</td>
<td>53</td>
<td>360.490</td>
<td>2.485</td>
<td>.008</td>
<td>.840</td>
<td>131.712</td>
<td>.987</td>
</tr>
<tr>
<td>Intercept</td>
<td>957693.172</td>
<td>1</td>
<td>957693.172</td>
<td>6602.109</td>
<td>.000</td>
<td>.996</td>
<td>6602.109</td>
<td>1.000</td>
</tr>
<tr>
<td>preatmitotal</td>
<td>19105.964</td>
<td>53</td>
<td>360.490</td>
<td>2.485</td>
<td>.008</td>
<td>.840</td>
<td>131.712</td>
<td>.987</td>
</tr>
<tr>
<td>Error</td>
<td>3626.467</td>
<td>25</td>
<td>145.059</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1222602.000</td>
<td>79</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>22732.430</td>
<td>78</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a Computed using alpha = .05
b R Squared = .840 (Adjusted R Squared = .502)

To explore the impact of self-regulated learning on mathematical attitude and achievement a univariate analysis was conducted using a linear regression model. The independent variables were analyzed individually. Only statistically significant variables were then added to the model. Finally, non-significant factors were removed from the final model (highest to lowest) until all independent variables were significant. The final regression equation (see Table 2) predicting mathematics attitude included only the pre-ATMI, $t(93) = 10.562, p < .001$, and the Integrated Math course, $t(93) = 3.225, p = .002$, as significant predictors, $R^2 = .570$, adjusted $R^2 = .561$. This model accounted for 56% of the variance in mathematics attitude among students.
Table 2
Linear Regression on ATMI Survey
Dependent Variable: Post-ATMI Survey Total

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td>69.068</td>
<td>5.131</td>
<td></td>
<td>13.462</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>preatmitotal</td>
<td>.404</td>
<td>.038</td>
<td>.718</td>
<td>10.562</td>
<td>&lt; .001</td>
</tr>
</tbody>
</table>

Computed using alpha = .05
R Squared = .570 (Adjusted R Squared = .561)

The final regression equation (see Table 3) predicting mathematics achievement included the pre-Polynomial survey, \( t(92) = 7.519, p < .001 \), the 8th grade Math course, \( t(92) = -2.445, p = .016 \), and students age being 14, \( t(92) = 2.735, p = .007 \), as significant predictors, \( R^2 = .441 \), adjusted \( R^2 = .422 \). This model accounted for 42% of the variance in mathematics achievement among 9th grade students.

Table 3
Linear Regression on Polynomial Survey
Dependent Variable: Post-Polynomial Survey Total

<table>
<thead>
<tr>
<th>(Constant)</th>
<th>15.943</th>
<th>1.713</th>
<th></th>
<th>9.304</th>
<th>&lt;.001</th>
</tr>
</thead>
<tbody>
<tr>
<td>polypretotal</td>
<td>.570</td>
<td>.076</td>
<td>.587</td>
<td>7.519</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>14yearold</td>
<td>2.562</td>
<td>.936</td>
<td>.215</td>
<td>2.735</td>
<td>.007</td>
</tr>
<tr>
<td>8thgrademath</td>
<td>-11.196</td>
<td>4.578</td>
<td>-.192</td>
<td>-2.445</td>
<td>.016</td>
</tr>
</tbody>
</table>

Note. Computed using alpha = .05
R Squared = .441 (Adjusted R Squared = .422)

The results showed no statistical difference in the scores for attitude and achievement between the alternate (did not receive the self-regulated learning treatment) and experimental groups.

**Barriers to Implementing Self-Regulated Learning Strategies**

There were many barriers to self-regulated learning that developed during this study. Through careful coding of the data, several themes developed describing these difficulties. The implementation of the self-regulated learning strategy is a focus of this study. The teachers were asked to use a teaching strategy based on self-regulation research to explore the possibilities of increasing both attitude and achievement in the
mathematics classroom. To this end the teachers needed to give up management of the
daily activities in the classroom to their students and assume the role of expert in their
classroom.

Regulation

Regulation occurs constantly in a typical classroom. The three teachers (Ms. Batts, Ms. Price, and Ms. Marple) and one student teacher (Ms. Newcomer) participating in this research showed high levels of regulation in their normal instruction. Ms. Marple describes her normal class,

Class begins with a warm-up. A warm-up will usually consist of 5 questions over the concepts learned in the previous class period. Students have about 5-10 minutes to complete. Then I go over the answers and we discuss any problems. Next, we go over the homework problems. Grades are taken several different ways – no credit, effort, and accuracy. After collecting the homework, I give notes and do example problems for the students. After several of these, I ask the students to try some similar problems. After the lecture, students work in pairs to complete “partner problems.” These consist of about 10 questions from the book or a worksheet over that day’s topic. Students may talk to each other and share ideas. They are to check each other’s answers and come to a consensus if they have different results. Then, they staple their work together and turn it in. After this is done, the homework assignment is given. (E. Marple, personal communication, December 18, 2006)

The other teachers provided similar descriptions of their classes. At no time did the teachers mention the students were given any choice or management of their learning. While differentiation was incorporated by Ms. Price, this technique did not allow the students to choose the method they wished to use.

From the beginning of the experiment it was very evident the teachers had full control and regulation of their classrooms. It was difficult for the teachers to give up this control and change their teaching style. This became apparent at the first meeting the researcher had to present the new instructional technique. A basic notion of self-regulated learning is the students’ ability to regulate their own learning. Within a social-constructivist framework it is also necessary for the student to share this knowledge socially. Combining these two ideas results in the method of sharing the learned knowledge being chosen by the students. The researcher suggested the students be able to choose the method in which they shared their knowledge and the teachers were opposed to this and decided to use a standard written assessment. When questioned on the
subsequent use of a standard written test Ms. Marple stated, “I don’t know how else I could assess their learning” (E. Marple, personal interview, March 14, 2007). Ms. Batts and Ms. Price commented that outside pressures including the principal and district personnel led them to use the written assessment. After the experiment when the researcher suggested the written test could have been an option to the students along with any other form both the student and teacher agreed upon, Ms. Batts agreed this would have been more appropriate with the self-regulated approach.

The teachers were involved in two sessions prior to the experiment in which they were introduced to self-regulated learning, and specifically the ideas that were to be implemented. During these sessions group decisions were made as to how the techniques would be implemented. While the researcher could have been strict in his implementation, he felt it was important to allow the teachers to assess the students and more importantly determine grades in a manner they deemed feasible. Another result of this process was the implementation of a quizzing system. Students were given the objectives for the unit on polynomials (Appendix C). The teachers developed quizzes to accompany each individual section. Rather than use these as self-checks for the students as they were originally intended, the teachers used these items as a strict quizzing system. The researcher was able to manipulate this by having the students complete the quizzes until they had 100% mastery of the topic in order to encourage the students to evaluate their learning, make adjustments, and not move to the next topic before they had mastery. In the first half of the experiment the teachers had a quiz rotation during class. Students were constantly taking quizzes, waiting for the teacher to grade them, and then returning them so the student could study more and then take the quiz again.

The teacher begins by grading quizzes that students have completed at the front of the room. This is the system that she has designed for herself. This limits her role of walking around the room and facilitating. However, this is giving her an opportunity to see student errors and call them to the front of the room for individual corrections on their papers. This is fine, but she is not giving the student the opportunity to evaluate their own mistake or even figure out their error. This will affect their self-management abilities. (Field Notes, January 17, 2007)

This iteration took place three times during this particular 90-minute block class period. The students were also forced to take notes in one teacher’s classes and provide them to
the teacher prior to taking the quiz, another regulation strategy. Not only were the
students being informed how they were to learn, and how they would be assessed, the
teacher was also evaluating the students’ work and informing them what they knew and
did not know. This was teacher regulation and does not adhere to the principles of self-
regulation. Two of the teachers did not view these quizzes as a form of regulation when
interviewed; rather they viewed it as a self-check for the students. Not only was this quiz
process regulating the students learning, but it was also filling a lot of the students’ in-
class time. Three teachers reported the quizzes only taking 10-25% or 10-20 minutes out
of the class. However, the student teacher reported this process taking 60% of the class
time. The researcher’s classroom observations showed this last figure to be much closer
to reality. Realizing this was a huge problem the researcher intervened at the midpoint of
the experiment and met with the teachers to change this structure. The result was the
teachers allowed the students to check their own quizzes, thus making them learning
checks (interestingly none of the teachers changed the name on the paper). This freed the
teachers to spend more time with the students, but more importantly allowed the students
to evaluate their own learning, an essential component of self-regulated learning. The
quizzes were still graded, making them mandatory and important to the students; a direct
contrast with self-regulated motivation strategies.

Regulation also occurred in the form of direct instruction by the teachers. All four
teachers reported using opener problems in their normal classrooms, a common approach
for most classroom teachers. The researcher found upon his observations this was still the
case in all classes.

