THE EFFECTS OF TEACHERS’ TEACHING STYLES AND EXPERIENCE ON
ELEMENTARY STUDENTS’ MATHEMATICAL ACHIEVEMENT

by

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Liberty University

A Dissertation Proposal Presented in Partial Fulfillment
Of the Requirements for the Degree
Doctor of Education

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ABSTRACT

The purpose of this causal comparative study was to determine if a statistically significant difference existed in the mathematical achievement of elementary students in classrooms led by teachers with different dominant teaching styles (Grasha, 1996) and varying years of teaching experience. Participants in this study included 29 upper elementary (grades 3-5) classroom teachers in an urban public school system located in Central Arkansas. Two one-way ANOVAs were used to compare the Arkansas Augmented Benchmark Examination’s (AABE) mathematics scores of 855 students in upper elementary classrooms of teachers with varied teaching styles and years of teaching experience. A two-variable Chi-square analysis was used to determine if students’ Academic Expected Performance (AEP) occurred more frequently with one teaching style than with another. The findings of this study revealed the AABE mathematical scores of students in classrooms with teachers using facilitator and delegator teaching styles significantly higher than students in classrooms of teachers using expert, formal authority, and personal model teaching styles. Students in classrooms with teachers with five or less years of teaching experience scored significantly lower than teachers with more than five years of teaching experience. The number of students who made AEP in mathematics who were taught in classrooms with facilitator teaching styles exceeded the number of students who were expected to make AEP in those classrooms.

Descriptors: Teaching Styles, Teaching Experience, Mathematical Achievement.
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CHAPTER ONE: INTRODUCTION

Students from the state of Arkansas have historically struggled with math performance (ARC, 2013). Spring of 2006 was the first year that Arkansas assessed students using the currently adopted Arkansas Mathematics Curriculum Frameworks (ADE, 2005). That first year, 64% of third grade, 53% of fourth grade, and 52% of fifth grade students (upper elementary students) from the Arkansas urban school district in this study met their AEP in mathematics (ARC, 2013). Multiple measures were implemented in an attempt to improve test scores, including adding district-wide interim assessment, providing additional teacher training, and changing curriculum. Those measures resulted in 88% of third, 84% of fourth, and 66% of fifth grade students meeting their AEP in mathematics in 2013 (ARC, 2013). Even though the district increased the number of proficient students from 2006 to 2013, the district remains below the expected percent proficient, especially at grade five. The gap between the 2013 expected and actual percent proficient was 26.5%. Therefore, the district remained designated as a “needs improvement” school district in 2013. The test results confirmed that teachers cannot continue to teach mathematics to students in the same manner and expect to get different results.

According to the National Center for Education Statistics, this epidemic of failure was not confined to the state of Arkansas (United States Department of Education, 2011a). Many hypotheses have been set forth to explain the low mathematics achievement scores nationwide. Konstantopoulos (2009) asserted that the most fundamental educational resource found to affect student achievement was the classroom teacher. More specifically, Good and Grouws (1979) determined that teachers and teaching methods could positively impact student progress in mathematics. Likewise, Darling-Hammond and Youngs (2002) and Palarady and Rumberger (2008) found a relationship between student achievement and teaching style.
Background

In their 1983 report *A Nation at Risk*, the National Commission on Excellence in Education issued a stark warning that student achievement was declining in reading and math. After multiple unsuccessful efforts to curtail this downward trend, President George W. Bush signed into law the No Child Left Behind Act (NCLB) in January of 2002. NCLB, with the general purpose of “eliminating the achievement gap that exists between groups of students within our nation's schools” (United States Department of Education, 2004) became the driving force behind a new era of teacher accountability for student learning. The new standard of achievement set forth by NCLB required students throughout the country, regardless of gender, ethnicity, or socioeconomic status, to make Adequate Yearly Progress (AYP) on student performance improvement goals. Thus, the success or failure of Arkansas public schools was measured by their ability to make AYP. An Arkansas school’s AYP status was dependent upon their students meeting prescribed performance expectations, also known as Annual Expected Performance Levels (AEP), on the state examinations (See Appendix A). AEP for grades three, four, and five for the 2012-2013 school year was defined by the Arkansas Department of Education (ADE) as attaining 92.5% of students scoring proficient or advanced in mathematics on the Arkansas Augmented Benchmark Examination (AABE).

The foundation of this study was the premise that student learning is contingent upon the instructional style of the teacher and the teacher’s use of the techniques that are best suited for the student. Vygotsky (1935) explained that cognitive development is determined not only by a student’s independent performance, but also by the performance of that student with assistance. This concept became known as the Zone of Proximal Development (ZPD) and can be applied to today’s educational settings by revealing how conceptual skills and abstract thought can be
stimulated in students by teachers’ instructional techniques. Current educators utilize Vygotsky’s ZPD theory by pushing students to new learning rather than limiting their growth to an expected level of achievement.

A direct connection can be made between Vygotsky’s ZPD (1935) and Bruner’s theory of instruction (1985). Bruner encouraged teachers to allow students’ to take over their own learning process. Even though teacher-student interactions were necessary in the learning process, Bruner (1985) and Grasha (1996) determined that teacher actions could also be a hindrance in the learning process if the teacher was not conscious of student perceptions of teacher actions. Although Bruner (1966) recognized a learner’s ability to thrive despite exposure to a variety of instructional practices, Grasha (1996) acknowledged that certain teaching styles could be more beneficial than others to students who are engaged in the learning process.

Grasha (1996), intrigued by the relationship between teaching styles and student achievement, sought to further define the individual characteristics inherent to specific styles. Through his research he identified five distinct teaching styles: expert, formal authority, personal model, facilitator, and delegator (Grasha, 2004). Grasha’s research revealed that teachers could influence student achievement by either assisting or hindering their ability to acquire new knowledge. He further theorized that as teachers become increasingly more aware of their teaching styles, they would be able to adjust their instructional activities to specifically target the needs of their students (1996). Wayne and Youngs (2003) found that teachers were partially responsible for their positive impact on student achievement.

Although numerous researchers (Dugas, 2005; Kabadayi, 2007; Vaughn & Baker, 2001) have utilized Grasha’s Teaching Style Inventory (TSI), few studies have examined the relationship between teaching styles and student achievement. Over the last decade, several
studies have utilized Grasha’s teaching styles in the post secondary realm. One researcher (Mwangi, 2004) sought to determine teacher effectiveness in counselor education based on teaching styles, while another (Rich, 2006) studied the relationship between teaching styles and the educational backgrounds of athletic trainers. Lucas (2005) investigated the teaching styles and instructional beliefs of teachers, the correlation between these variables, and the incorporation of technology in the classroom. McGowan (2007) conducted a post secondary study that examined the relationship between teaching styles and student achievement. McGowan (2007) found a positive correlation between an occupational instructors’ teaching styles and their students’ achievement, but recommended research be done in other discipline areas as well.

At the elementary level, only two studies were found that examined teaching styles and student achievement. Andrews (2004) found no statistically significant relationship between teaching styles and students’ reading achievement scores.

Davis-Langston (2012) found a positive correlation between teaching styles and the mathematical achievement (specifically in numbers and operations) of upper elementary school students. With the national implementation of Common Core State Standards and the accompanying assessment in 2015, the mathematical standards in upper elementary will have a greater focus on numbers and operations.

As the demands for an improvement in student outcomes continue to center on molding and modifying the methods used by teachers (Darling-Hammond & Youngs, 2002), the application of Grasha’s theory of teaching styles may prove to be a beneficial means of exploring why some Arkansas students meet the state’s AEP in mathematics, while others do not. Only a limited number of research studies have been completed using Grasha’s TSI with children, and
only one correlational study investigated teaching style in relation to mathematical achievement at the upper elementary school level. The described studies recommended further investigation of the relationship between teaching style and student achievement; thus, the need is evident for this study to examine the relationship between teaching style and mathematical achievement.

**Problem Statement**

Many upper elementary Arkansas students, like other students in the United States, were falling behind in mathematics compared to students in other countries. According to the National Center for Education Statistics, the 2011 Trends in International Mathematics and Science Study (TIMSS) reported that fourth grade students in eight other countries scored higher, on average, in mathematics than fourth grade students in the United States (United States Department of Education, 2011b). In an attempt to explain this poor math performance, researchers have explored the general relationship between teaching styles and various teacher attributes (Lucas, 2005; Mwangi, 2004; Rich, 2006). However, very few studies have addressed the impact of teachers’ individual teaching style on student achievement (Andrews 2004; McGowan, 2007), and even fewer have addressed the impact of teachers’ individual teaching style specially on upper elementary students’ mathematical achievement (Davis-Langston, 2012).

**Purpose Statement**

The purpose of this causal-comparative research study was to investigate the effect of teachers’ teaching style on the mathematical performance of upper elementary students (grades 3-5) in an urban Arkansas school district on the AABE (Arkansas Comprehensive Testing, Assessment and Accountability Program [ACTAAP], 2010). The independent variable, teaching styles, was determined by the TSI developed by Grasha (1996). The dependent variable,
students’ mathematical achievement, was measured by performance on the AABE. Classroom teachers’ teaching experience, categorized by years of teaching service, was included as a second independent variable.

**Significance of the Study**

A deeper understanding of effective educational practices has the ability to produce an environment conducive to subject specific learning and generate widespread gains in students’ mathematical achievement. The information gained in this study not only benefitted the local school system by providing population specific information on the relationship between classroom teachers’ teaching style and students’ mathematical performance on the state mandated standardized test, but also provided more insight into professional development needs. Specifically, the results of this study revealed which teaching styles were most likely to result in increased mathematics standardized test scores, thus informing staffing decisions by giving administrators the ability to match employment candidates to vacant positions in light of their teaching styles. These more informed staffing decisions could lead to a decrease in the achievement gap between different demographic populations and an increase in the percentage of students achieving AEP in the state of Arkansas.

Researchers believe instructional delivery of mathematical material plays just as vital of a role in the mastery of mathematics as the students’ cognitive ability (Papanastasiou, 2002). According to Holcomb (2001), teacher trainees typically develop a teaching style that is most comfortable to their personality, regardless of the subject matter or students that they intend to teach. The results of this study could impact the way higher education departments teach and train future elementary teachers.
**Research Questions**

The following research questions were addressed in this study.

RQ1: Do teachers’ teaching styles make a statistically significant difference in the mathematics achievement scores of upper elementary school students, as measured by the AABE?

RQ2: Do teachers’ years of teaching experience make a statistically significant difference in the mathematics achievement scores of upper elementary school students, as measured by the AABE?

RQ3: Do teachers’ teaching styles make a statistically significant difference in the frequency of upper elementary students making AEP in mathematics, as measured by the AABE?

**Hypotheses and Null Hypotheses**

Following are the associated research hypotheses and null hypotheses:

H1: Teachers’ teaching styles will make a statistically significant difference in upper elementary school students’ mathematics achievement scores, as measured by the AABE.

H_{01}: Teacher’s teaching style will not make a statistically significant difference in upper elementary school students’ mathematics achievement scores, as measured by the AABE.

H2: Teachers’ years of teaching experience will make a statistically significant difference in upper elementary school students’ mathematics achievement scores, as measured by the AABE.

H_{02}: Teachers’ years of teaching experience will not make a statistically significant difference in upper elementary school students’ mathematics achievement scores, as measured by the AABE.
H3: One or more teaching styles will make a statistically significant difference in the frequency of upper elementary students making AEP in mathematics.

$H_0$: One or more teaching styles will not make a statistically significant difference in the frequency of upper elementary students making AEP in mathematics.

**Identification of Variables**

Teaching Style, Mathematical Achievement, Teaching Experience, and Annual Expected Performance levels were the variables of interest in this study. Each variable is described below.

Teaching Style is broadly defined as the personal traits, characteristics, beliefs, and skills that are presented during classroom instruction. In this study, the teaching style, an independent variable, was defined as one of the five major teaching style categories—expert, formal authority, personal model, facilitator, and delegator—determined by the TSI (Grasha, 1996). The five teaching styles are defined by Grasha (1996) as follows:

- *Expert*: The teacher displays knowledge and expertise that students need. The teacher challenges students to enhance their competence and is concerned with preparing students (Grasha, 1996).

- *Formal Authority*: The teacher possesses status among students and is concerned with learning goals, rules of conduct, and providing feedback (Grasha, 1996).

- *Personal Model*: The teacher instructs through personal example and engages student to observe and replicate the instructor’s approach (Grasha, 1996).

- *Facilitator*: The teacher guides and directs students by asking questions, exploring options, and encouraging alternative solutions (Grasha, 1996). The teacher strives to develop responsibility and independent thought in students (Grasha, 1996).
• Delegator: The teacher strives to promote student learning through project studies and is available as a student resource (Grasha, 1996).

Teaching Experience, another independent variable of this study, is defined as the number of years a teacher has spent working in the professional realm of education. For this study, teaching experience is categorized in the following range levels of experience: 5 or less, 6-10, 11-20, and more than 20.

Mathematical achievement is the dependent variable for this study and is defined as the students’ mathematical scale score on the AABE’s (ACTAAP, 2010) mathematics subtest. Students’ scale scores are categorized into one of four possible performance areas:

a. Below Basic
b. Basic
c. Proficient
d. Advanced.

The Annual Expected Performance Level (AEP) is the scale score students in Arkansas are required to achieve and be considered proficient on the AABE each year as configured by the annual measurable objectives. In order for upper elementary students in Arkansas to make AEP on the 2013 mathematics subtest of the AABE, the following performance level scale scores were required for each grade level (ADE, 2013a):

• Third grade-500
• Fourth grade-559
• Fifth grade- 604
Definitions

In order to ensure that the communication in this study is received as intended, following is a list of words found in this study along with their corresponding definitions:

*Adequate Yearly Progress (AYP)*: Adequate yearly progress is defined as the measurement standard that the United States Department of Education utilizes to determine how schools are performing academically on standardized assessments in mathematics and English language arts. Results are reported for whole school group as well as subgroup populations of students (ACTAAP, 2010).

*Annual Measurable Objective (AMO)*: Annual measurable objective is defined as the percent of students who are expected to score proficient or advanced each year in order to make AYP. In Arkansas, the AMO consists of increasing increments of allowable student proficiency as the year progresses towards 2014 and is formulated into the Annual Expected Performance Level. For year 2013, 92.5% of the students were expected to score as proficient or above (ACTAAP, 2010).

*Combined Population*: The combined population is operationally defined as the testing population of all student subpopulations, except the first year limited English proficient students, as mandated by NCLB (ACTAAP, 2010).

*Mathematics Achievement (performance)*: Mathematics achievement is defined as the students’ mathematical scale score, as measured by AABE mathematics subtest (ACTAAP, 2010).

*Scale Score*: The scale score is based on the calculation of the difficulty of the test questions and the number of correct responses. Scale scores are useful for comparing student performance across grade levels and over spans of time (ACTAAP, 2010).
CHAPTER TWO: REVIEW OF THE LITERATURE

This literature review begins with an introduction to the chapter, followed by an examination of the theoretical framework upon which this study is based. The theoretical framework focuses on the principles of student development in the learning process, the role of the teacher in student learning, and the manner in which teaching styles affect mathematical achievement. Next is the review of literature. The review of literature presents a historical view of the manner in which students learn mathematical concepts, a review of research describing instructional practices in mathematics, a historical review of teaching styles, the fundamental beliefs of Anthony Grasha, a detailing of Grasha’s teaching style categories, and research utilizing Grasha’s TSI. A summary concludes the chapter. The summary contains the practical significance of the information that was presented in the literature review and a justification for improving the instructional practices of teachers in the field of mathematics education.

Theoretical Framework

The theories that framed the research topic are Vygotsky’s (1930) Zone of Proximal Development, Bruner’s (1985) Theory of Instruction, and Skemp’s Mathematical Theory of Relational Understanding.

Many researchers take differing and often conflicting views on whether stages of development guide learning (Piaget, 1970) or whether learning stimulates potential development (Anderson & D’Ambrosio 2008). Even more points of view exist about the means by which learning actually occurs in children. While some theorists believe learning occurs in isolated instances supported by conditioning (Pavlov, 1927), others feel that natural internal development actually guides the learning (Bruner, 1985; Piaget & Inhelder, 1969). Dewey (1938) suggested that students learn by applying past experiences to new experiences in order to formulate new knowledge. In contrast, Gagne (1985) suggested that students have various levels of learning that
require hierarchical prerequisites of instructional strategies in order for the student to process new intellectual skills. Between these two ideas exist a range of theories about whether learning is simply enhanced by the amount of time spent on learning (Carroll, 1989; Slavin, 1980) or whether it is affected by external influences such as environmental surroundings or socio-cultural interactions (Skinner, 1953). The more integrative, socio-cultural approach described in Vygotsky’s (1930) Zone of Proximal Development (ZPD) is the accepted theoretical premise for this study.

In his view of cognitive development, Vygotsky (1930) provided evidence that he accepted the idea that inherent developmental stages, similar to those detailed by Piaget (1970), are at the basis of learning. Vygotsky also combined those developmental beliefs with the Marxist view that humans ultimately develop their intellectual potential through the driving forces of their environmental exposure (Vygotsky, 1931). Piaget (1970) and Bruner (1985) shared similar constructivist perspectives with Vygotsky and agreed with his thoughts on the processes of child development. Bandura’s (1977) Social Learning Theory also complimented Vygotsky’s Social Development Theory (1930). Vygotsky would have supported Bandura’s statement, "learning would be exceedingly laborious, not to mention hazardous, if people had to rely solely on the effects of their own actions to inform them what to do” (Bandura, 1977, p. 22). Vygotsky (1930) specifically focused on the social-historical environment while developing his integrative theory. He recognized that traditional internal developmental cues, such as imitation and natural curiosity, lead to maturational growth, but theorized those internal forces alone could not direct an individual through more advanced thought processes.

Vygotsky (1935) began to study child behavior in more depth and to look specifically at students’ performance along with school instruction. He realized that conventional tests only evaluated the level of mastery of students performing in isolation. After observing students under
directed instruction, Vygotsky discovered that students often performed at higher cognitive levels with modest assistance. In a particular reported instance, Vygotsky described a situation in which two students on the same individually academic performance level achieved at markedly higher levels when given assistance on a more advanced problem. This incident revealed to Vygotsky that future cognitive development is determined by not only the level of individual performance, but also by the performance the student is capable of with assistance. In 1930, he named this measured ability between a student’s actual performance level and the student’s potential level the ZPD. With the ZPD, Vygotsky proposed children were capable of combining their innate abilities and knowledge with social cues and interactions in order to further extend their cognitive growth. Vygotsky believed adult instruction assisted and often prompted student development further than what was obtained through self-discovery alone. For this reason, Vygotsky encouraged educators to develop further studies for determining the extent of interaction between intrinsic development and socio-cultural forces. Even though modern educators accept the view that an interaction between natural development and external factors affects the student learning process, an uncertainty remains as to the specific implications of certain types of interactions.

Role of the Teacher

Vygotsky’s ZPD concept highlighted the role of the teacher in increasing a child’s learning potential. His observational study (1930) provided the evidence necessary for future researchers to explore instructional techniques. Vygotsky’s (1935) example of an infant initially walking by holding on to an adult’s hand, even though the infant could not yet walk alone, supported the theory of ZPD. The analogy of an adult guiding an infant’s steps before the infant was developmentally ready allows educators to make similar assumptions for other cognitive and internal development connections. Therefore, the ZPD directly pertains to teacher-student
interaction, and provides suitable justification for teachers initiating knowledge beyond students’ current performance levels.

One can also apply the ZPD theory to today’s educational settings, revealing that conceptual skills and abstract thought can be stimulated in students through teachers’ instructional techniques. Once aware of the ZPD and how this takes place in the learning process, a teacher can choose to utilize an instructional practice that guides the learner into greater depths of knowledge rather than merely delegating or dispensing informational tidbits to the learner. Teachers have the ability to prompt students to question new learning strategies that are just beginning to develop. A teacher’s prompt to delve further into the learning will challenge student thinking and possibly extend the learning. Likewise, Bruner (1966) compared mental growth to the rises and rests of a staircase. As the learner’s knowledge is nurtured, the concepts eventually mature and advance to the next level of learning. Rather than focusing on a student’s readiness to learn, Bruner (1966) believed that the staircase of learning potential was present for every learner, but environmental influences, including instructional tactics, had the ability to halt, slow, or advance the learning.

Bruner believed that learning is indeed sensitive by nature, but the learner is rather adaptive to a teacher’s range of instructional approaches (Bruner, 1985). In the *Theory of Instruction*, Bruner (1966) confirmed Vygotsky’s finding that a learner’s growth and development were assisted by various external means. Bruner (1985) stated, “Any learner has a host of learning strategies at command,” (p.8), but it is the teacher who equips students with the “procedures and sensibilities” (p. 8) to lead them to their potential for obtaining knowledge. Conversely, if a teacher has the ability to lead students to their potential, a teacher may also fail to provide students with opportunities that build complex thought patterns. Bruner (1985) recognized that certain educational environments could potentially be responsible for irreversible
learning deficits in students. Bruner (1966) warned that these potential learning deficits could be established prior to entering a formal educational system. Whether the instructor is a parent or a formal instructor, the relationship between instructor and student is significant and has long-lasting effects. Bruner (1966) stated,

Since this is a relation between one who possess something and one who does not, there is always a special problem of authority involved in the instructional situation. The regulation of this authority relationship affects the nature of the learning that occurs, the degree to which a learner develops an independent skill, the degree to which he is confident of his ability to perform on his own, and so on. The relations between one who instructs and one who is instructed is never indifferent in its effect upon learning. (p. 42)

With the current educational dilemma (debating the methods and practices best suited for leading students into the twenty-first century) one may find Bruner’s wisdom even more relevant today. Bruner (1966) stated, “We are entering a period of technological maturity in which education will require constant redefinition” (p. 32). He also explained, “The period ahead may involve such a rapid rate of change in specific technology that narrow skills will become obsolete” (Bruner, 1966, p. 32). Indeed, education has evolved greatly over the past few decades, and Bruner correctly acknowledged that without the mastery of simpler skills, more elaborated ones will become increasingly out of reach for students. Therefore, Bruner suggested that educators provide students with opportunities to share in dialogue, paraphrase their thoughts, and internalize their learning in order to reach higher skills. He also charged educators to facilitate the exploration of learning to encourage learning and problem-solving (Bruner, 1966). In order to address the accelerated change within the educational system, Bruner proposed a theory of instruction:
A theory of instruction is prescriptive in the sense that it sets forth rules concerning the
most effective way of achieving knowledge or skill. By the same token, it provides a
yardstick for criticizing or evaluating any particular way of teaching or learning. (Bruner,
1966, p. 40)

Bruner’s (1966) Theory of Instruction is prescriptive, rather than descriptive, in the sense
that instructional methods are prepared by educators based on how the material can best be
learned by the student. Bruner’s Theory of Instruction consists of four major principles that are
practical for not only analyzing instruction, but for determining the best method to lead a child
toward learning. First, Bruner declared that instruction should specify which educational
experiences most effectively lead a learner toward learning. With various instructional methods
producing a range of educational experiences for learners, teachers should be mindful of the
means in which material is delivered to students in order to reap the most benefit from the
experience. Second, instruction must identify how a body of knowledge should be organized so
that learners can readily grasp the concept. When teaching a complex body of knowledge,
teachers should examine the structure of the knowledge in order to provide students with smaller
components of information at a given time. By breaking the body of knowledge down into more
manageable bits of information, students build mental frameworks that enable them to obtain the
whole body of knowledge. Third, instruction must detail the manner and order in which the
material should be disseminated for learning. For example, if a teacher was to prepare lessons
pertaining to the Laws of Motion, the teacher would need to decide how to best introduce the
material so students gain the most understanding. The teacher may choose to provide students
with experimental motion experiences before mentioning the laws. The teacher may probe
students to inquiry by questioning the relationship between forces and motion. In contrast, the
teacher might simply state the laws of motion, display the mathematical formulas for each, and
follow up with discussion. Bruner (1966) suggested that the sequences teachers choose to deliver material have an impact on how well students attain the overall body of knowledge. Bruner provided educators the flexibility to determine the pace and choice between extrinsic and intrinsic reward, once the material was released to students. Fourth, Bruner believed that instruction must utilize both types of reward, but that student learning progressed further with intrinsic rewards. Bruner’s theory of instruction reminds educators that the purpose of teaching is not only to supply students with a prescribed body of knowledge, but also to supply them with the know-how to process knowledge.