The class starts with a warm-up exercise based on the previous day’s minimal
work. This is similar to the activity that Ms. Marple is using to start her day. Once
again after the students work the problem the teacher is working the problems and
using questioning techniques to have the students respond. This is not what we
want or need. The students are not evaluating their work and the teacher is
regulating their learning with this technique. The teacher is instructing with direct
instruction. (Field Notes, January 22, 2007)

It seems the teachers were unable to let go of this control over the students. This process
was also tweaked by the researcher during the midpoint meeting. The teachers modified
the technique by simply providing the answers to the questions in written form rather
than going over them as a whole-class and asking questions of individual students. This
was an improvement, but students were still required to complete the activity and in Ms. Price’s class she gave participation points for doing so.

Another large regulation technique was the implementation of a timeline for the students. To be successful in self-regulation the student must work at their chosen rate. The timeline was introduced as a minimum requirement for the students due to the time constraints of the experimental technique. The researcher hoped this would be used as a tool for the students to see their reasonable progression. However, the teachers held the students to the timeline and forced students to take the assessment before the students had completed all of the necessary pre-requisites to do so.

The teacher starts the class by reminding the students of the timeline and the end date for this experiment. She then goes to each student and gives them a progress report of scores she has for their quizzes. This shows she doesn’t trust her students to discern what they have completed and what they have left to complete. It has been hard for the teacher to let go of her management strategies and allow the students to be accountable for their work. (Field Notes, February 12, 2007)

The teachers also found it important to keep students on task. Ms. Batts commented,

It drove me crazy that they weren’t on task and were wasting time. They weren’t getting anything out of it. I feel like it’s my job to keep them on task. Yes it’s a form of regulation. I have pressures from the principal to keep them on task. It was very difficult seeing the kids not on task. I didn’t mind them talking to friends about math as long as it was only math. It wasn’t organized (I like to be organized). (M. Batts, personal interview, March 16, 2007)

The teachers were under pressure for the students to work, but they did not feel comfortable allowing the students to choose when, how, and what they did to learn.

All of these forms of regulation were present prior to the experiment. All teachers had their own timeline, used quizzes extensively, assessed through tests, and used openers and direct instruction techniques. Even though they all could define self-regulation and sometimes recognized they were regulating the students’ learning it was difficult for them to change their behaviors. They repeatedly regulated the students’ learning throughout the experiment thus putting the results in jeopardy.

*Roles*

The self-regulated learning strategy was implemented in various ways by the teachers. This implementation highlighted both the advantages and disadvantages of the
strategy. The teachers were asked to take on a facilitation role within the classroom. No longer were they to lead whole-class discussions, instruct directly, or evaluate the students learning. Instead they were asked to take on the role of an expert in the classroom who could be viewed as a facilitator from an education perspective. The researcher instructed the teachers to have the students ask questions and not to interfere or circulate around the room asking questions of the students. For the most part the teachers complied with this request. When asked to describe a typical interaction with a student during this time, Ms. Newcomer stated,

I was comfortable. I would sit beside the student and talk the student through how to do it. I would show an example. Then I would give a couple problems to try from the book. Then they could ask further questions. Sometimes I would write down notes for them. Most of the time I would wait for the students, but sometimes I would go to the students specifically, if I could tell they were frustrated. (J. Newcomer, personal interview, March 15, 2007)

This highlights both the correct approach and the struggles with facilitation encountered by all of the teachers. Ms. Newcomer was able to comfortably approach students on an individual basis and would mostly wait for them to ask questions. However, when talking with them she was unable to ask them questions or probe their knowledge to help the student construct the knowledge they needed. Instead she would show them an example and talk them through the problems. This technique did not help to guide and promote self-regulation.

Others encountered the same difficulties, often saying they worked through examples while the students watched or just explicitly explained the method for solving the problem. While this is not a bad approach, the problem lies in the teachers’ inability to link the new knowledge to the previously constructed knowledge. Ms. Price had a different experience. Rather than work through problems she greeted the students with a series of questions.

I would ask the students which resources they had used. If they hadn’t used any I would encourage them to find some other resources. The students had to ask specific questions. I would model the procedure or idea. Then I would go back after they had worked two or three problems. (S. Price, personal interview, March 28, 2007)
The telling part here is her first question to the students; it was directed at what they had tried on their own. If they had not made sufficient effort or asked a specific question then she tried to help guide their regulation by directing them to other resources. This is an important concept in self-regulated learning. While the teacher is viewed as an expert, she is not the only expert in the room. The students had access to textbooks, and other printed materials from the internet that contained expert knowledge.

Ms. Price was by far the most comfortable in the role of a facilitator. She moved about the room constantly and her students were willing to ask her questions. However, as she noted, the students’ questions had to be direct and show an effort on their part to learn before she would offer any assistance. She had built a good rapport with her students and just as she felt comfortable, they were comfortable in having her as a facilitator.

Another advantage of self-regulated learning is the students’ ability to proceed at their own pace. This is also demanding on the teacher due to the differing levels of knowledge each student possesses at any given time. As a facilitator the teacher must be able to quickly assess the individual student’s knowledge and then provide feedback and questions that help to stimulate the student within their ZPD. This puts a demand on the teacher to understand the material completely but more importantly to be able to question effectively. The teachers in the study did not show expertise in this area and this was evident in their descriptions of their interactions. Only one teacher stated that she would ask the students questions about what they already knew.

The research materials were an integral part of this research. Due to financial and resource restrictions students could not research topics on their own during school time outside of the contained classroom. The researcher developed notebooks to be placed in the classroom that provided several alternate resources for each objective. The lack of computers made video and other computing technology non-accessible during this time. Web links to computerized models were provided to the students for use at home or after school in the computer lab. In addition each student had a textbook with each objective, examples, and practice problems for their use. This did not exhaust all of the possible resources thus limiting the study.
The researcher’s observations revealed little use of resources outside of the textbook. The teachers often recommended the students use other resources but the students failed to do so. There were, however, some instances of the students using the materials successfully. A positive finding involved three of the four teachers adding materials they thought would be helpful to the resource notebooks. The teachers gave varying outlooks on the reasons students didn’t use the outside resources (other than the text). “They have never had to go to outside sources. Even though we talked about them, they weren’t accustomed to this process. They haven’t learned there are other resources for learning (other than the teacher and text)” (J. Newcomer, personal interview, March 15, 2007). On the other hand Ms. Batts had different ideas. “They were not motivated and didn’t want to put forth the effort. When we told them they had to do it they did but when we didn’t it was extra work” (M. Batts, personal interview, March 16, 2007). Interestingly these two teachers are talking about the same students. Ms. Marple added that “I told them to go to the resource packets…but students don’t like to read.” (E. Marple, personal interview, March 14, 2007). The implementation of outside resources requires the student to be able to research and read about a given topic rather than having the teacher provide all the information needed. This skill was either lacking in most of the students, or they lacked the motivation and effort to use these other resources.

**Attitudes**

The teachers’ perceptions and attitudes toward the self-regulated learning technique played a vital role in the results of the study. During the qualitative analysis several themes developed in this area. Teacher comfort, teacher understanding, student ability, teachers’ perceptions of learning, and teachers’ perceptions of learning were the major themes emerging from this analysis.

**Teacher Comfort**

The four teachers involved in this study displayed varying degrees of comfort during the experiment. Three of the four teachers displayed personalities that demanded order and organization within their classrooms. These three had the most difficulty implementing the self-regulation techniques and allowing their students to have control over their learning. Ms. Marple stated, “I like to have control of the classroom” (E. Marple, personal interview, March 14, 2007). When asked what was hardest about giving
up control Ms. Batts commented, “Not being able to teach. Not having class discussions and explaining it as a whole. This is very important. I feel like I reach more kids this way” (M. Batts, personal interview, March 16, 2007). Later when asked about the most challenging part of the study she stated,

It was very difficult seeing the kids not on task. I didn’t mind them talking to friends about math as long as it was only math. It wasn’t organized (I like to be organized). I wasn’t able to do whole-class instruction. The research didn’t fit my personality. (M. Batts, personal interview, March 16, 2007)

The control issues spread even to the student teacher. Classroom observations revealed Ms. Newcomer was constantly telling the students they needed to be working on mathematics. “It really bothers me (when students are off task). It’s my responsibility to keep them on task” (J. Newcomer, personal interview, March 15, 2007). Meanwhile Ms. Price showed signs of some control. On one hand the most challenging thing for her was “keeping my mouth shut. I like to have class control for the first part of class to settle them down” (S. Price, personal interview, March 28, 2007). When asked about her comfort level in class she stated, “The setting was okay and I felt comfortable with the class” (S. Price, personal interview, March 28, 2007). This was indeed true. The researcher’s classroom observations showed Ms. Price to be very comfortable in the role of a facilitator. She moved about the room purposefully during class and was able to offer individual help as well as conducting small group discussions. Despite her concerns she was not able to reach all the students, it was evident she was able to provide more meaningful one-on-one direction than in her normal classes. She also was able to target those students who needed her help and did not display any negative attitudes toward the instruction during class time.

The comfort level was exhibited through the teachers’ control of the learning processes within their classrooms. The previously discussed quizzes, timeline, and assessment all allowed the teachers to retain control over their students. Structure was developed by each teacher in their own way. All four used an opener to keep students on track to finish their studies by the end of the study. Ms. Price employed a point system for crediting students who were actively working on mathematics and an exit slip system to hold the students accountable for learning. Ms. Batts and Ms. Newcomer were continually prodding their students to be on task. Ms. Marple used note taking procedures
in order to control the students’ method of learning. A telling comment came from Ms. Batts' discussion at the end of the research project. “I wanted my kids back. I wanted to be back in control…they are back where I want them now” (M. Batts, March 16, 2007).