A statement of caution pertaining to the role of the teacher in Bruner’s Theory of Instruction prompted, in part, the rationale for this study. Bruner warned educators to avoid the problem of interfering with students’ ability to take over their own role in the learning process (Bruner, 1966). Grasha (1996) also recognized the importance of teacher-student interactions in the learning process. Student learning remains contingent upon teacher-student encounters and the level of success of those two-way encounters. He said that students “develop through changes in teacher and student perceptions of each other, their actions toward each other, and the ‘give and take’ inherent in their encounters” (Grasha, 1996, p. 41). Bruner explained that students can possibly develop a dependence on teacher assistance in their learning, and that teacher-student communication cycles can sometimes stall or even block the learning process (Bruner, 1966). Although Bruner acknowledged that learners were capable of coping and adjusting to various instructional techniques, certain teaching practices could actually hinder student development if the teacher’s style is not preferred by the student.

In order to formulate a complete theoretical framework for this study, a need exists for a review of literature related to mathematical learning. Skemp (1987, 1989, 2006), a mathematician and psychologist, devoted much time to researching and analyzing the thought processes which
learners implement when they learn mathematics. After much research, Skemp (1987) became increasingly concerned with the discovery that many intelligent students couldn’t “do” mathematics. Skemp sought to find the answer as to why otherwise intelligent students had difficulties learning mathematics. Through his research and personal investigations, Skemp (2006) developed and proposed the Mathematical Theory of Relational and Instrumental Understanding.

To best explain the Mathematical Theory of Relational and Instrumental Understanding, Skemp (2006) used the analogy of a person visiting a town for the first time. When unfamiliar with a town, an individual would attempt to learn how to get from point A to point B. The first successful route, regardless of time or distance, would become the fixed plan this individual continues to use to travel between points A and B. The noted references along the way direct the individual between these two points. With these references, the individual may turn right out of the front door, go straight past the church, and so on. After some time, the individual would begin to explore the town, with little to no intent of getting to or from any given point, but rather to create a mental map of the town. During this exploration, however, the individual makes connections to other routes that lead successfully to points A and B. In contrast to the first scenario, if a person with a mental map of the town gets off track, the individual would be able to produce a variety of plans in order to reach points A and point B. Additionally, if this individual made a wrong turn in the derived path plan, the individual, still aware of locations on the mental map, could successfully adjust path routes without getting lost. In the first example, the fixed form of knowledge required to get from one point to another based on memorized references was what Skemp (2006) described as instrumental understanding. In the second example, the formation of an overall awareness of point A and point B as they appear on a mental map of the town, was what Skemp (2006) referred to as relational understanding.
Skemp’s analogy of the person visiting a new town and the learning of mathematics are quite similar. A situation in which students learn what actions to perform using a step-by-step method in order to reach an answer to a problem is an example of instrumental learning (Skemp, 2006); instrumental learning occurs many times using direct teaching pedagogy. A situation in which students can produce an unlimited set of plans in order to solve a problem successfully is an example of relational learning (Skemp, 2006); relational learning is more likely to occur with inquiry or discovery pedagogy.

Instrumental learning is what many educators identify as rote memorization. With instrumental learning, students simply memorize procedures and steps to reach an outcome. This process of instrumental learning utilizes less brain function than relational learning and provides little depth into the reasoning or true understanding of a mathematical problem (Skemp, 1987). Many species other than humans learn using this instrumental or memorization method of learning (Skemp, 1987). Skemp (1987) acknowledged that even the simplest of animal species can learn ordered steps to complete complicated tasks, but for the learner, instrumental learning is absent of any underlying principles or meaning as to the purpose for performing the task, or to what benefit there is in finding the end result.

Relational learning is one of the things that separate humans from all other species. With relational learning, individuals are able to manipulate abstract structures and formulate new conceptual ideas. The new individual structures of knowledge are referred to as schema (Skemp, 2006). Individual schemas are then stored as knowledge and utilized to construct further knowledge when introduced to other structures of information (Skemp, 1987). When schemas are joined to form a new structure of knowledge, they become a concept. According to Skemp (1987), the ability for learners to put new mathematical experiences together with previously learned mathematical schemas and concepts in order to make a mathematical application is the
highest level learning strategy that learners possess. Skemp (1987) identified this highly developed mathematical learning strategy of utilizing schema and concepts as relational learning.

When considering whether one form of learning mathematics was more ideal than the other, Skemp (2006) once again compared these two forms of mathematical learning to the two processes described in learning how to maneuver around a new town. Could the individual in both scenarios get from point A to point B? The answer is “yes,” but an educator must ask a more probing question: Which is better, instrumental or relational learning, for students to master mathematics and be able to build future concepts of knowledge? Skemp (1987) believed that learners utilizing relational learning rather than instrumental learning would progress more successfully in their mathematical development (Skemp, 1987).

Skemp issued four statements of learning virtues supporting the usage of relational learning versus instrumental learning. First, Skemp (2006) acknowledged that learners who used relational learning strategies became quickly independent in reaching their own schema of knowledge. Second, the ability for learners to build their own schema of knowledge was found to be intrinsically satisfying to the learners (Skemp, 2006). Skemp’s third virtue of relational learning described that the first two virtues enhanced a learner’s level of confidence and therefore, encouraged the learner to pursue additional schemas of knowledge. The final virtue for developing relational learning over instrumental learning was that learners would come to realize that their schemas are never complete (Skemp, 2006). As relational learners developed schemas and concepts of knowledge, Skemp discovered that they became ever more aware of endless learning possibilities. With relational learners’ gaining confidence in the third virtue and awareness of endless learning potential in the fourth, Skemp (2006) concluded that relational learning leads learners to self-reward; therefore, the learning process becomes meaningful and self-perpetuating. These four learning virtues of relational learning were not evidenced within the
learners of instrumental learning. On the contrary, Skemp (1987) found students who utilized instrumental learning while developing mathematical skills often reported boredom, disconnect from the content material, and a lack of purpose for performing the mathematical tasks (Skemp 1987). Skemp’s (2006) mathematical theory of relational understanding enhances the theoretical framework of this study by proposing the need for instructional practices that foster specific learning strategies so students can best develop mathematically.

The theoretical framework in this study provides three distinct inferences regarding student learning and instructional practices. First, teachers should not limit the mental growth of students by teaching to their current level of knowledge, but rather challenge and push each learner to new levels of learning (Vygotsky, 1931). Second, teachers should recognize the impact and importance of instructional practices on the student’s learning environment (Bruner, 1966). Finally, teachers should foster a style of teaching that specifically promotes relational understanding in mathematical learners (Skemp, 2006). The foundation of this study is the premise that students’ mathematical achievement is contingent upon the style of teaching and teaching techniques utilized by the teacher during the learning process.

**Review of the Literature**

The following review consists of a synthesis of literature that pertains to teachers’ teaching style and mathematical achievement. The review reveals pertinent historical and background information on (a) mathematical learning concepts, (b) instructional practices for mathematics, (c) teaching styles, (d) Grasha’s fundamental beliefs, (e) Grasha’s teaching styles, and (f) research utilizing Grasha’s TSI.

**Mathematical Learning Concepts**

Before educators can make improvements in the teaching of mathematics, a true understanding of how students learn mathematics is crucial. Skemp (1987) attempted to answer
this question for educators: What is mathematical understanding, and by what means can educators help to foster true mathematical understanding in their students? After much research, Skemp (1987) categorized two basic types of mathematical learning, which he named “habit learning” and “intelligent learning.” Skemp (2006) formulated the Mathematical Theory of Relational and Instrumental Understanding based on these two basic categories of mathematics learning. In mathematics, the habit learning notion became known as instrumental learning, while intelligent learning was recognized as relational learning.

Despite his profound comprehension of student development with mathematical concepts, Skemp (1987) was baffled as to why his students were still struggling with mathematics. At the prompting of the following words by Hassler Whitney, Skemp sought to advance his personal knowledge and improve his teaching by delving into the psychology of learning and teaching mathematics:

For several decades we have been seeing increasing failure in school mathematics education, in spite of intensive efforts in many directions to improve matters. It should be very clear that we are missing something fundamental about the schooling process. But we do not even seem to be sincerely interested in this; we push for ‘excellence’ without regard for causes of failure or side effects of interventions; we try to cure symptoms in place of finding the underlying disease, and we focus on the passing of tests instead of meaningful goals. (Whitney, 1985, p.127)

Skemp (2006) argued that educators would not be any more successful in the future than in the past if the factors that affected student learning, including the ways in which students were being taught, were not addressed. For this reason, Skemp devoted his efforts to understanding two fundamental areas: how children learn and teaching practices.
Understanding relational and instrumental learning alone was not enough for Skemp (1989) to solve his professional problem as a teacher. He noticed that mathematics was not the only subject poorly taught and misunderstood, but the difficulties in developing mathematical knowledge proved to stand out in learners. Skemp declared that educators could measure the intelligence of a learner at any given time, but the capacity of intelligence a learner possessed was not possible to measure in any one circumstance. With this view, Skemp (1989) argued “Learners of any age will not succeed in learning mathematics unless they are taught in ways which enable them to bring intelligence, rather than rote learning, into use for their learning of mathematics” (p.26). As evidenced even more recently by Wiggins and McTighe (2008), they too recognized the differences in mathematical learning and how students perform. Wiggins and McTighe (2008) revealed that students typically perform well on mathematical assessments that require recall (instrumental), but do not perform well on material requiring analysis or application (relational). The continual trend of student underperformance on mathematical assessments stresses the point that teachers should provide students with instructional opportunities that develop understanding in the content before challenging students with the complexities of relational learning (Whitney, 1985).

Skemp (1989) provided a scenario of a learner memorizing a 10-digit phone number in one instance and a separate 10-digit sequence in another instance in order to explain the advantage of intelligence learning over habit learning. In the first example, he acknowledged that the memorization of phone numbers would provide a learner with little to no interest. Furthermore, Skemp recognized that being asked to memorize additional phone numbers would not only be difficult for the learner, but that the memorization of the first phone number provided the learner no assistance in memorizing the others. In the second scenario, however, the learner discovered a pattern to the sequence of 10 digits, and only had to learn the first number and the
pattern in order to remember all 10 numbers. If asked to extend the sequence of numbers, the learner could easily utilize the pattern discovered from the original list and generate a lengthier list of numbers. In contrast to the first scenario where the learner relied on habit learning, the learner in the second scenario utilized intelligent learning to not only recreate the original list of numbers, but to extend the list indefinitely, which further developed his mathematical proficiency.

The 10-digit learning analogy exemplified that intelligent learning is highly adaptable in mathematics, whereas habit learning, no matter how persistent, has low adaptability in problem solving (Skemp, 1989). Although Skemp estimated that 95% of mathematical content requires intelligent learning, compared to 5% habit learning, he found that the majority of students learned mathematics by utilizing habit learning methods. Because a child can memorize so many rules, and the fact that the early years of mathematical content are number and order specific, a teacher may not realize the harm being done by habit learning until students reach obstacles in the middle grades. All too often, Skemp (1989) found that the memorization methods became too complicated for the increasing mathematical content, and inevitably led students to frustration and a cessation in mathematical progress. When student progress slows or stops, educators may wonder why students have stalled in their learning or why some students struggle with certain mathematical content, while other students do not. Teachers unknowingly support habit learning by providing students with frequent explanations for solving problems and providing step-by-step instructions when they struggle with mathematical understanding (Fennema et al., 1996). As a consequence, the way mathematics is taught in schools is often disconnected from the way children need to think about solving problems in real world scenarios (Carpenter, Fennema, Peterson, Chiang, & Loef, 1989). Skemp proposed that teachers could save students from mathematics failure by utilizing intelligent teaching. Skemp (1989) stated, “Intelligent teaching
involves knowing which kind of learning to get children to use for different kinds of tasks, and how to get them to use it” (p.35).

When compared to other subjects being taught in the school environment, Skemp (1989) noted the lack of continuity in the learning of mathematics. From the onset of students learning to read, they learn that reading is beneficial for gaining information, providing entertainment, and expanding knowledge. For many reasons, both children and adults expect reading to enrich their minds and provide a lifetime of resources. In contrast, Skemp acknowledged that most students at the primary level first learned mathematics for the purpose of teacher or parent approval, and secondly for achieving an acceptable academic grade or reward. To expound the issue further, one study reported that teachers related students’ knowledge in mathematics to the students’ performances on examinations (Peterson, Fennema, Carpenter, & Loef, 1989). Therefore, teachers’ instruction in mathematics is oftentimes based falsely around misleading information about what students really know or understand mathematically. Skemp (1989) acknowledged purposes for learning mathematics were not only contradictory between the school environment and the real world, but prevented learners from experiencing the power and enjoyment of obtaining beneficial mathematical tools.

In addition to understanding the manner in which learners develop and obtain their mathematical knowledge, Miller, Stringfellow, Kaffar, Ferreira, and Mancl (2011) identified three modes of mathematical knowledge: conceptual, procedural, and declarative. Conceptual knowledge is the depth of understanding of mathematical operations, concepts, and meaning. Procedural knowledge is the step by step methodology utilized in solving mathematical problems. Declarative knowledge is the ability to memorize and recall mathematical facts (Miller et al., 2011). Miller et al recognized the importance of teaching strategies and suggested that teachers
should specifically plan their instructional strategies so their teaching addresses all three modes of students’ mathematical knowledge during the learning process.

With the current educational challenges regarding mathematics and increasing international demand for enhancing the mathematical knowledge of students, researchers are beginning to delve more into the environmental factors that surround students during their mathematics instruction (Papanastasiou, 2002; Powell & Kalina, 2009). Traditionally, teachers taught mathematics in a manner which promoted memorization, recall of facts, and computational operations. The teaching of mathematics has not advanced much beyond the basic level of declarative knowledge. In contrast, modern technological advancement drives a greater need for complex conceptual innovation in mathematics (Powell & Kalina, 2009). Many of the current researchers find that educators need to claim greater instructional responsibility (Hansson, 2010) and devise means to become more effective in teaching mathematical constructs in order for students to truly develop conceptual mathematical knowledge (Desoete, Roeyers, & Buysse, 2001; Powell & Kalina, 2009). As societal expectations of students’ mathematical knowledge evolve, so too should teaching strategies.

Instructional Practices for Mathematics

When mathematical achievement falls below expectations, the manner in which teachers present material to students becomes the focal point of parents, educators, and educational agencies. Teachers are expected to identify the mathematical weaknesses of their students and devise the instructional means that will fill the learning gaps. The traditional instructional practice for students that fall behind in mathematics involves a teacher reteaching the lagging skill and demonstrating sample problems, followed by students practicing the skill and retesting over the material (Gifford & Latham, 2013). While this instructional practice may work for some students, educators often find this approach ineffective, and their students’ mathematical
achievement plateaus. In fact, many researchers have found traditional teaching practices inadequate for developing mathematical competency in students, and in some instances this style of teaching may even be counterproductive (Gifford & Latham, 2013; Muir, 2008; Walshaw, 2012).

Gifford and Latham (2013) asked teachers why the traditional instructional strategies did not improve the mathematical skills of all students (Gifford & Latham, 2013). The teachers stated that some students lack the ability to listen or concentrate for long periods of time, rather than mentioning their inability to master mathematical skills (Gifford & Latham, 2013). This response prompted Gifford and Latham to identify key factors in specific teaching interventions that engaged students in mathematics learning. Over 65% of the students in the four year research study advanced two or more levels within their mathematical curriculum when those factors were presented (Gifford & Latham, 2013). Gifford and Latham identified the following key factors responsible for increasing student engagement, increasing comprehension levels, and formulating mathematical connections:

- higher order questions
- personal or familiar story contexts
- peer discussion and mathematical talk
- cooperative learning
- secure mathematical environment
- positive teacher responses to student ideas

Since all students have the ability to become capable mathematical learners (Taylor, 1990), Gifford and Latham (2013) concluded that “teachers hold the power to create, or remove, glass ceilings on children’s mathematical attainment” (p.33).
Samuelson (2010) found that traditional teaching and peer collaboration was better suited than independent work strategies alone for improving seventh grade students’ performance in computational concepts. However, those collaboration groups were exposed to significantly higher order thinking than students in the other teaching practice treatment groups. The students who actively participated in the peer and teacher collaborations developed more critical mathematical understanding. Instructional practices that foster student discussion and positive teacher feedback “provides students with the opportunity to explore variations between their own and their partners’ knowledge and thinking, to correct misconceptions, and to fill gaps in understanding” (Samuelson, 2010, p.37). Likewise, Olson, Cooper, and Lougheed (2011) found that students working in Problem based Learning Environments (PBL) searched for understanding, meaning, and solutions and out-performed students in traditional whole class environments on mathematics assessments (Olson et al., 2011). Instructional practices that promote student reflections on prior knowledge while attempting to develop new mathematical connections are found to enhance students’ attitudes toward learning mathematics and are highly effective in increasing student success (Olson et al., 2011). The results of these studies indicated that different teaching practices affect different mathematical learning outcomes.

Because of the ever advancing mathematical demands of the highly technical and complex 21st century workforce, more researchers are beginning to conduct studies that focus specifically on the instructional practices that promote problem solving (Abdullah, Zakaria, & Halim, 2012; Ali, Hukamdad, Akhter, & Khan, 2010; Staub & Stern, 2002). In one longitudinal study, second and third grade classrooms were classified into two instructional practice categories—associationist (traditional) and cognitive constructivist (Staub & Stern, 2002). The students in the traditional classrooms exhibited an underlying knowledge of number facts and computation routines, but lacked the depth of conceptual knowledge necessary for solving more complex
problems (Staub & Stern, 2002). Teachers in those traditional classrooms presented structured lessons with specific content objectives and provided students with practice, reward, and an assessment upon completion. Teachers modeling the cognitive constructivist method initiated content material in a socially interactive context and prompted questions that assisted students in making rigorous constructs of knowledge (Staub and Stern, 2002). However, greater student achievement gains were identified in the classrooms of teachers who assigned challenging mathematical tasks in the form of word problems than in the classrooms of teachers who utilized traditional approaches to mathematics instruction (Staub & Stern, 2002). Not only did the students who were taught with the cognitive constructivist approach demonstrate higher achievement gains, but they also displayed evidence of a greater depth of knowledge (Staub & Stern, 2002).

Ali et al. (2010) found a significant difference between the mathematical achievement of students taught with problem-solving methods and the mathematical achievement of students taught using traditional approaches, where students remain passive and receive information. With the premise that “telling is not teaching and listening is not learning” (Ali et al., 2010, p. 67), the study found that problem-solving, where teachers act as facilitators, is a more effective instructional practice for teaching and learning mathematics than traditional approaches. Additionally, Ali et al. made the claim that problem-solving enables students to become more effective at solving real life problems and equips them with the thinking skill set that will prove beneficial in meeting ever changing societal demands. Student-centered practice is not standardized, but rather personalized to each student’s knowledge and previously acquired experience.

In an experimental study conducted by Abdullah et al. (2012), the experimental group was exposed to strategic visualization thinking strategies for solving mathematical word problems.
The treatment group demonstrated a greater conceptual understanding of mathematics by outperforming the students who received the conventional instructional approach. The findings in this study demonstrated the importance of students creating a visual representation of their mathematics problems in order to devise a solution strategy (Abdullah et al., 2012). The visual representation strategy allowed students the opportunity to develop a better conceptual understanding of problems and make analytical connections to future problems (Abdullah et al., 2012).

In regards to the concerns about the lagging mathematics achievement of American students (United States Department of Education, 2011b) and the academic plateaus that are reported about American students (United States Department of Education, 2011a), consideration should be given to the aforementioned research on mathematical instructional practices. This poor mathematics performance may not be the result of students’ incapability to perform sufficiently in mathematics, but rather teachers not utilizing effective instructional practices. Sound mathematical pedagogical knowledge enables teachers to “develop the flexibility for spotting opportunities that they can use for moving students’ understanding forward” (Walshaw, 2012, p.185).

Teaching Styles

Researchers have long examined teacher roles in the classroom (Mann et al., 1970). For example, Duffey and Martin (1973) categorized teaching styles as either direct and indirect. Gamoran and Nystrand (1991) further described the direct teaching style as strong verbal command in the classroom. Direct style teachers tend to create strict performance tasks with clear instructions that allow for little student individuality (Gamoran & Nystrand, 1991). Although direct teaching styles are effective in communicating the learning tasks to students and maintaining their focus, it disregards student responses and their input to learning (Gamoran &

Research conducted by Michel, Cater, and Varela (2009) labeled teaching styles as either active or passive. The focus of active teaching is student learning. Active teaching improves students’ participation in class, attitudes about learning, and levels of higher order thinking (Michel et al., 2009). Whereas, passive teaching, a common traditional lecture style, limits student participation, reduces attention levels, and curtails the retention of material being covered (Michel et al., 2009).

Pierro, Presaghi, Higgins, and Kruglanski (2009) designated the two teaching styles as supportive and controlling. They found that teachers who lead student-centered instruction and provide an open classroom environment are considered to exhibit a supportive teaching style. Teachers with strict classroom guidelines and a rigid, business-like approach to assessment driven classroom instruction are considered to display a controlling teaching style (Pierro et al., 2009). The study revealed that assessment-driven students, meaning those who are motivated by adult approval and their own academic performance, were more satisfied with the controlling teaching style versus the supportive style (Pierro et al., 2009). In contrast, students who were high-locomotors, meaning they are typically intrinsically motivated and more kinetic in their learning, preferred a classroom climate with more supportive characteristics (Pierro et al., 2009).

While previously attention was placed on the significance of students’ learning styles and teachers’ various teaching styles (Duffey & Martin, 1973; Gregorc, 1979; 1984), recent research has scrutinized teaching styles more exclusively. Chatoupis (2010) analyzed teaching styles and
placed them on a spectrum of various identifiable teaching characteristics. LaBillois and Lagacé-Séguin (2009) explored the relationship between teachers’ teaching styles and the personal behavioral factors that prompt students’ own personal growth and development. They found that teachers’ teaching styles do more than influence their students’ knowledge and skill levels; they are also responsible for encouraging or discouraging specific self-concepts that leave lasting impressions on the way students develop their learning tactics. After decades of work (Cohen & Amidon, 2004; Gamoran & Nystrand, 1991; Gregorc, 1979; 1984; LaBillois & Lagacé-Séguin, 2009; Mann et al., 1970), no consensus conclusions have been reached by researchers that identify which teaching styles, if any, are most effective to actuate optimal student learning.