**Teacher Understanding**

The teachers’ understanding of self-regulated learning was excellent. All four came up with definitions that fit the researcher’s definition of self-regulation. Responses included “the students are responsible to find their own way to learn the material” (S. Price, personal interview, March 28, 2007); “students are in control of what they are learning” (E. Marple, personal interview, March 14, 2007); and “students are in control of the learning environment and pace they learn” (M. Batts, personal interview, March 16, 2007). These responses were consistent over time in all instances.

More importantly the teachers understood the implementation of the strategy was aimed at improving the attitudes of the students. When asked why the researcher suggested this study, Ms. Batts responded with “to help students with their attitudes” (M. Batts, personal interview, March 16, 2007). This idea to increase attitudes also related to the teachers’ philosophy of teaching. Ms. Price’s goal for teaching involves helping the students to “understand the curriculum so they are not afraid of mathematics and are not uncomfortable with it” (M. Price, personal interview, December 18, 2006). Ms. Newcomer’s goal is for “students to enjoy math and like it” (J. Newcomer, personal interview, January 5, 2007), and Ms. Batts added she “hopes to develop in students a love of learning and mathematics. I want students to see that math is exciting and easy” (M. Batts, personal interview, January 3, 2007). All teachers seemed genuinely enthusiastic about their jobs and wanted to help students understand and enjoy mathematics.

The teachers’ reoccurring reason for entering their profession was their belief that a student must possess good knowledge of mathematics in order to be successful in life. Ms. Newcomer reported her reason for teaching mathematics was “to convey that it is important for society and life. I believe if students can’t complete Algebra I they won’t be successful in life” (J. Newcomer, personal interview, January 5, 2007). Ms. Price commented “I hope students are comfortable enough to perform mathematics and are prepared for life” (S. Price, personal interview, December 18, 2007), and Ms. Marple added “students don’t understand that they need to learn now so they can be successful
later” (E. Marple, personal interview, December 18, 2007). This need to prepare students for life was not evident in the teachers’ implementation of the self-regulated learning technique.

There is a district-wide open response question for each mathematical unit. The researcher included this problem in the resource materials. However, none of the teachers or students ever used the open-response items. Even more importantly, no teacher was ever observed helping the students make connections between the mathematical topic and the students’ everyday lives. A fundamental idea of constructivism is the new learning must be related to previous knowledge and understanding. Included is the motivation the student has to learn this new information. The teachers never encouraged the students to develop these connections despite their statements that they wished for students to learn mathematics so they could be successful in life. Real-life problems can help motivate students to understand and make connections in their life. When asked about real life problems Ms. Marple responded that this “wouldn’t have helped with the students’ motivation since they don’t like them” (E. Marple, personal interview, March 14, 2007) and Ms. Newcomer also added “it would not help the students with their motivation” (J. Newcomer, personal interview, March 15, 2007). Ms. Price stated “I’m not sure how it would have (helped)” (S. Price, personal interview, March 28, 2007). The teachers did not make the connection that motivation could be improved through making connections to the students’ lives.

The teachers were also able to make the connection between self-regulated learning and learning outside of the classroom. Self-regulated learning is a construct that is used extensively to learn outside the classroom. Its basic tenets of analyzing a problem, implementing a solution, and evaluating that decision occur daily for most people. This is all completed without the help of a teacher in most cases, although an expert may be consulted. The teachers stated they did view self-regulated learning as something their students needed to be able to do.

Definitely, the higher you go the more you need it. It is valuable and I can see trying to make it a normal part of my instruction. The maturity level is not there at this level. Subtle or gradual integration would be more effective. This is perfect for home-schooling. Yes, self-regulation is how people learn. (E. Marple, personal interview, March 14, 2007)
Interestingly Ms. Marple does not believe the students can do it at the freshman level and goes on to say it would be great for home-schooling. This shows her inability to see it as a viable way to learn for students and may stem from her inability to give up control in the classroom. Ms. Price had similar ideas.

Yes, students need to know how to learn outside of the whole-group instruction world. After school, students will need to know how to find answers when a teacher isn’t there. I am trying in my classroom to incorporate cooperative learning as much as possible. This simulates how someone in a new job would learn new things by asking co-workers for help and not just the boss. (S. Price, personal interview, March 28, 2007)

In this instance Ms. Price expresses the idea that it is important to learn how to learn in this manner and cites her use of cooperative learning as working toward self-regulated learning. Ms. Batts thoughts on the topic were similar.

Yes it is something students need to learn how to do. They are going to encounter this in life, especially in college. I hope that my higher-level classes are doing some of their own regulation. The non-advanced classes are not prepared for this. Yes I view it as real life. I learned (self-regulation) in college. It was trial by fire.” (M. Batts, personal interview, March 16, 2007)

The telling statement is she does not view it as viable for lower-level students. However, she states they are going to need to regulate their own learning in college. From her statements it seems as though she thinks students will learn in college how to regulate their learning. All of the teachers recognized the importance of self-regulation and its use after high school, both in college and in the non-academic world. However, they did not view it as something the students could accomplish on their own at this level.

**Student Ability**

A reoccurring theme in the interviews was the students’ abilities to regulate their own learning. This experiment was a radical change from the teacher’s normal teaching routine. Subsequently the students were asked to make choices in situations where previously the choices had been made for them. The teachers had various perceptions on the students’ ability to participate and why they lacked these abilities. Maturity was often mentioned as a reason the students were unable to regulate their learning. “They aren’t mature enough to handle it. There isn’t enough motivation. There isn’t enough intelligence (cognitive level). This might be possible in different subject area” (M. Batts,
Maturity and motivation play a role in the students’ abilities to regulate their learning.

While these are viable explanations, the students’ inability to regulate may be due to another construct Ms. Marple mentioned, teacher dependence.

Teacher dependence seemed to pervade throughout the teachers comments and in most cases they were more than happy to accommodate this dependence. “The students want me to hand it to them. They don’t want to do work. This is okay with me because that is the way I like to instruct” (M. Batts, personal interview, March 16, 2007). She even went as far as to say “the students developed a new appreciation for the teacher (during this experiment)” (M. Batts, personal interview, March 16, 2007) when asked about what the students learned. Ms. Price was a little more positive in her outlook.

They learned they don’t have to have everything spoon-fed to them. They learned how to read the textbook better. (Previously) they didn’t really read the textbook...(they were) used to the teacher telling them. The students don’t want to be out of their comfort zone. This is how they have learned previously. (S. Price, personal interview, March 28, 2007)

Ms. Newcomer had a level approach also. When questioned on why the students often commented they wanted the teacher to teach them she stated,

The students are lazy. They were used to the teacher teaching. They mean direct instruction or that the teacher organizes what they are doing...management. (We) tell them how to do the work, giving them examples and guidance. They didn’t
know how to learn on their own. They need to be taught how to learn on their own.

Ms. Newcomer has great insight in that the students have been taught to learn from direct instruction and they must be taught how to learn through self-regulation. The researcher did not have time to have the teachers slowly implement the self-regulation strategy. Instead they were thrown into it fully and left to manage their learning explicitly where they had been guided previously by the instructor.

A telling summary of this situation is found in the field notes from a classroom observation of Ms. Marple.

The teacher mentioned to me that she had a “revolt” in the first period of the day. She stated that the students said they were “tired of teaching themselves” and that “they wanted her to teach.” While this is disheartening, it also gives light to the fact that the students are dependent on the teacher for learning. From a larger perspective we’re developing students who aren’t responsible for their own advancement and who won’t be able to learn once outside of the classroom in the absence of an authority figure managing their learning. (Field Notes, January 17, 2007)

The students did not have the skills to regulate their learning. This is due to the fact that the students have become dependent on the teachers to manage their learning in our current educational system.

*Teachers Perceptions of Learning*

The teachers’ perceptions of learning varied greatly throughout the study. Before the study started most prophesized the instruction would be successful for some and some would struggle, mirroring typical instruction results. At representative response was given by Ms. Batts,

I think those students with good grades and that are repeaters will “love it” since they will know the content and there will be no specific homework. I think those that are struggling will find it difficult and that I will need to hold their hand. A few will fail no matter what since it is new to them and they will have new responsibilities. (M. Batts, personal interview, January 5, 2007)

The researcher had a more positive perception. He though the students would be highly successful because they could choose the method they liked and the teacher would be able to help more students individually.
The teachers decided to split the unit into two “chapters” and gave a written assessment for a grade after each chapter. The researcher asked the teachers to compare student learning at this point to learning of previous years’ classes and also to the students’ performance in the first semester of school (the research began as the second semester started). Ms. Marple reported that the students had equal achievement levels when compared to the previous semester as well as previous years’ classes. Ms. Price added,

"As a whole class they did what I thought they would have done (using a traditional method). A few of my top students did not score well. If they had been taught in the traditional way they would have done “A” work. (S. Price, March 28, 2007)

The chapter tests were created for the research, therefore each teacher used the same instrument. Ms. Batts was skeptical about the student performance. Although it was similar to the students’ previous grades she stated, “They would not have been able to pass my test” (M. Batts, personal interview, March 16, 2007).

After the midpoint of the experiment, these views were quite different. When asked about the students’ learning after the study was complete three of the four teachers viewed it as less achievement than a “traditional” class.

- “They learned less than in previous years” (E. Marple, personal interview, March 14, 2007).
- “Their knowledge was below average after chapter 5, but after chapter 4 it was average” (J. Newcomer, personal interview, March 15, 2007).
- “I don’t think they know as much as if I would have taught them (direct instruction)” (M. Batts, personal interview, March 16, 2007).
- “I feel their knowledge was comparable to what it would have been after a traditionally taught unit” (S. Price, personal interview, March 28, 2007).

Interestingly, Ms. Batts (with Ms. Newcomer) and Ms. Marple were so certain the knowledge was less they incorporated two days of review to go back over the objectives using direct instruction. When asked about their students’ knowledge level when they reviewed they had two different responses. Ms. Marple reported that “some of the students understood and some didn’t” (E. Marple, personal interview, March 14, 2007). Ms. Batts on the other hand was pleasantly surprised. “It was different than what I thought when I started to review. I didn’t think they got it, but when I reviewed with
them they got more than I thought and maybe more than they thought they got” (M. Batts, personal interview, March 16, 2007).

These perceptions are quite interesting. Three of the four teachers displayed an obvious dislike for the research at the end of the study. They viewed it as ineffective for student learning, a main goal of their teaching. However these perceptions of learning are in contrast to the quantitative findings. Using a pre/post test design with a 43-item polynomial survey, no statistically significant difference was found in the learning of the experimental and control group. These attitudes and views were possibly a product of the teachers’ comfort with the technique and their inability to constantly assess the students as they do in their traditional approach.

**Teachers Perceptions of Attitudes**

Each teacher stated a goal of their instruction was for their students to like and enjoy math. Their instruction, however, failed to work toward these aims in both their traditional approach and during this study. None of the teachers used the open-response questions (which related math to real life) available to them and no one implemented any real-life problems in their interactions with the students. There was also no observed discussion with students relating the mathematics to the students’ personal lives outside of the mathematics classroom. Understandably, three of the four teachers viewed the students’ attitudes at the end of the study as comparable to their attitudes at the beginning.

- “Their attitudes did not change much” (E. Marple, personal interview, March 14, 2007).
- “Their attitudes were the same as they were before. Their ideas toward the research are worse” (J. Newcomer, personal interview, March 15, 2007).
- “Students seemed to like the approach at first but grew weary of it after they fell behind on the timeline. It seemed they were more annoyed at the end of the study” (S. Price, personal interview, March 28, 2007).

These teachers mentioned the students’ attitudes toward self-regulated learning were worse. This was an interesting comment given the students had probably not encountered self-regulated learning and so there was no baseline from which to form an opinion. The focus of the study was actually on their attitudes toward mathematics. To this end Ms. Batts believed the attitudes declined. She stated, “I don’t think they like math” (M. Batts,
personal interview, March 16, 2007). This is a fascinating result given Ms. Batts and Ms. Newcomer were referring to the same students. Even more interesting were the results of the attitude survey, mentioned above. Using the Attitude Toward Mathematics Inventory (ATMI) (Tapia, 1996), it was found that student attitudes were not statistically significantly different than those of the control group nor from pre- to post-survey.

Conclusions and Implications

While there was no statistically significant difference in the attitudes and achievement of the experiment group in relation to the alternate group (did not receive self-regulated learning treatment), it is nonetheless an encouraging finding. The implementation of the self-regulated learning technique encountered many factors which could have dissipated its effectiveness. The teachers repeatedly regulated the students’ learning through quizzes, timelines, and even direct instruction. This confounded the quantitative results. The teachers also showed no outward signs of encouraging the students through the building of intrinsic motivation. Without this guidance it is unlikely the students saw this form of instruction as different from their normal encounters. There was not any bridging of the mathematics with the students’ lives or future goals. In addition the assessment was not a performance assessment or one of the students’ choosing, thus mandating the student learn the material for procedural knowledge which would lead to high performance on a written exam.

The timeliness and duration of the intervention should also be considered when viewing the results. The intervention occurred for a short six-week period with little development of self-regulation skills prior to the intervention. The students were required to switch from a teacher-directed classroom to a student-centered approach in which they made numerous choices about their learning. Given this substantial change in instruction it is quite impressive the students’ attitudes and achievement were not statistically significantly different than those of the control group. The findings for attitude are similar to other studies completed in mathematics education. While it is hypothesized choice will lead to better attitudes, the qualitative analysis revealed the students were frustrated with the technique, possibly due to their level of preparedness. While the ATMI measured the students’ attitudes toward mathematics in general, some of the students may have used this opportunity to voice their attitudes toward this experiment rather than mathematics in
general. Even so, students still achieved at the same level as with direct instruction and other approaches.

This research provides some interesting ideas for future self-regulated learning research. A longitudinal study of the instruction is needed in order to gain full insight into its effects. It will be important to gradually implement the self-regulated learning instruction and develop the students’ skills before allowing them to fully regulate their own learning. It will also be important for the researcher to fully communicate with the teacher the ideas present in self-regulated learning and their corresponding techniques within the classroom. Working with the instructor to constantly make adjustments to eliminate barriers will be vital. This will give us a better outlook as to how self-regulated learning can be used effectively within the secondary classroom as well as its impact on student attitudes in mathematics.
CHAPTER VI
DISCUSSION, CONCLUSIONS, and RECOMMENDATIONS

Discussion

Normality was assessed for each survey, ATMI and polynomial (pre and post), due to the underlying assumption that needed to be met when using parametric analyses. The conclusion was the scores were normally distributed. Therefore, the researcher was able to conduct parametric analyses on the data.

Attitudes Towards Mathematics Inventory (ATMI)

The reliability and validity of the ATMI instrument was high. These measures were not conducted for this study due to previous research on the instrument. The results of the survey revealed no statistically significant differences in the alternate (did not receive self-regulated learning treatment) and experimental groups in both the pre- and post-surveys. This is a good finding in that the experiment did not negatively affect the students’ attitudes toward mathematics. The bad news is the choice and freedoms they were given did not necessarily lead towards better attitudes toward mathematics. These findings may have been influenced by the lack of instruction toward motivational strategies by the instructors. In individual interactions teachers failed to help the students find areas in which the mathematics would be useful to them. To this end the instruction took the form of normal instruction in which the students learn for the sake of performing well on the assessment without regard for how the mathematics may be useful in their daily lives. Attitudes might have also been influenced by the students’ lack of experience in regulating their learning. The newness of the approach and the lack of the skills needed to be successful could have confounded the results of the attitude survey. Taking all of these things into consideration it is important to realize the lack of statistically significant differences revealed the instruction did not harm the students, but rather maintained the status quo. This maintenance was revealed in an ANOVA test of the ATMI.

The only statistically significant predictors of attitude were prior attitude and the students’ involvement in Integrated Math, a previous math course some students took. Previous findings confirm prior attitude is a predictor of later attitude (Ma & Xu, 2004). The second result of an individual course, Integrated Math, creating a difference is somewhat muddled by the control a teacher has on this variable. It may be that this
course contained a fair amount of regulation by the students and therefore their attitudes were increased during this experiment.

*Polynomial Survey*

The polynomial survey was scored for correct responses. Item-response theory was used to analyze each individual question and determine its discrimination, difficulty level, and distractors. Due to the research design the researcher could not remove items; however, the analysis showed only minimal gains in alpha for the removal of a few items on the pre-survey and post-survey. The student was then given a total composite score that was compared between pre- and post-survey. The researcher analyzed gains as well as ending knowledge in comparison with the control group. The survey was developed using district assessments and teacher input. The items directly corresponded with the objectives in the student rubric, giving the survey content validity in this specific instance.

The survey included demographic questions. These were used as independent variables in the analysis of data for both the attitude and polynomial surveys. Links between gender, class, age, previous course and grade information, and ethnicity were analyzed.

Results were inconclusive since the ANOVA test failed to meet the homogeneity of variances requirements. Despite the teachers’ perceptions that the students did worse then they would have normally, analysis showed means that were less than one point difference between the alternate (did not receive the treatment of self-regulated learning) and experimental groups. The students’ unfamiliarity with the technique and their dependence on the teacher for regulation in normal instruction give a positive outlook to these findings. It is hypothesized with more use of the self-regulated learning technique, students would see more achievement gains. Comparison of the experimental group’s pre- and post-survey scores revealed an overall statistically significant gain in achievement during the experiment. We can conclude that self-regulated learning is a valid instructional technique that can be used effectively in the secondary classroom. The effectiveness of the technique is in question, however, due to the teachers’ constant use of regulation strategies. It is unclear whether these strategies helped the students to achieve or were a hindrance to self-regulated learning’s effectiveness.
**Perceptions**

The teachers’ attitudes toward the instructional technique were less than ideal at the end of the study. Three of the teachers were visibly frustrated and wanted to return to their preferred method of instruction, namely direct instructional techniques. They perceived the instruction to be ineffective and detrimental to their goals. However, the technique actually aligned with their goals of making mathematics worthwhile to their students and preparing their students for their futures. The teachers’ comfort level influenced the teachers greatly. They did not know how to facilitate properly or how to guide students in self-regulated learning. Their skill set in relation to this technique was lacking. Therefore, they felt disconnected from the students as if they were not instructing. This change in role was foreign to them and their need for control and organization created a strong dislike for the approach. This dislike clouded their judgment of the students’ attitudes and achievement during the instruction. It also resulted in the students not receiving the guidance necessary for the approach to be successful.