Grasha’s (1994) five teaching styles: expert, formal authority, personal model, facilitator, and delegator were utilized as the teaching style basis for this study. By analyzing the reasoning behind each of Grasha’s five teaching styles, evidence was found that each of Grasha’s teaching styles are closely related to one of the aforementioned researchers. Grasha’s delegator, facilitator, and personal model teaching styles are closely related to Duffey and Martin’s (1973) indirect teaching style; Michel, Cater, and Varela’s (2009) active teaching style; and the supportive teaching style of Pierro et al. (2009). Whereas, Grasha’s expert and formal authority teaching styles are closely related to Duffey and Martin’s direct teaching style; Michel, Cater, and Varela’s passive teaching style; and the controlling teaching style of Pierro et al. Based on this synthesis of literature, Grasha’s teaching styles effectively encompass the available teaching style research.

Grasha (1994) detailed his study of teaching styles by delineating the positive and negative impacts of each style upon student learning. Each teaching style generated unique conditions among learners in the classroom. Grasha’s foundational beliefs complimented those of Vygotsky (1930) and Bruner (1966), and strengthened the theoretical framework of this research; therefore, his five teaching styles were selected as the basis of teaching styles in this study.
Grasha’s Fundamental Beliefs

In order to create a self-reflective teaching inventory, Grasha (1994) utilized the personal traits characterized by Carl Jung (1976). Grasha’s (1994) initial interest began with student learning styles and led to further investigations of instructional practices. He discovered consistent patterns of thought and behavior and found them to be reflective of a teacher’s overall style of teaching. Instructors vary in their teaching roles according to the way they choose to deliver subject content, involve students in the lesson, guide their own involvement, and evaluate student progress (Grasha, 1996). Grasha (1996) stated, “The unique ways [teachers] interpret and execute role guidelines define our styles as teachers” (p. 17). After studying teaching behaviors, and how different teacher performance resulted in variations in teaching methods, Grasha identified the five aforementioned distinct teaching styles. In addition to identifying those distinct teaching styles, Grasha (2001) recognized that teachers adopted a pattern of actions that formulated a proper fit for their task of teaching. Once a teaching style was replicated and became comfortable to the teacher, that style developed into their teaching approach of choice. Once a teaching style was comfortably developed, teachers consistently exhibited their style during all content instruction (Grasha, 1996). If certain teaching styles are deemed more effective than other styles or at least more effective in certain content areas, then much consideration should be given to professional development for novice teachers aimed at altering their teaching styles accordingly.

Grasha’s teaching style questionnaire, *Grasha’s TSI* (1996), not only assisted educators in determining their own instructional style, but also allowed them to determine if their practices were more conducive to learning, or more likely to hinder student learning (Grasha, 2001). Grasha (1996) suggested that educators utilize the self-reflective TSI in a “consciousness raising” (p. 23) manner in order to improve the connection between teachers and students, ultimately
improving students’ academic performance. The results of the TSI, could affect one’s approach to teaching, assist educators in enhancing a student’s ability to acquire and retain information, and contribute to students’ ability to concentrate, think critically, and become self-directed and motivated learners (Grasha, 1996). 

Grasha’s Teaching Styles

When focusing on teaching styles, Grasha considered not only the method in which teachers delivered their instruction, but also the manner in which students received the particular instruction type. In addition to detailing the teacher behaviors exhibited in the identified teaching styles, Grasha (1996) explained the various effects, both positive and negative, that each teaching style had on students during the learning process. Grasha (1996) identified five dominant teaching styles: expert, formal authority, personal model, facilitator, and delegator.

The teacher displaying the expert teaching style possesses the knowledge and expertise students need, challenges students to reach their potential, and is concerned with preparing students for assigned goals (Grasha, 1996). A significant negative association was found between the expert teaching style and student emotional regulation and anxiety level. Grasha (1996) explained that teachers exhibiting the expert teaching style believed that they held the power and knowledge for student learning. He theorized that this teacher behavior increased student anxiety. Students who were able to self-regulate or control their anxiety were more likely to succeed in classrooms with teachers exhibiting an expert teaching style; whereas, students in the same classroom who possessed low self-regulation for anxiety had difficulty controlling their anxiety and struggled academically (LaBillois & Lagacé-Séguin, 2009). Expert teachers tend to be directive in their teaching approach and stress factual information (Grasha, 1996). The advantage of the expert teaching style is that individual students may quickly acquire vast amounts of knowledge. Unfortunately, students who acquire knowledge in classrooms led by teachers with an expert teaching style may be disadvantaged because their knowledge is superficial. They often lack deeper understanding, and their thought processes produce minimal answers (Grasha, 1996). The expert
instructor’s bold display of knowledge can also intimidate some students and negatively impact their participation and learning.

The teacher exhibiting the formal authority teaching style seeks to establish status among students based on their own authority and knowledge (Grasha, 1994). The formal authority teacher is methodical in planning and traditional in establishing learning goals and classroom structure. The formal authority teacher enforces strict rules of conduct, maintains high learning expectations, and provides definitive feedback (Grasha, 1996). Because the formal authority teacher is concerned with correct answers and standard teaching and learning methods, students can struggle when their ideas and answers are not deemed acceptable by the instructor. Students who do not perform to the formal authority instructor’s expectations develop a sense of inadequacy and subsequently limit their academic efforts (Grasha, 1996). The interdependence between styles and processes implied that a traditional lecture presentation, qualifying as a formal style of teaching, would typically result in developing dependent participants in the classroom (Grasha, 2001).

The teacher displaying the personal model teaching style leads students by personal example. The personal model teacher encourages students to observe how things are done and to imitate the instructor’s modeled approach (Grasha, 1996). Student responses and learning are evaluated by their accuracy and consistency (Grasha, 1994). Similar to the formal authority style, the personal model teaching style can also cause some students to feel inadequate if they cannot perform to the standards set forth by the teacher. Students are at a disadvantage when a teacher utilizes the personal model teaching style and believes his or her approach is indeed the best, and does not make use of other methods (Grasha, 1996). The limited flexibility that results when a teacher does not make use of other method puts students at academic risk.
The teacher exemplifying the facilitator teaching style guides and directs student learning by asking questions and offering alternative solutions (Grasha, 1994). Facilitative teachers explore their own teaching strategies and encourage students to do the same by thinking critically during the learning process (Grasha, 1996). The facilitative teacher strives to develop independent thought in students through personal, inquiry-based, teacher-student interactions focused primarily on student needs (Grasha, 1996). Learner flexibility is endorsed by the facilitator teaching style, but students can become uncomfortable with the teaching style if it is not implemented in a supportive manner. Teachers need to be mindful that the facilitative teaching style is more time consuming than other styles, and that in some instances, they could use other approaches with equal effectiveness (Grasha, 1996).

The teacher exhibiting the delegator teaching style strives to promote independent student learning through preplanned studies, and acts as a resource for the students by answering their questions (Grasha, 1996). Students under the influence of the delegator teaching style are entrusted with the responsibility of their own learning and encouraged to seek out important material to be investigated (Grasha, 1996). Although the delegator teaching style has the advantage of encouraging students to perceive themselves as independent learners, it also has the disadvantages of making students anxious and causing their learning readiness to be misread (Grasha, 1996).

Since 2000, Grasha’s TSI has been utilized with adults, adolescents, and children in research studies that investigated teaching styles (Andrews, 2004; Davis-Langston, 2012; Lucas, 2005). In addition, the TSI has been used to investigate behaviors and academic performance in various content areas.

Of the eight research studies found using Grasha’s TSI, six studies used adult samples and two used samples comprised of children. Five of the studies with adult subjects investigated the
relationship between teaching styles and teacher or student behaviors. The research studies that investigated the relationship between teaching style and behaviors included:

- perception of their teachers’ effectiveness in counselor education (Mwangi, 2004),
- decision to adopt a course management system for engineering students (Dugas, 2005),
- identification of the teaching style of social work field educators (Short, 2001),
- relationship to teachers’ beliefs toward and use of instructional technology (Lucas, 2005), and
- relationship to the educational background of entry level athletic trainers in a Commission on Accreditation of Allied Health Education program (Rich, 2006).

The sixth adult study investigated teaching style and student achievement, as measured by the end-of-course examination of college students in both core and occupational departments (McGowan, 2007). Although further research was recommended, the results of the study revealed a positive correlation between teaching style and student achievement.

In a study conducted by Andrews (2004), 39 educators were selected by a convenience sample in Arizona’s third through sixth grade charter schools in order to determine the effect of their predominant teaching style and certification status on student achievement in reading. Teacher subjects completed Grasha’s TSI in order to determine their predominant teaching style. Reading achievement scores were gathered from the state required Stanford 9 Achievement Test. Seventeen of the teacher subjects held a valid state teaching certification, while the other 22 teacher subjects in the study did not. Although the researcher found no significant correlation between teaching style or certification and teachers’ class average reading achievement scores, Andrews recommended other correlational studies between teaching style and reading achievement scores.
In a study by Davis-Langston (2012), 100 third through fifth grade teachers in an urban Georgia school district were sampled in order to examine the interaction between their teaching styles, perception of self-efficacy in teaching mathematics, and student achievement in mathematics. Eighty-nine percent of the students in the school system were low-income students, 96% of the students were African American, and most students did not have any ancestors or siblings who had attended college. Andrews found statistically significant positive correlations between the personal model, facilitator and delegator teaching styles and the level of student achievement in numbers and operations. A statistically significant, positive relationship was found between the formal authority and facilitator teaching styles and student achievement in geometry. Finally, a statistically significant, negative correlation was found between the expert teaching style and the overall percentage of students whose Criterion-Referenced Competency Test scores exceeded proficiency on mathematics standards. As teachers’ awareness of their use of the personal model, facilitator, and delegator teaching styles increased, so did their students’ achievement in numbers and operations and geometry (Andrews, 2004). Andrews recommended further research in other settings.

Summary

The literature reveals that there is a relationship between cognitive development and instructional practice. Bruner believed that natural maturational development, along with internal cues and curiosity, is the path that leads individuals to learning, but noted that learners are rather adaptive to a range of instructional approaches (1985). Although every student has the potential to learn, Bruner (1966) cautioned that some instructional tactics have the ability to slow, or even halt, the learning. In his Theory of Instruction, Bruner (1966) suggested teachers prepare lessons in a prescriptive manner so that the best teaching methods are utilized for leading individual students toward learning. Vygotsky (1930) took a more in-depth look at student performance
with specific emphasis on direct instruction and discovered that students performed at higher
cognitive levels with guidance. Vygotsky concluded that cognitive development is not solely
determined by the level of performance a learner generates individually, but also by the
performance level the learner is capable of with assistance (1930). Vygotsky (1931) believed that
environmental and social cues assisted (and often prompted) a learner’s development further than
what was obtained through self-discovery alone.

The literature on cognitive function is relevant to learning mathematics because it suggests
that individuals must put new mathematical experiences together with previously formed
mathematical schemas in order to make a mathematical application (Skemp, 1987). Relational
and instrumental learning are described by Skemp (2006) as the two types of learning strategies
individuals choose to utilize in order to build mathematical concepts. Although an estimated 95% of
mathematical learning requires relational learning, Skemp (1989) found that the majority of
teachers in his studies taught students by encouraging them to utilize the instrumental learning
methods. At the point instrumental learning strategies are no longer sufficient for the increasingly
complex mathematics; students will demonstrate a stall in their learning progression and begin to
struggle with future mathematical content (Skemp, 1989).

The findings in this study supported and added depth to educators’ understanding of the
inherently social process that is woven into student development and learning. The social and
interpersonal interactions between teachers and students that Vygotsky (1935) addressed are vital
foundations to current beliefs in education. However, the literature poses no answer for the
following questions that still exist. While considering Bruner’s (1966) Theory of Instruction,
educators may ask themselves whether or not students should have to modify their learning style
in order to adapt to the teacher’s chosen instructional delivery method. Should educators be made
aware of techniques and instructional styles preferred by students in educational settings and
become more receptive to students’ needs when content specific material is being taught? Which instructional practices would most likely encourage students to utilize thinking strategies that are more conducive for developing complex mathematical concepts?