**Barriers**

These teachers’ perceptions led to many barriers to self-regulation and its effectiveness as an instructional technique. Teachers consistently used regulation strategies. While the teachers claimed the students were dependent upon them, the teachers also forced themselves into the students’ process. Constantly prodding the students to be on task and assessing the students through a written test allowed the teacher to remain in control of the process, creating a level of comfort in the instruction. The timeline was used to this end, and the quizzes allowed the teacher to assess and evaluate daily. Foremost the students’ choice of learning approaches was hindered by the lack of resources and the written assessment. The teachers’ choice of assessment led students to learn procedures rather than trying to understand the concepts and integrating them into their knowledge structures.

The teachers were able to facilitate learning with individuals and small groups. However, their approach to these interactions did not promote the students to regulate their learning. Only one teacher asked questions of the students and tried to guide them in their learning. The remaining teachers seized the opportunity as a chance to directly
instruct thus maintaining the students’ dependence upon the teacher and allowing the teacher control over the learning situation. These instances of control were a constant barrier to the students’ self-regulation.

The experiment time and circumstances also created a barrier. The short time of the intervention did not allow for proper preparation of the students for a new approach involving new tasks and responsibilities. Instead, the students were simply put in the situation and asked to do the best they could with the skills they possessed. Some students were more adept at this than others. This time constraint does not follow the tenets of self-regulated learning. Students must be allowed to learn at their own rate and complete their work as they can. This time constraint resulted in students being forced into assessments they were not prepared for. This possibly caused a decrease in attitude and a decrease in achievement overall.

Conclusions

The data analysis revealed statistically significant student achievement gains while also seeing student attitudes decrease (although the decrease was not statistically significant). This finding duplicates the results of Ma and Xu (2004). While this does not seem to be a good result, the implication of using self-regulated learning gives this result more clout. Despite the introduction of a new approach, self-regulated learners achieved at a level equivalent to a typical instructional group.

The instructional technique used was not pure in any sense. Butler (2002) lists several keys to instruction with self-regulation. They include the teacher listening to and making sense of the students understanding as well as having the students articulate their ideas in their own words and projects. None of these ideas were implemented with any frequency during this project.

The students were required by the teachers to complete their work with 100% mastery. According to Ma and Xu (2004), this increase in success should lead to better attitudes toward math. However, this was not evident in the study. There was no evidence the students viewed this as a success since the written assessments provided the students with an opportunity to have negative feelings and failure in mathematics.

Results showed that motivational patterns were learned, and more importantly students learned to dislike mathematics (Middleton & Spanias, 1999). Of great
importance to educators was the strong effect of motivation, attitude, and engagement on success in mathematics (Singh et al., 2002). This study lacked any signs of teachers guiding motivational patterns. No real-life problems were implemented and the teachers failed to make connections between the mathematics and the students’ lives and goals. Failing to do so most likely resulted in lower attitudes toward mathematics.

In order for self-regulation to be effective students must evaluate their own learning (Butler, 2002). This experiment was filled with regulation and evaluation by the teacher. Instead of allowing the students this control, the teachers continued to tell the students when they had learned the objectives sufficiently and directed the students in how they could share this new knowledge. This limited the students’ abilities to choose their preferred method of learning and did not reduce test anxiety or stereotype threat as was hoped (Steele, 1997).

**Recommendations**

Further research is need on mathematics attitudes and achievement and their subsequent relationship. Also, research on self-regulated learning in the mathematics classroom is in dire need. There is a lack of literature on self-regulated learning in general, and even more so in the classroom. Most of the literature available concentrates on the skills and abilities that help regulate, but no specific instructional techniques have been outlined for practicing teachers to use.

A longitudinal study of self-regulated learning and its subsequent impact on attitude and achievement in mathematics is warranted based on the findings of this study. It will be essential to choose a teacher that is willing to be flexible and would be comfortable in the role of facilitator. It will also be necessary for the researcher to continually monitor and guide the teacher in their activities within the classroom. The study should begin with a gradual implementation of self-regulation so the students have the opportunity to adjust and develop their self-regulation skills. This will give the teacher time to adjust to this new instructional approach and become more comfortable, especially with the development of intrinsic motivation. It will also give the researcher the ability to address concerns that arise prior to full self-regulation occurring. This study will provide concrete results as to the effectiveness of self-regulation as an instructional
technique within the secondary mathematics classroom in regards to achievement and attitude.
REFERENCES


APPENDIX A
Polynomial Survey

Name: ___________________________ Teacher: ___________________________

Date: ___________________________ Block: ___________________________

Background Information

What is your gender?

___ Male
___ Female

What is your age? _______________

What is your current grade level? _______________

What math course did you take last school year? _______________

What grade did you receive in your math course last year? _____________

What is your ethnic background?

___ American Indian or Alaskan Native
___ Asian or Pacific Islander
___ African American
___ Hispanic/Latino
___ White (Non-Hispanic)
___ Other or prefer not to answer

Please answer the following questions to the best of your ability. Please try to show all your work on this survey. If you are unable to, attach all additional work to the back of the test. Thank you!

1. Write the expression \( r \cdot r \cdot s \cdot 4 \cdot s \cdot s \) in exponential form.

   a) \( 4r^2s^3 \)
   b) \( 4rs \)
   c) \( r^2s^4s^2 \)
   d) \( r^34s^2 \)

2. Choose the correct exponent and base for \( 5^2 \).

   a) Base = 5, Exponent = 2
   b) Base = 2, Exponent = 5

---

1 The questions on this survey closely and accurately follow the County Curriculum Map where the research was conducted. It in no way represents the views of the researcher, the University of Kentucky, or its faculties as to its mathematical accuracy.
3. Evaluate $5a^2b$ when $a = 4$ and $b = -3$.
   a) 120  b) -240  c) 180  d) -180

4) Multiply $5x^2$ by $7y$.
   a) $5xy$  b) $35xy^2$  c) $35x^2$  d) $35x^2y$

5) Which of these is a polynomial?
   a) $3x^2$  b) $2x^2 + 1$  c) $x$  d) $2p^3$

6) What is the degree of the polynomial in #5?
   a) 1  b) 2  c) 3  d) 4

7) Write this polynomial in standard form: $3 + 7x^2 - 3x^3 + x$
   a) $7x^2 - 3x^3 + 3 + x$  b) $x + 3 - 3x^2 + 7x^2$  c) $-3x^3 + 7x + 3 + x$  d) $-3x^3 + 7x^2 + x + 3$

8) Simplify the expression $(7n - 6) + (2n + 1)$.
   a) $9n - 5$  b) $9n + 7$  c) $5n - 5$  d) $5n - 7$

9) Simplify the expression $(7n - 6) - (2n + 1)$.
   a) $9n - 5$  b) $9n + 7$  c) $5n - 5$  d) $5n - 7$

10) Multiply $(5a^3b)(2ab^2)$.
    a) $5a^4b^3$  b) $10ab$  c) $2a^4b^3$  d) $10a^4b^3$

11) Multiply $(4x^3)(10x)$.
    a) $40x^4$  b) $10x^3$  c) $40x$  d) $4x^4$

12) Simplify $(x^2)^4(x^3)$
    a) $x^9$  b) $x^{24}$  c) $x^{11}$  d) $x^{14}$

13) Multiply $x(3x + 2)$.
    a) $3x^2 + 2$  b) $4x + 2$  c) $3x^2 + 2x$  d) $5x^2$
14) Multiply \((3k - 7)(k + 1)\).
   a) \(3k^2 - 7\)  
   b) \(3k^2 - 6k - 7\)  
   c) \(3k - 7\)  
   d) \(3k^2 - 6k\)

15) Solve the following equation for \(y\): \(y - 3 = 4(x - 2)\)
   a) \(4x - 5\)  
   b) \(4x - 11\)  
   c) \(4x + 1\)  
   d) \(4x - 1\)

16) Simplify \((3x + 7)^2\).
   a) \(6x + 14\)  
   b) \(9x^2 + 49\)  
   c) \(6x + 7x + 49\)  
   d) \(9x^2 + 42x + 49\)

17) Solve \(A = s^2 + 2rs\) for \(r\). Are there any restrictions?
   a) yes  
   b) no

18) Jan can run at 7.5 m/s and Mary at 8.0 m/s. On a race track Jan is given a 25 m head start, and the race ends in a tie. How long is the track?
   a) 25 m  
   b) 50 m  
   c) 100 m  
   d) 400 m

19) List all the positive factors of 32
   a) 1, 2, 8, 32  
   b) 4, 8, 16  
   c) 1, 2, 32  
   d) 1, 2, 4, 8, 16, 32

20) Find the prime factorization of 32
   a) \(2 \cdot 2 \cdot 2 \cdot 3\)  
   b) \(2 \cdot 2 \cdot 2 \cdot 2 \cdot 2\)  
   c) \(2 \cdot 4 \cdot 4\)  
   d) \(4 \cdot 8\)

21) Find the GCF for 45 and 60
   a) 180  
   b) 20  
   c) 5  
   d) 15

22) Simplify \(\frac{-20x^3y}{15xy^4}\)
   a) \(\frac{-4x^2}{3y^3}\)  
   b) \(\frac{-4}{3}x^2y^3\)  
   c) \(\frac{-3x^2}{4y^3}\)  
   d) \(\frac{-3}{4}x^2y^3\)

23) Find the missing factor: \(12a^2b = (4a)\) (?)
   a) \(8a^2b\)  
   b) \(8ab\)  
   c) \(3ab\)  
   d) \(3a^2b\)
24) Find the GCF of $12x^2yz^3$ and $20x^2y^2z^2$.
   a) $4x^2yz^2$    b) $4x^2y^2z^2$    c) $4xyz$    d) $60x^2y^2z^2$

25) Divide $(25x - 20)$ by 5.
   a) $25x - 4$    b) $5x - 20$    c) $20x - 15$    d) $5x - 4$

26) Factor: $5a^3 + 25a^2$
   a) $5a^2(a + 5)$    b) $5(a^3 + 5^2)$    c) $5a^2(a^2 + 25)$    d) $5a(a^2 + 5a)$

27) Multiply $(a + b) (a - b)$
   a) $2a$    b) $a^2 - b^2$    c) $2a - 2b$    d) $a^2 + b^2$

28) Factor $(x^2 - 25)$.
   a) $(x + 5) (x - 5)$    b) $(x - 5)^2$    c) $(x + 5)^2$    d) $x(x - 25)$

29) Find $(x + 3)^2$
   a) $x^2 + 9$    b) $x^2 + 9x + 9$    c) $x + 9x$    d) $x^2 + 6x + 9$

30) Is $x^2 + 5x + 4$ a perfect square trinomial?
   a) yes    b) no

31) Factor $(x^2 + 8x + 16)$.
   a) $(x + 4) (x - 4)$    b) $(x + 8)^2$    c) $(x + 4)^2$    d) $(x + 8) (x - 8)$

32) Correctly label this polynomial: $2x^3 + 5$
   a) monomial    b) binomial    c) trinomial    d) none of the these

33) Factor $x^2 + 5x + 4$.
   a) $(x + 1) (x + 4)$    b) $x(x + 4)$    c) $(x - 1) (x + 4)$    d) $(x + 1) (x - 4)$

34) Factor $x^2 + 3x - 4$.
   a) $(x + 1) (x + 4)$    b) $x(x + 4)$    c) $(x - 1) (x + 4)$    d) $(x + 1) (x - 4)$
35) Is $5x - 3$ a prime polynomial?
   a) yes  b) no

36) Factor $2x^2 + 7x - 9$.
   a) $(x - 3)^2$  b) $(2x + 9)(x - 1)$  c) $(2x - 9)(x - 1)$  d) $(2x + 9)(x + 1)$

37) Factor $a(a - 2) + 3(a - 2)$.
   a) $(a + 3)(a - 2)$  b) $3a(a - 2)$  c) $3a^2(a - 2)$  d) $(a - 3)(a + 2)$

38) Which of these is the opposite of $3x - y$?
   a) $-(3x - y)$  b) $y - 3x$  c) both of these  d) neither of these

39) Factor: $y^4 - 2y^2 - y^3$
   a) $-3y^9$  b) $y(-2y - y^2)$  c) $y^2(y^2 - 2 - y)$  d) $y(y - 2)$

40) Solve $(y + 7)(y - 5) = 0$
   a) $y = 7$  b) $y = 5$  c) $y = -7, y = -5$  d) $y = -7, y = 5$

41) What type of equation is $2x^2 + 5x + 4 = 0$
   a) linear  b) quadratic  c) cubic  d) none of these

42) Is $8x = 8$ in standard form?
   a) yes  b) no

43) The length of a rectangle is 8 cm greater than its width. Find the dimensions of the rectangle if its area is 105 cm$^2$.
   a) $7 \text{ cm} \times 15 \text{ cm}$  b) $8 \text{ cm} \times 9 \text{ cm}$  c) $10 \text{ cm} \times 18 \text{ cm}$  d) $5 \text{ cm} \times 13 \text{ cm}$
APPENDIX B
Attitudes Toward Mathematics Inventory (ATMI)

Name: ____________________________    Teacher: ____________________________

Date:______________________________    Block: _____________________________

Directions: This inventory consists of statements about your attitude toward mathematics. There are no correct or incorrect responses. Read each item carefully. Please think about how you feel about each item. Circle the letter that most closely corresponds to how the statements best describes your feelings. Use the following response scale to respond to each item.

PLEASE USE THESE RESPONSE CODES:  
A – Strongly Disagree
B – Disagree
C – Neutral
D – Agree
E – Strongly Agree

1. Mathematics is a very worthwhile and necessary subject.
   A    B   C   D     E
   Strongly Disagree Disagree Neutral Agree  Strongly Agree

2. I want to develop my mathematical skills.
   A    B   C   D     E
   Strongly Disagree Disagree Neutral Agree  Strongly Agree

3. I get a great deal of satisfaction out of solving a mathematics problem.
   A    B   C   D     E
   Strongly Disagree Disagree Neutral Agree  Strongly Agree

4. Mathematics helps develop the mind and teaches a person to think.
   A    B   C   D     E
   Strongly Disagree Disagree Neutral Agree  Strongly Agree
5. Mathematics is important in everyday life.

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6. Mathematics is one of the most important subjects for people to study.

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7. High school math courses would be very helpful no matter what I decide to study.

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8. I can think of many ways that I use math outside of school.

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9. Mathematics is one of my most dreaded subjects.

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10. My mind goes blank and I am unable to think clearly when working with mathematics.

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11. Studying mathematics makes me feel nervous.

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12. Mathematics makes me feel uncomfortable.

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13. I am always under a terrible strain in a math class.

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14. When I hear the word mathematics, I have a feeling of dislike.

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15. It makes me nervous to even think about having to do a mathematics problem.

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16. Mathematics does not scare me at all.

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17. I have a lot of self-confidence when it comes to mathematics

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18. I am able to solve mathematics problems without too much difficulty.

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19. I expect to do fairly well in any math class I take.

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<tbody>
<tr>
<td></td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Neutral</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
</tbody>
</table>

20. I am always confused in my mathematics class.

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<td>Disagree</td>
<td>Neutral</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
</tbody>
</table>
21. I feel a sense of insecurity when attempting mathematics.

   A    B   C   D     E
   Strongly Disagree Disagree Neutral Agree Strongly Agree

22. I learn mathematics easily.

   A    B   C   D     E
   Strongly Disagree Disagree Neutral Agree Strongly Agree

23. I am confident that I could learn advanced mathematics.

   A    B   C   D     E
   Strongly Disagree Disagree Neutral Agree Strongly Agree

24. I have usually enjoyed studying mathematics in school.

   A    B   C   D     E
   Strongly Disagree Disagree Neutral Agree Strongly Agree

25. Mathematics is dull and boring.

   A    B   C   D     E
   Strongly Disagree Disagree Neutral Agree Strongly Agree

26. I like to solve new problems in mathematics.

   A    B   C   D     E
   Strongly Disagree Disagree Neutral Agree Strongly Agree

27. I would prefer to do an assignment in math than to write an essay.

   A    B   C   D     E
   Strongly Disagree Disagree Neutral Agree Strongly Agree

28. I would like to avoid using mathematics in college.

   A    B   C   D     E
   Strongly Disagree Disagree Neutral Agree Strongly Agree
29. I really like mathematics.

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<th>A</th>
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<td>Disagree</td>
<td>Neutral</td>
<td>Agree</td>
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</table>

30. I am happier in a math class than in any other class.

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<tr>
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<td>Neutral</td>
<td>Agree</td>
<td>Strongly Agree</td>
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</table>

31. Mathematics is a very interesting subject.

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<td>Neutral</td>
<td>Agree</td>
<td>Strongly Agree</td>
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</table>

32. I am willing to take more than the required amount of mathematics.

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<td>Disagree</td>
<td>Neutral</td>
<td>Agree</td>
<td>Strongly Agree</td>
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</tbody>
</table>

33. I plan to take as much mathematics as I can during my education.

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<td>Disagree</td>
<td>Neutral</td>
<td>Agree</td>
<td>Strongly Agree</td>
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</tbody>
</table>

34. The challenge of math appeals to me.

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<td>Disagree</td>
<td>Neutral</td>
<td>Agree</td>
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</tbody>
</table>

35. I think studying advanced mathematics is useful.

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<td>Disagree</td>
<td>Neutral</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
</tbody>
</table>

36. I believe studying math helps me with problem solving in other areas.

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<th>D</th>
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<td>Disagree</td>
<td>Neutral</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
</tbody>
</table>
37. I am comfortable expressing my own ideas on how to look for solutions to a difficult problem in math.