This study sought to specifically address if certain teaching styles are more effective than others for presenting mathematical content to children? Can one teaching style or technique best meet the developmental needs of children during mathematical instruction?
CHAPTER THREE: METHODOLOGY

The purpose of this causal comparative study was to investigate if a statistically significant difference existed in the mathematical achievement of upper level elementary students in the classrooms of teachers with different teaching styles. Secondly, this study investigated if there was a statistically significant difference in the mathematical achievement scores of students in classrooms of teachers with various years of teaching experience. Finally, a determination was made as to which teaching style or styles were associated with the greatest frequency of students making Annual Expected Performance (AEP) in mathematics.

This chapter contains a description of the research methods used to conduct the research. First, the study design is presented, followed by the research questions and hypotheses. A description of the participants, setting, and instruments is next. A detailed description of the procedures and an explanation of how the data was analyzed conclude the chapter.

Research Design

When identifying relationships between two independent and one dependent variable after an event has already occurred, it is appropriate to use a causal comparative research design (Gall, M., Gall, J., & Borg, 2007). Therefore, a causal comparative research design was selected to determine whether the nonmanipulative independent variables (teaching style and teaching experience) had an effect on the dependent variable (students’ mathematical achievement) (Creswell, 2009). Even though Ary, Jacobs, Razavieh, and Sorensen (2006) explained that the cause and effect conclusions reached with causal comparative designs are not strong, they do suggest that causal comparative research is useful as an initial exploratory study. The causal comparative design was appropriate for this study because the researcher utilized teacher participants who were already employed and placed in classrooms. The researcher could not
manipulate the assignment of students to teachers’ classrooms; hence, the researcher made use of convenience sampling.

This study was conducted in the 41 upper elementary classrooms in an urban public school district in Central Arkansas. Those classrooms supplied 29 teachers and 855 student subjects for this study. The teaching style of each participating teacher in this district was identified using Grasha’s Teaching Style Inventory (TSI), a categorical inventory. Teachers were grouped into the teaching style subgroups based on their predominant teaching style. The two instruments of data collection in this study, the TSI (Grasha, 1996) and the Arkansas Augmented Benchmark Examination (AABE) (ACTAAP, 2010), were utilized for comparative analyses between teachers’ teaching styles and years of teaching experience, and their students’ mathematical achievement.

Initially, the assumptions tests for the one-way Analysis of Variance (ANOVA) were conducted to confirm that the one-way ANOVA was a valid test procedure for the hypotheses R1 and R2. For R1, the ANOVA was used to compare the students’ mathematical achievement across the five different teaching styles. For R2, the ANOVA was used to compare the students’ mathematics achievement across the four categories of years of teaching experience. Finally, a two-variable Chi-square analysis was conducted for hypothesis 3 to determine if attainment of AEP occurred more frequently for students of teachers with a particular teaching style. The results of this study provided greater clarification of the relationship that exists between teaching style and students’ mathematical achievement in the target school district.

**Research Questions**

The following research questions were addressed in this study.

RQ1: Do teachers’ teaching styles make a statistically significant difference in the mathematics achievement scores of upper elementary school students, as measured by the AABE?
RQ2: Do teachers’ years of teaching experience make a statistically significant difference in the mathematics achievement scores of upper elementary school students, as measured by the AABE?

RQ3: Do teachers’ teaching styles make a statistically significant difference in the frequency of upper elementary students making AEP in mathematics, as measured by the AABE?

**Hypotheses and Null Hypotheses**

Following are the associated research hypotheses and null hypotheses:

H1: Teachers’ teaching styles will make a statistically significant difference in upper elementary school students’ mathematics achievement scores, as measured by the AABE.

H\(_0\)1: Teacher’s teaching style will not make a statistically significant difference in upper elementary school students’ mathematics achievement scores, as measured by the AABE.

H2: Teachers’ years of teaching experience will make a statistically significant difference in upper elementary school students’ mathematics achievement scores, as measured by the AABE.

H\(_0\)2: Teachers’ years of teaching experience will not make a statistically significant difference in upper elementary school students’ mathematics achievement scores, as measured by the AABE.

H3: One or more teaching styles will make a statistically significant difference in the frequency of upper elementary students making AEP in mathematics.

H\(_0\)3: One or more teaching styles will not make a statistically significant difference in the frequency of upper elementary students making AEP in mathematics.

**Description of Participants**

Since Arkansas requires a battery of mathematics assessments known as the Arkansas Augmented Benchmark Examination (AABE) in upper elementary school (ACTAAP, 2011), the
teachers of students at these grade levels were selected for this research study. Twenty-nine teachers and 855 students from the 41 upper elementary classrooms in the target public school district were available for participation.

The sample was comprised of 13 third grade teachers, 12 fourth grade teachers, and four fifth grade teachers. The frequency counts and percentage of teachers in each range of teaching experience are indicated in Table 1.

Table 1

<table>
<thead>
<tr>
<th>Teaching Experience</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td>12</td>
<td>41.4</td>
</tr>
<tr>
<td>6-10</td>
<td>8</td>
<td>27.6</td>
</tr>
<tr>
<td>11-20</td>
<td>7</td>
<td>24.1</td>
</tr>
<tr>
<td>21+</td>
<td>2</td>
<td>6.9</td>
</tr>
</tbody>
</table>

As evident in Table 1, over 40% of the teachers participating in this study have five years or less of teaching experience. The target school district is an inner city district, thus the teaching staff has a high turnover. Also note that approximately 7% have more than 20 years teaching experience. Sixty-six percent of the upper elementary teachers participating in this study possessed a Bachelor’s degree as their highest level of education, while the remaining 34% held a Master’s degree or higher. A description of the students in the classrooms of the participating teachers is included in Table 2.
Table 2

*Grade Level, Ethnicity, Gender, Socioeconomic Status of Students in Participating Teachers Classrooms*

<table>
<thead>
<tr>
<th>Grade</th>
<th>Ethnicity</th>
<th>Gender</th>
<th>Free &amp; Reduced Lunch</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>African American</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hispanic</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Caucasian</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>Female</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Male</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>92</td>
<td>60.4%</td>
<td>162</td>
</tr>
<tr>
<td>4</td>
<td>125</td>
<td>43.1%</td>
<td>115</td>
</tr>
<tr>
<td>5</td>
<td>100</td>
<td>37.1%</td>
<td>122</td>
</tr>
<tr>
<td>Total</td>
<td>317</td>
<td>37.1%</td>
<td>399</td>
</tr>
</tbody>
</table>

The ethnicity of the student sample consisted of 53.4% minority students and 46.6% Caucasian students. However, the third grade sample had a higher percentage of Caucasians than the other grades. The gender of the student sample was approximately the same, with 51.8% female and 48.2% male. The third grade sample had a higher percentage of females than the other grades. The student sample was predominantly low socioeconomic, with 75.7% qualifying for free or reduced lunch. The percentage of students who qualified for free or reduced lunch was approximately the same for all three grades.

By limiting this study to teachers in grades three through five, more control and conformity of extraneous variables were provided. All upper elementary teachers in the study followed the same *Investigations* standards-based mathematics curriculum (TERC, 2008) that was developed by The Educational Research Center (TERC) and received the same *Investigations* professional development provided by the school district. Thus, students in grades 3-5 use the same mathematical curriculum, resources, and have received the same professional development training. In addition, they are all certified as K-6 Arkansas teachers. Since the state of Arkansas excludes first year English Language Learners (ELL) and students with severe disabilities who
complete an Alternative Portfolio Assessment, these same two groups of students were excluded from this study.

Although research samples drawn by a random sampling from a population may be more powerful and informative in research studies, there are situations, as was the case with this study, when it is deemed acceptable to draw a convenience sample from the population as long as inferences could be made as to the generalizability of the convenience sample to the population (Ary et al., 2006; Gall, M., Gall, J., & Borg, 2007). The classroom samples in this study were representative of the urban population in Central Arkansas since all the students in the designated grade levels of this urban Central Arkansas school district were utilized in the sampling.

**Setting**

This study was conducted in an urban, public school system that is centrally located in the state of Arkansas. The system served approximately 4,000 students at the time that the research was conducted and employed approximately 260 classroom teachers. Approximately 80% of the students were considered economically disadvantaged and received free or reduced lunch rate. The ethnicity breakdown of the student population was as follows: 42% African American, 44% Caucasian, 13% Hispanic, and 1% other. Fourteen percent of students had identified disabilities, while nearly 5% of the students were identified as English Language Learners (ADE, 2011).

The school district consists of eight schools: four elementary (grades K-4), one intermediate (grades 5-6), one junior high (grades 7-8), one high school (grades 9-12), and one alternative education school (K-12). The research was performed within the four elementary schools (grades 3-4) and at the fifth grade level of the intermediate school. Three elementary schools in the district contained 20 traditional classrooms with 20 teachers. One elementary school utilized the team teaching method, where four mathematics teachers were responsible for eight classrooms of students. The fifth grade level of the intermediate school was
departmentalized by content area; therefore, four mathematics teachers were responsible for 13 classrooms.

**Instrumentation**

The instruments selected for this study were Grasha’s TSI (Appendix B) and Arkansas’ state assessment instrument, AABE. Grasha’s TSI (1996) was selected to measure the independent variable, predominant teaching styles. The mathematical subtest of the AABE (ACTAAP, 2010) was selected to measure the dependent variable, mathematical achievement of students.

**Teaching Style Inventory**

According to Grasha (1996), the Teaching Style Inventory (TSI) instrument is appropriate for use with teachers at the upper elementary level for the collection of teaching style data for this study. The TSI is a 40-item self-reflective and self-reporting instrument. The TSI assists educators in determining their own instructional style and enables teachers to determine if their practices are more conducive to learning or more likely to hinder student learning. The five teaching styles are defined by Grasha (1996) as follows:

- **Expert:** The teacher displays knowledge and expertise that students need. The teacher challenges students to enhance their competence, and is concerned with preparing students (Grasha, 1996).

- **Formal Authority:** The teacher possesses status among students and is concerned with learning goals, rules of conduct, and providing feedback (Grasha, 1996).

- **Personal Model:** The teacher instructs through personal example and engages student to observe and replicate the instructor’s approach (Grasha, 1996).
• **Facilitator**: The teacher guides and directs students by asking questions, exploring options, and encouraging alternative solutions (Grasha, 1996). The teacher strives to develop responsibility and independent thought in students (Grasha, 1996).

• **Delegator**: The teacher strives to promote student learning through project studies and is available as a student resource (Grasha, 1996).

**Arkansas Augmented Benchmark Examination**

The AABE (ACTAAP, 2010) was the criterion-referenced test mandated by Arkansas to measure students’ performances based on the Arkansas Mathematics Curriculum (ADE) at each grade level. The criterion referenced AABE measured student performance against a specific standard of performance (cut score; ADE, 2012).

Students in each participating teacher’s classroom took the AABE for Mathematics April 9-12, 2013. The state of Arkansas determines the amount of time required for administering the AABE. The mathematics portion of the AABE was administered for a total of 2 hours and 50 minutes over a period of three days (ADE, 2012). Each of the possible examination forms, labeled A-J, were composed of five open response and 40 multiple choice questions from each of the five mathematical strands (ADE, 2012). The five mathematical strands were Number and Operations, Algebra, Geometry, Measurement, and Data Analysis and Probability. Results from the AABE were released to schools in early June following the April administration dates of the examinations.

**Reliability.** The specific questions included on each annual AABE assessment varies, therefore reliability evidence for the AABE is determined after each annual assessment. The reporting of the overall stratified coefficient alpha on the AABE indicated the degree of internal consistency for each of the grades. The AABE’s 2013 overall stratified coefficient alpha (ADE, 2013b), the grade level item-test correlation for the multiple-choice subtest (ADE, 2013b), and
the grade level item-test correlation for the open response subtest (ADE, 2013b) are reported in Table 3. For the 2013 tests, the three grade-level examinations varied little in their degree of internal consistency or the item-test correlations for either the multiple choices or the open response subtest. Further details pertaining to reliability are included in Appendix C.

Table 3

**AABE Grade Level Reliability**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Overall Stratified Coefficient Alpha</th>
<th>Item-Test Correlation for Multiple Choice Subtest</th>
<th>Item-Test Correlation for the Open Response Subtest</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>.86</td>
<td>.33</td>
<td>.60</td>
</tr>
<tr>
<td>4</td>
<td>.85</td>
<td>.31</td>
<td>.60</td>
</tr>
<tr>
<td>5</td>
<td>.88</td>
<td>.34</td>
<td>.59</td>
</tr>
</tbody>
</table>

Brennan stated, “The decision consistency measure is an estimate of how reliable the test classifies students into the performance classifications” (Brennan, 2004, as cited in ADE, 2013b, p.66). Arkansas depended on a strong decision consistency measure for the AABE since the placement of student performance classifications affects the cut scores for meeting AYP. For the three 2013 grade-level examinations, the decision consistency measure and the decision accuracy measure varied little. The 2013 decision consistency and accuracy grade-level measures for mathematics (ADE, 2013b) are reported in Table 4.

Table 4

**2013 Decision Consistency and Decision Accuracy Measures**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Decision Consistency Measure</th>
<th>Decision Accuracy Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>.84</td>
<td>.78</td>
</tr>
<tr>
<td>4</td>
<td>.80</td>
<td>.73</td>
</tr>
<tr>
<td>5</td>
<td>.79</td>
<td>.71</td>
</tr>
</tbody>
</table>
Validity. Validity refers to “the extent to which an instrument measured what it claimed to measure” (Ary et al., 2006, p.243). Since the actual questions on the AABE vary annually, test validation is an ongoing process. Test validation began with the test design and development and has continued throughout the life of the test (ADE, 2013b). Evidence of test validity must be accumulated and reviewed annually from various sources to process the usefulness of a test and to ensure the interpretations of the test scores (ADE, 2013b). Detailed information about the validity of the AABE can be found in Appendix D.

Content validity. Ary et al. (2006) described content validity as the degree to which the sample of items, tasks, or questions on a test cover the curricular standards (Arkansas Mathematics Curriculum Frameworks; ADE, 2005) to be measured. The ADE staff, professional test developers, and measurement and assessment experts from Questar (the testing company awarded the bid for the AABE) provided strong content-related expertise regarding assessment development (ADE, 2013b). These assessment experts offered evidence of the AABE’s content validity by ensuring that the AABE assessment items were accurate for the specific student learning expectations they measure in the Arkansas Mathematics Curriculum Frameworks (ADE, 2013b).

Procedures

After the approval by the dissertation committee, the purpose of the study was explained to the selected school district’s administration. Permission was requested from the superintendent of schools in order to conduct the study. After written permission from the superintendent (Appendix E) was received, the Institutional Review Board (IRB) application was completed, along with the researcher’s dissertation chair member’s signature. This completed application
was then sent to Liberty University’s IRB for review. Following the IRB preliminary review, revisions were completed and final approval was received (Appendix F).

After all approvals were granted, appointments with building principals were made with the intent of requesting permission and scheduling a date to speak to the upper elementary teachers during one of their regularly scheduled faculty meetings. By this time, the TSI (Grasha, 1996) survey was loaded onto the Survey Monkey website and was ready for teacher participation (See Grasha’s permission for research usage of the TSI in Appendix G). The web link containing the TSI survey was submitted to teacher participants via email notification once informed consent was gained.

A participant letter (Appendix H) that summarized the general purpose of the study was provided to the teacher participants at the participant meeting. Each participating upper elementary teacher was provided instructions for completing the TSI survey that was posted on Survey Monkey, a website organized for collecting and storing questionnaire data. The participants were asked to sign in to Survey Monkey using the last four digits of their state-assigned teacher identification numbers. The teaching style that the survey indicated for each participating teacher was only made available to those participants who made a written request to the researcher.

Two copies of the consent form (Appendix I) were provided to participants at the participation meeting. One copy of the consent was signed and returned to the researcher, and the other copy was retained by the participant for his or her personal records. The consent form contained a statement that confirmed the guaranteed confidentiality and security of all individual teacher information and school records. A predetermined deadline for completing the online TSI (Grasha, 1996) was provided to the teacher participants during the meeting.
Eligible participants who were absent from the participant meeting were requested to return the signed consent form via an email. Prior to the deadline, all teachers were sent a follow-up email reiterating the survey instructions, thus reminding those teachers who had not completed the survey. Based on participation rates from previously completed studies in the district, and the fact that the district’s administration was providing support and approval for this study, a strong participation rate was expected. Indeed, 100% of the eligible teachers participated.

Participating teachers completed Grasha’s TSI pertaining to their personal mathematical teaching behaviors and characteristics electronically on the Survey Monkey web link. Survey completion took participants approximately 10-15 minutes. Teachers provided numerically rated answers based on a seven-point Likert scale. A ranking of a one was designated as strongly disagree and a seven was designated as strongly agree.

To determine teachers’ predominant teaching style, the researcher transferred the teacher responses for each of the 40 items onto a TSI score sheet. The participants’ inventory scores vary between 1.0 and 7.0, inclusively. Since many of the participating teachers were elementary teachers from traditionally self-contained classroom settings and responsible for teaching more than one subject content area, teachers were instructed to mark answers only as they applied to the teaching characteristics that they exhibited during mathematical instruction.

Each participating teacher’s responses from Grasha’s TSI were retrieved from the Survey monkey web link and recorded on a Grasha’s Teaching Style Score Sheet in order to determine each teacher’s predominant teaching style while teaching mathematics. Grasha’s Teaching Style Score Sheet categorizes each of the 40 inventory questions into their proper teaching style columns. Participants responded to each of the inventory items by providing a numerical ranking from 1-7, where a 1 represented strongly disagree and a 7 represented strongly agree. The numerical responses in each teaching style column were totaled and then divided by eight; the
number of questions in the TSI for each teaching style, to determine which teaching style
category the teacher had the highest average score. Each teacher’s dominant teaching style was
identified as the teaching style receiving the highest ranking score on their TSI score sheet.
Grasha (2001) explained how teachers could possibly possess some characteristics from each of
the five teaching styles; however, the strongest and most frequent characteristics presented during
instruction determine a teacher’s dominant style of teaching.

The District Test Coordinator provided the researcher with a copy of each participating
teacher’s students’ mathematics scale score from the AABE. Additionally, the District Testing
Coordinator provided the researcher with the number of students from each teacher’s classroom
who made AEP and who did not make AEP, with the teacher’s identification code as the only
identifier. For reporting purposes, the district testing coordinator was able to provide the
researcher with the students’ mathematics scores without identifying their names or their
teachers’ name. The participating teachers were thereafter identified by the last four digits of
their state assigned identification numbers. Due to her position, the district testing coordinator
had authorized access to the district’s benchmark test results, which included the state assigned
teacher identification numbers.

**Data Analysis**

Students’ mathematical scores, teachers’ years of experience, and teachers’ teaching styles were
entered into a Statistical Package for the Social Sciences (SPSS; Kirkpatrick & Feeney, 2007) for
statistical analysis. A one way Analysis of Variance (ANOVA) was used for analyzing Research
Hypotheses 1 and 2 in this study. The ANOVA was used to compare the students’ mathematical
achievement across the independent variables of teaching style and years of teaching experience.
The ANOVA was an appropriate statistical test for this study because:

- It evaluated the amount of between-groups variance in students’ scores with the
amount of within groups variance (Ary et al., 2006; Gall, M., et al., 2007).

- The AABE scores were an interval scale of measurement.
- Each student took the assessment independently.
- The measures were assumed to be normally distributed.
- The variances within the teaching style groups were assumed to have homogeneity of variance.
- Random selection of students was not possible; however, students were assigned in classrooms with equal representation of gender, intelligence, disability, and ELL.
- The independent variable was categorical in nature.

The ANOVA was also recognized as a preferred alternative to multiple \( t \)-tests since it had the versatility and ability to test the difference between two or more means (Ary et al., 2006; Gall, M., et al., 2007; Green & Salkind, 2008). Since the null hypotheses stated that no statistically significance difference existed, the researcher was interested in any significant difference. Therefore, a two-tailed test was used with an alpha value of .05 and power of .80. There were four degrees of freedom because of the five treatment groups. According to Green and Salkind (2008), researchers have the freedom to determine an effect size that reasonably defines the line between meaningful and trivial differences by utilizing Cohen’s \( d \) (1988). The researcher chose a desired effect size of five for this study. The one way ANOVAs indicated a significant difference in the mathematical achievement scores of students in classrooms of teachers with different teaching styles and years of teaching experience. Therefore, the Tukey HSD post hoc procedure was used to pinpoint where the difference existed.

A two-variable Chi-square analysis was used to determine if the number of students making AEP was higher in classrooms where a teacher exhibited one teaching style over another. The Chi-square test statistic was an appropriate test statistic for Hypothesis 3 because both the
independent and dependent variables were categorical in nature. The only assumption that needed to be met in order for the Chi-square analysis to be utilized was the assumption of categorical data (Ary et al., 2006).
CHAPTER FOUR: FINDINGS

The intent of this study was to determine if there was a statistically significant difference in the mathematical achievement of upper level elementary students (grades 3-5) in the classrooms of teachers with different teaching styles and various years of teaching experience. The study also sought to determine which teaching styles were associated with the greatest frequency of students making AEP in mathematics.

Results were collected from 29 upper elementary teachers and their 855 students in an inner city school district in Central Arkansas. This chapter is organized into four sections. The first section is the descriptive data for the independent and dependent variables. In the next section, the results of the assumptions tests for the research hypotheses are presented. The third section describes the data analysis for the three hypotheses. The final section provides a summary of the results.

Descriptive Statistics

For participating teachers, the category with the highest average score was the teacher’s predominant teaching style for teaching mathematics. Participating teachers’ categorical ratings are reported in Table 5.
Table 5

*Ratings of Participating Teachers for Expert, Formal Authority, Personal Model, Facilitator, and Delegator Teaching Style*

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Expert</th>
<th>Formal Authority</th>
<th>Personal Model</th>
<th>Facilitator</th>
<th>Delegator</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.9</td>
<td>4.5</td>
<td>3.4</td>
<td>6.4</td>
<td>6.1</td>
</tr>
<tr>
<td>2</td>
<td>3.3</td>
<td>3.7</td>
<td>5.1</td>
<td>6.8</td>
<td>5.1</td>
</tr>
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<td>3</td>
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</tr>
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<td>4.4</td>
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</tr>
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<td>5</td>
<td>3.9</td>
<td>5.6</td>
<td>5.5</td>
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</tr>
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<td>6</td>
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</tr>
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<td>7</td>
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<td>6.0</td>
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</tr>
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<td>6.0</td>
<td>5.8</td>
<td>5.3</td>
<td>4.3</td>
</tr>
<tr>
<td>20</td>
<td>4.3</td>
<td>5.4</td>
<td>5.1</td>
<td>6.0</td>
<td>5.5</td>
</tr>
<tr>
<td>21</td>
<td>4.1</td>
<td>5.4</td>
<td>4.4</td>
<td>6.8</td>
<td>5.0</td>
</tr>
<tr>
<td>22</td>
<td>5.1</td>
<td>4.4</td>
<td>4.9</td>
<td>5.9</td>
<td>5.6</td>
</tr>
<tr>
<td>23</td>
<td>5.0</td>
<td>5.4</td>
<td>5.8</td>
<td>5.4</td>
<td>4.4</td>
</tr>
<tr>
<td>24</td>
<td>4.4</td>
<td>5.3</td>
<td>4.8</td>
<td>5.5</td>
<td>5.3</td>
</tr>
<tr>
<td>25</td>
<td>4.5</td>
<td>5.3</td>
<td>4.9</td>
<td>5.5</td>
<td>4.6</td>
</tr>
<tr>
<td>26</td>
<td>5.0</td>
<td>4.6</td>
<td>4.3</td>
<td>6.3</td>
<td>5.6</td>
</tr>
<tr>
<td>27</td>
<td>5.6</td>
<td>5.6</td>
<td>6.3</td>
<td>5.8</td>
<td>6.4</td>
</tr>
<tr>
<td>28</td>
<td>4.9</td>
<td>5.3</td>
<td>5.0</td>
<td>5.8</td>
<td>5.9</td>
</tr>
<tr>
<td>29</td>
<td>4.6</td>
<td>4.7</td>
<td>5.0</td>
<td>5.8</td>
<td>6.0</td>
</tr>
</tbody>
</table>

The frequency and percent of the teachers’ predominant teaching style is recorded in Table 6.