A  B  C  D  E
Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

38. I am comfortable answering questions in math class.

A  B  C  D  E
Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

39. A strong math background could help me in my professional life.

A  B  C  D  E
Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

40. I believe I am good at solving math problems.

A  B  C  D  E
Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

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APPENDIX C
List of Objectives for Polynomials

<table>
<thead>
<tr>
<th>Section</th>
<th>Part</th>
<th>Objective</th>
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<tbody>
<tr>
<td>4.1</td>
<td>A</td>
<td>The student will be able to simplify expressions involving exponents and write them in proper exponential form</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>The student will be able to define and identify an exponent and its base</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>The student will be able to evaluate expressions with exponents when given the unknown values</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>The student will be able to multiply one variable expressions</td>
</tr>
<tr>
<td>4.2</td>
<td>A</td>
<td>The student will be able to define polynomial and give an example</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>The student will be able to define the degree of a term</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>The student will be able to define the degree of a polynomial</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>The student will be able to describe the standard form of a polynomial and organize a polynomial in this form</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>The student will be able to add polynomials vertically</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>The student will be able to add polynomials horizontally</td>
</tr>
<tr>
<td></td>
<td>G</td>
<td>The student will be able to subtract polynomials vertically</td>
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<tr>
<td></td>
<td>H</td>
<td>The student will be able to subtract polynomials horizontally</td>
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<tr>
<td></td>
<td>I</td>
<td>The student will be able to define a monomial and generate an example</td>
</tr>
<tr>
<td></td>
<td>J</td>
<td>The student will be able to define a binomial and generate an example</td>
</tr>
<tr>
<td></td>
<td>K</td>
<td>The student will be able to define a trinomial and generate an example</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>The student will be able to identify the coefficients in a polynomial</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>The student will be able to collect like terms within one or more algebraic expressions</td>
</tr>
<tr>
<td>Section</td>
<td>4.3</td>
<td>4.4</td>
</tr>
<tr>
<td>---------</td>
<td>-----</td>
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</tr>
<tr>
<td>A</td>
<td>The student will be able to multiply a monomial by a monomial using algebra tiles.</td>
<td>The student will be able to raise a power to a power within a monomial in order to simplify the expression.</td>
</tr>
<tr>
<td>B</td>
<td>The student will be able to multiply a monomial by a monomial using the distributive property.</td>
<td>The student will be able to use the laws of exponents to simplify monomial algebraic expressions.</td>
</tr>
<tr>
<td>C</td>
<td>The student will be able to multiply monomial expressions with the same base.</td>
<td></td>
</tr>
<tr>
<td>4.4</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>4.5</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>4.6</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>4.7</td>
<td>A</td>
<td>B</td>
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<tr>
<td>4.9</td>
<td>A</td>
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</tr>
<tr>
<td>B</td>
<td>The student will be able to draw a picture correctly representing a given word problem involving geometric shapes and polynomials</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>The student will be able to correctly elicit pertinent information from a given word problem</td>
<td></td>
</tr>
<tr>
<td>5.1</td>
<td>A</td>
<td>The student will be able to list all pairs of factors for a given integer</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>The student will be able to find the prime factorization of a given value</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>The student will be able to define and list prime numbers</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>The student will be able to identify common factors for two or more integers</td>
</tr>
<tr>
<td></td>
<td>E</td>
<td>The student will be able to identify the greatest common factor (GCF) for two or more integers</td>
</tr>
<tr>
<td>5.2</td>
<td>A</td>
<td>The student will be able to divide and simplify monomial expressions</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>The student will be able to find the greatest common factor (GCF) of several monomials</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>The student will be able to find the missing factor when given a polynomial and a factor</td>
</tr>
<tr>
<td>5.3</td>
<td>A</td>
<td>The student will be able to divide polynomials by monomials</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>The student will be able to find monomial factors of polynomials</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>The student will be able to define the greatest monomial factor and find it for a given polynomial</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>The student will be able to find areas of geometric shapes by factoring polynomial expressions</td>
</tr>
<tr>
<td>5.5</td>
<td>A</td>
<td>The student will be able to find the product of the sum and difference of two terms</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>The student will be able to factor an expression that is the difference of two squares</td>
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<tr>
<td>5.6</td>
<td>A</td>
<td>The student will be able to find the square of a binomial using algebra tiles</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>The student will be able to find the square of a binomial using the distributive property</td>
</tr>
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<td>---</td>
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</tr>
<tr>
<td>C</td>
<td>The student will be able to define, identify and create perfect square trinomials</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>The student will be able to factor perfect square trinomials</td>
<td></td>
</tr>
<tr>
<td>5.7</td>
<td>A</td>
<td>The student will be able to factor quadratic trinomials whose quadratic coefficient is 1 and whose constant term is positive using factor pairs</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>The student will be able to factor quadratic trinomials whose quadratic coefficient is 1 and whose constant term is positive using algebra tiles</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>The student will be able to define and identify a prime polynomial</td>
</tr>
<tr>
<td>5.8</td>
<td>A</td>
<td>The student will be able to factor quadratic trinomials whose quadratic coefficient is 1 and whose constant term is negative using factor pairs</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>The student will be able to factor quadratic trinomials whose quadratic coefficient is 1 and whose constant term is negative using algebra tiles</td>
</tr>
<tr>
<td>5.9</td>
<td>A</td>
<td>The student will be able to factor general quadratic trinomials with integral coefficients using factor pairs</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>The student will be able to factor general quadratic trinomials with integral coefficients using algebra tiles</td>
</tr>
<tr>
<td>5.10</td>
<td>A</td>
<td>The student will be able to factor a polynomial by grouping terms</td>
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<td></td>
<td>B</td>
<td>The student will be able to recognize factors that are the opposite of each other</td>
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<tr>
<td>5.11</td>
<td>A</td>
<td>The student will be able to factor a polynomial completely using a variety of methods</td>
</tr>
<tr>
<td>5.12</td>
<td>A</td>
<td>The student will be able to state the zero-product property</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>The student will be able to use the zero-product property to solve polynomial equations</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>The student will be able to label linear, quadratic, and cubic equations</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>The student will be able to write a polynomial equation in standard form</td>
</tr>
<tr>
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<td>E</td>
<td>The student will understand the concept of a multiple root</td>
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<tr>
<td><strong>5.13</strong></td>
<td><strong>A</strong></td>
<td>The student will be able to solve real-life problems involving areas of geometric shapes and polynomial equations</td>
</tr>
<tr>
<td></td>
<td><strong>B</strong></td>
<td>The student will be able to draw a picture correctly representing a given word problem involving geometric shapes and polynomial equations</td>
</tr>
<tr>
<td></td>
<td><strong>C</strong></td>
<td>The student will be able to correctly elicit pertinent information from a given word problem involving polynomial equations</td>
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### APPENDIX D

#### Student Resource Guide

<table>
<thead>
<tr>
<th>Section</th>
<th>Part(s)</th>
<th>Resource</th>
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</thead>
</table>
| 4.1     | A, B, C, D               | McDougal Little Algebra Structure and Method, pg. 141-142  
1. Prentice Hall Algebra, pg. 15-18  
| Suggested Exercises | McDougal Little Algebra Structure and Method, pg. 143-144  
#1-19, 24-35, 40-49 |
| 4.2     | A,B,C,D                  | McDougal Little Algebra Structure and Method, pg. 146-147  
4. Prentice Hall Algebra, pg. 465  
5. McDougal Little Algebra I, pg. 576  
6. [www.purplemath.com/modules/polydefs.htm](http://www.purplemath.com/modules/polydefs.htm)  
| 4.2     | E, F                     | McDougal Little Algebra Structure and Method, pg. 146-147  
4. Prentice Hall Algebra, pg. 465-466  
5. McDougal Little Algebra I, pg. 577, 579  
| 4.2     | G,H                      | McDougal Little Algebra Structure and Method, pg. 146-147  
4. Prentice Hall Algebra, pg. 466-467  
5. McDougal Little Algebra I, pg. 577-578  
11. [http://regentsprep.org/Regents/Math/polyadd/sp_subt.htm](http://regentsprep.org/Regents/Math/polyadd/sp_subt.htm) |
| 4.2     | I, J, K, L, M            | McDougal Little Algebra Structure and Method, pg. 146-147  
4. Prentice Hall Algebra, pg. 465  
5. McDougal Little Algebra I, pg. 576  
| Suggested Exercises | McDougal Little Algebra Structure and Method, pg. 148-150  
#1-20, 31-36, 41-44, 49-52 and Problems 1-4 (pg 150) |
| 4.3  | A       | McDougal Little Algebra Structure and Method, pg. 152-153  
|      |         | 14. Prentice Hall Algebra, pg. 470  
|      |         | 15. McDougal Little Algebra I, pg. 584  
|      |         | 16. [http://www.iit.edu/~smile/ma8711.html](http://www.iit.edu/~smile/ma8711.html)  
|      |         | 17. [http://www.delmar.edu/aims/Files/Presentations/David_Let's%20Do%20Algebra%20Tiles.ppt](http://www.delmar.edu/aims/Files/Presentations/David_Let's%20Do%20Algebra%20Tiles.ppt)  
| 4.3  | B       | McDougal Little Algebra Structure and Method, pg. 152-153  
|      |         | 14. Prentice Hall Algebra, pg. 470  
|      |         | 15. McDougal Little Algebra I, pg. 584-585  
| 4.3  | C       | McDougal Little Algebra Structure and Method, pg. 152-153  
|      |         | 17. [http://www.delmar.edu/aims/Files/Presentations/David_Let's%20Do%20Algebra%20Tiles.ppt](http://www.delmar.edu/aims/Files/Presentations/David_Let's%20Do%20Algebra%20Tiles.ppt)  
| Suggested Exercises | McDougal Little Algebra Structure and Method, pg. 153-154  
|      |         | #1-37, 41-46  
| 4.4  | A, B    | McDougal Little Algebra Structure and Method, pg. 155  
|      |         | 18. McDougal Little Algebra I, pg. 450-451  
| Suggested Exercises | McDougal Little Algebra Structure and Method, pg. 156-157  
|      |         | #1-16, 24-30, 33, 35, 51, 52  
| 4.5  | A       | McDougal Little Algebra Structure and Method, pg. 158, 689, 690  
|      |         | 17. [http://www.delmar.edu/aims/Files/Presentations/David_Let's%20Do%20Algebra%20Tiles.ppt](http://www.delmar.edu/aims/Files/Presentations/David_Let's%20Do%20Algebra%20Tiles.ppt)  
|      |         | 22. [http://plato.acadiau.ca/COURSES/Educ/Reid/Virtual-manipulatives/tiles/tiles.html](http://plato.acadiau.ca/COURSES/Educ/Reid/Virtual-manipulatives/tiles/tiles.html)  
|      |         | 23. [http://nlvm.usu.edu/en/nav/frames_asid_189_g_4_t_2.html?open=activities](http://nlvm.usu.edu/en/nav/frames_asid_189_g_4_t_2.html?open=activities) (web only)  

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<th>Section</th>
<th>Exercises</th>
<th>Notes</th>
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<td>Suggested Exercises</td>
<td>McDougal Little Algebra Structure and Method, pg. 159-160 #5-12, 23-32, 37-40, 46</td>
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<tr>
<td>Mandatory Exercise</td>
<td>30. Open Response Question : Floor Plan</td>
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<td>Day</td>
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<td>B Block</td>
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APPENDIX F
Questions for Teacher Interviews Prior to Research

1. Please tell me why you decided to become a mathematics teacher.
   a. When did you know you wanted to be a teacher?
   b. Why did you choose to be a teacher?
   c. What drew you to the subject of mathematics?

2. What do you hope to accomplish as a teacher?

3. How do you think the self-regulated learning instructional method is going to affect your students?

4. Do you believe your students will be successful in achieving all of the objectives with the self-regulated learning instructional technique? Why or why not?

5. Why did you agree to do this research?

6. Do you think this research will help you to become a better teacher?
   a. What do you hope to gain from it?
APPENDIX G
Teacher Survey Questions

1. Please describe your typical class period from beginning to end.

2. What is involved in lesson planning for you?
   a. How much time do you typically spend developing your plans?

3. What types of assessment do you use?
   a. Why do you choose these assessments?
   b. Do you take daily grades?
   c. Do you use quizzes?
   d. How much importance do you place on cumulative assessments?

4. How do you view mathematical knowledge?
   a. Is it something to be transferred or to be developed?

5. Do you use different instructional (teaching) techniques in your classroom? Why?
APPENDIX H
Teacher Post-Interview Questions

1. What is self-regulated learning?
2. In general, what if anything, do you think was gained by your students in this research?
3. What was the most challenging thing for you in this research project?
4. What part(s) of self-regulated learning, in particular this design, do you feel are not feasible for freshman students?
5. How difficult was it for you to give up control of the classroom?
6. (Marple) You started with journals and they quickly went away. Why did you decide not to use them?
7. (Marple) In the first observation you were exhausted at the end of the period. Did the changes made help with this? Do you think that they were as effective as the structure you had before the change?
8. I didn’t view many students using the resource guide. Do you have any ideas why this was the case? How could we have better introduced these to the students?
9. (Batts) You were constantly keeping the students on task through comments and prodding. Why did you feel this was necessary? Is this a form of regulation?
10. (Batts) There was an incident where you disciplined a student for being off-task. Later on in the period you started talking about lunch with the entire class. How did you view this? Are you ok with the students being off-task?
11. Do you believe the quizzes you were giving the students were regulating their learning? What was your purpose in using them? How much time did students spend taking these quizzes?
12. (Price) You started with a funny arrangement of chairs. What was your intention with this design? Why did you change back to a more formal arrangement?
13. (Price) You used an exit slip with your students. Was this successful? What were you able to gather from this approach?
14. Were you comfortable in being a facilitator? What approach did you use when students asked for help? Did you seek out students or wait for them to come to you? Why?
15. Did you use the open-response questions? Why or why not? I viewed this as a valuable opportunity to apply the mathematics to a real-world problem. Do you think this would have helped with the students’ motivation?

16. At about the midpoint we changed the quiz structure. Was this helpful? How did it change class for you and your students?

17. Algebra tiles were a large part of this unit. Do you think they are necessary? What is the point in having the students use them? How did your students view the tiles?

18. I saw the students draw algebra tiles but rarely if ever get the sets out. What problems does this pose?

19. The first test scores were similar to previous grades for all the classes. What were your thoughts at this time? What were your perceptions of your student’s attitudes toward math and toward the research at this time?

20. Throughout the research students rarely worked practice problems. What are some reasons for this?

21. How do you think we can better prepare students for self-regulated learning? What are the prerequisite skills they need?

22. (Batts) A lot of your time was taken with management issues. Did you feel like you were doing a lot of extra work?

23. (Batts) You stated in front of the students that you wouldn’t be extending the instructional technique. Do you think this had any affect on the students’ attitudes and work in the research? Why were you not going to extend the research? The data has yet to be analyzed so we’re not sure whether it was successful or not.

24. What would you consider a success for this instructional technique?

25. (Price) You added materials to the resources the researcher provided. Why did you do this? What were the results?

26. (Price) You seemed very comfortable as a facilitator. Did you feel comfortable? You expressed you weren’t sure if you were reaching everyone. Do you still feel this way?

27. (Price) Your bulletin boards are full except for this class. Is there a reason you decided not to place anything for your Algebra class?
28. Students often said they would rather the teacher teach them? What do you make of this? What do you provide that the research technique did not provide? Why do you think students struggle with this?

29. (Batts) You used a high-level approach to factoring that was very abstract with students. I must confess it took me a while to figure out what you were doing and why it worked. Why were you timid in using the algebra tiles which are much more concrete and can help develop conceptual understanding rather than abstract algebraic manipulations?

30. (Batts & Marple) I know you planned to review the chapters with the students. What was your impression of their knowledge when you did this? How do you think the students perceive this?

31. At the beginning I suggested allowing the students to negotiate a way to show you their knowledge rather than a test. Why do you think I made this suggestion? Why were you opposed to it?

32. Students were constantly on or behind pace. What do you think caused this? Would it have been different if we didn’t give them a timeline? Do you think your students learned “the hard way” after the first chapter?

33. What did you gain from participating in this research? What will you use in your classroom in the future?

34. What parts of the technique did you view as a failure and why do you think that they failed?

35. Do you view self-regulation as something students need to be able to do? Does this align with your goals for teaching?

36. In conclusion, what are your views on your students’ mathematical attitudes now? How would you rate their knowledge on the unit of study?
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EDUCATIONAL EXPERIENCE

University of Kentucky M.S., Education, 2004. Emphasis in Mathematics Education. Lexington, Kentucky
Under the direction of Dr. Doug Jones.
Centre College B.S., Mathematics, 2002. Danville, Kentucky
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PROFESSIONAL POSITIONS

2003-present Teaching and Research Assistant in Curriculum and Instruction, University of Kentucky, Lexington, Kentucky
Fall 2005-presents Director of Undergraduate Secondary Mathematics Education Advising, University of Kentucky, Lexington, Kentucky
Fall 2003-present Mathematics Substitute Teacher for Pulaski County, Fayette County and Lincoln County School Districts
2006-present Booker T. Washington Elementary School Research Consultant, Fayette County School District and University of Kentucky, Lexington, Kentucky
Summer 2006 Research Assistant and Consultant, University of Kentucky, Lexington, Kentucky
Fall 2005 Secondary Mathematics Teacher, Pulaski County School District, Somerset, Kentucky
Spring 2005 Research consultant for Appalachian Mathematics and Science Partnership (AMSP), University of Kentucky, Lexington, Kentucky
2002-2003 Secondary Mathematics Teacher, Lincoln County School District, Stanford, Kentucky
SCHOLASTIC AND PROFESSIONAL HONORS

- Department of Curriculum and Instruction Graduate Teaching and Research Assistantship/Scholarship, Tuition + Benefits, University of Kentucky, 2003-2007
- NSCAA High School Team Academic Award, Pulaski County High School, 2005
- UK-COE Graduate Scholarship, $500, University of Kentucky, 2004
- Order of Omega Academic Scholarship, $500, Centre College, 2002
- SCAC Academic Honor Roll, Centre College Baseball Team, 1999, 2002

PROFESSIONAL MEMBERSHIPS

- National Council of Teachers of Mathematics (NCTM)
- American Educational Research Association
- Kappa Delta Pi Honor Society
- National Soccer Coaches Association of America
- Kentucky High School Soccer Coaches Association

PRESENTATIONS