The largest range of teachers’ categorical ratings was facilitator, with a range of 5.0-6.8.

However, facilitator included the largest number of participants. The highest range of teachers’ ratings was delegator with a range of 5.8-6.4. The range of ratings for expert, formal authority,
and personal model were all within the range 5.3-6.1, inclusively. The percent of the participating teachers who viewed themselves as using either facilitator or delegator style was 65.5%. Approximately 7% of the teachers saw themselves as using an expert style. This was expected, since all the teachers participating in this study were upper elementary teachers, and elementary teachers are generally not trained to use lectures as their predominant style with children.

Table 6

*Frequency and Percent of Teachers’ Predominant Teaching Styles and Teachers Range of Ratings*

<table>
<thead>
<tr>
<th>Teaching Style</th>
<th>Range of Categorical Ratings</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expert</td>
<td>5.3-6.1</td>
<td>2</td>
<td>6.9</td>
</tr>
<tr>
<td>Formal Authority</td>
<td>5.3-6.0</td>
<td>5</td>
<td>17.2</td>
</tr>
<tr>
<td>Personal Model</td>
<td>5.3-6.0</td>
<td>3</td>
<td>10.3</td>
</tr>
<tr>
<td>Facilitator</td>
<td>5.0-6.8</td>
<td>15</td>
<td>51.7</td>
</tr>
<tr>
<td>Delegator</td>
<td>5.8-6.4</td>
<td>4</td>
<td>13.8</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>29</td>
<td>100</td>
</tr>
</tbody>
</table>

**Assumption Testing**

Preliminary assumption testing for the one way ANOVA was conducted. The assumptions tested were normality, independence of observations, and homoscedasticity (Green & Salkind, 2008).

The normality histogram for the dependent variable for the 5 levels of the categorical independent variable teaching style can be seen in Figure 1. The histograms of mathematical achievement scores for teaching styles personal model, facilitator, and delegator appear to be normal. However, the histograms of mathematical achievement scores for teaching styles expert
and formal authority appear platykurtic. Therefore the skewness and kurtosis measures were
used to support the normality assumption.

Figure 1.
*Normality Histogram for Mathematical Achievement Scores with Normal Curve Displayed by Teaching Styles*

The skewness and kurtosis statistics for teaching style are displayed in Table 7. The
skewness and kurtosis statistics for the independent variable teaching style confirmed normality
with a statistic value between ±1.0, with the exception of the kurtosis statistic for expert teaching
style. However, the kurtosis for expert teaching style was 1.865, which is in the acceptable range
of ±2. A kurtosis value between ±1.0 is considered excellent, but a value between ±2 is
acceptable (Green & Salkind, 2008).
Table 7

Skewness and Kurtosis Statistics for Mathematical Achievement Scores by Teaching Style

<table>
<thead>
<tr>
<th>Teaching Style</th>
<th>Skewness Statistic</th>
<th>Skewness Std. Error</th>
<th>Kurtosis Statistic</th>
<th>Kurtosis Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expert</td>
<td>-.64</td>
<td>.24</td>
<td>1.87</td>
<td>.47</td>
</tr>
<tr>
<td>Formal Authority</td>
<td>-.33</td>
<td>.37</td>
<td>-.22</td>
<td>.72</td>
</tr>
<tr>
<td>Personal Model</td>
<td>.02</td>
<td>.30</td>
<td>.45</td>
<td>.59</td>
</tr>
<tr>
<td>Facilitator</td>
<td>.05</td>
<td>.12</td>
<td>.47</td>
<td>.25</td>
</tr>
<tr>
<td>Delegator</td>
<td>-.22</td>
<td>.15</td>
<td>.18</td>
<td>.30</td>
</tr>
</tbody>
</table>

The normality histograms for the dependent variable for the 4 levels of the categorical independent variable teaching experience can be seen in Figure 2. The histograms of mathematical achievement scores for 0-5, 6-10, and 11-20 categories of years of teaching experience appear to be normal. However, the histograms of mathematical achievement scores for over 20 years of teaching experience appear platykurtic. Therefore the skewness and kurtosis measures were used to support the normality assumption.
Figure 2.
Normality Histogram for Mathematical Achievement Scores with Normal Curve Displayed for Teaching Experience

The skewness and kurtosis statistics years of teaching experience are displayed in Table 8. The skewness and kurtosis statistics for the independent variable teaching style confirmed normality with a statistic value between ±1.0.

Table 8

<table>
<thead>
<tr>
<th>Yrs. of Teaching Experience</th>
<th>Skewness Statistic</th>
<th>Skewness Std. Error</th>
<th>Kurtosis Statistic</th>
<th>Kurtosis Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td>.02</td>
<td>.16</td>
<td>.96</td>
<td>.31</td>
</tr>
<tr>
<td>6-10</td>
<td>-.19</td>
<td>.14</td>
<td>.83</td>
<td>.28</td>
</tr>
<tr>
<td>11-20</td>
<td>-.14</td>
<td>.15</td>
<td>.10</td>
<td>.29</td>
</tr>
<tr>
<td>21+</td>
<td>.74</td>
<td>.37</td>
<td>.72</td>
<td>.73</td>
</tr>
</tbody>
</table>
Levene’s Test of Equality of Variances was utilized to assess the homogeneity of variances of teaching style and years of teaching experience data. The results of the Levene test for homogeneity of variance by teaching style and years of teaching experience is reported in Table 9. The result of Levene’s procedure for the teaching style data, \( p = .32 \), indicated that the variances for each group do not differ significantly. Therefore, the one-way ANOVA analysis is a valid procedure for comparing teaching style and students’ mathematical AABE scores. The result of Levene’s procedure for years of teaching experience, \( p = .10 \), indicated that the variances for each group do not differ significantly.

Table 9

<table>
<thead>
<tr>
<th>Variable</th>
<th>Levene Statistic</th>
<th>df</th>
<th>df</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Style</td>
<td>1.18</td>
<td>4</td>
<td>850</td>
<td>.32</td>
</tr>
<tr>
<td>Teaching Experience</td>
<td>2.12</td>
<td>3</td>
<td>851</td>
<td>.10</td>
</tr>
</tbody>
</table>

Each student took the AABE independently. Random selection of students was not possible; however, students were assigned in classrooms with equal representation of gender, intelligence, disability, and ELL. Therefore, the assumptions of normality, homoscedasticity, independence of observation are valid for the mathematical achievement scores by the independent categories, and the one-way ANOVA analysis is a valid procedure for the mathematical achievement scores comparisons across levels of teaching style and years of teaching experience.
Analysis of Research Hypotheses

Research Hypothesis 1

RQ1: Do teachers’ teaching styles make a statistically significant difference in upper elementary school students’ mathematical achievement scores on the AABE?

H1: Teachers’ teaching styles will make a statistically significant difference in upper elementary school students’ mathematics achievement scores, as measured by the AABE.

H₀₁: There will be no difference in the mathematical achievement scores of upper elementary school students’ in classrooms of teachers with different teaching styles.

To assess Research Hypothesis 1, the researcher conducted a one-way ANOVA using the Statistical Package for Social Sciences (SPSS), to determine if a statistically significant difference existed in upper elementary school students’ mathematical achievement scores on the AABE in classrooms of teachers with different Grasha’s Teaching Styles. The number of participants, AABE mean, and AABE standard deviation by teaching style are reported in Table 10.

Table 10

<table>
<thead>
<tr>
<th>Teaching Style</th>
<th>n</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expert</td>
<td>42</td>
<td>609.2</td>
<td>86.8</td>
</tr>
<tr>
<td>Formal Authority</td>
<td>103</td>
<td>616.5</td>
<td>90.7</td>
</tr>
<tr>
<td>Personal Model</td>
<td>64</td>
<td>589.7</td>
<td>85.4</td>
</tr>
<tr>
<td>Facilitator</td>
<td>388</td>
<td>632.4</td>
<td>99.3</td>
</tr>
<tr>
<td>Delegator</td>
<td>258</td>
<td>659.8</td>
<td>98.1</td>
</tr>
</tbody>
</table>

The range of AABE means across teaching style categories was 44.7. Delegator teaching style had the highest AABE mean; however, only four participating teachers viewed themselves as using delegator style. The second highest AABE mean was facilitator, with 15 participating
teachers viewing themselves as using a facilitator teaching style. The lowest AABE mean was Personal Model.

The result of the ANOVA test is reported in Table 11. H₀₁ was rejected since the difference in the AABE mean score by teaching-style category was statistically significant (p = .00)

Table 11

*One-Way Analysis of Variance of Achievement Scores by Teaching Style*

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>355,593.0</td>
<td>4</td>
<td>88,898.3</td>
<td>9.56</td>
<td>.00</td>
</tr>
<tr>
<td>Within Groups</td>
<td>7,902,540.1</td>
<td>850</td>
<td>9297.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>8,258,133.2</td>
<td>854</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Since a statistically significant difference was found using the one-way ANOVA for teaching style, the Tukey HSD procedure was conducted using SPSS. The results of the Tukey HSD procedure are reported in Table 12. The Mean Difference was calculated by subtracting the mean achievement score for Teaching Style J (second column in Table 12) from the mean achievement score for Teaching Style I (first column in Table 12).
Table 12
*Tukey HSD Pairwise Comparison of Achievement Scores by Teaching Style*

<table>
<thead>
<tr>
<th>Teaching Style I</th>
<th>Teaching Style J</th>
<th>Mean Difference (I-J)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expert</td>
<td>Formal Authority</td>
<td>-7.27</td>
<td>.99</td>
</tr>
<tr>
<td></td>
<td>Personal Model</td>
<td>19.56</td>
<td>.85</td>
</tr>
<tr>
<td></td>
<td>Facilitator</td>
<td>-23.23</td>
<td>.57</td>
</tr>
<tr>
<td></td>
<td>Delegator</td>
<td>-50.57</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td>Expert</td>
<td>7.27</td>
<td>.99</td>
</tr>
<tr>
<td>Formal Authority</td>
<td>Personal Model</td>
<td>26.83</td>
<td>.41</td>
</tr>
<tr>
<td></td>
<td>Facilitator</td>
<td>-15.96</td>
<td>.57</td>
</tr>
<tr>
<td></td>
<td>Delegator</td>
<td>-43.30</td>
<td>.00</td>
</tr>
<tr>
<td></td>
<td>Expert</td>
<td>-19.56</td>
<td>.85</td>
</tr>
<tr>
<td>Personal Model</td>
<td>Formal Authority</td>
<td>-26.83</td>
<td>.41</td>
</tr>
<tr>
<td></td>
<td>Facilitator</td>
<td>-42.78</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td>Delegator</td>
<td>-70.13</td>
<td>.00</td>
</tr>
<tr>
<td></td>
<td>Expert</td>
<td>23.23</td>
<td>.57</td>
</tr>
<tr>
<td>Facilitator</td>
<td>Formal Authority</td>
<td>15.96</td>
<td>.57</td>
</tr>
<tr>
<td></td>
<td>Personal Model</td>
<td>42.78</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td>Delegator</td>
<td>-27.35</td>
<td>.00</td>
</tr>
<tr>
<td></td>
<td>Expert</td>
<td>50.57</td>
<td>.01</td>
</tr>
<tr>
<td>Delegator</td>
<td>Formal Authority</td>
<td>43.30</td>
<td>.00</td>
</tr>
<tr>
<td></td>
<td>Personal Model</td>
<td>70.13</td>
<td>.00</td>
</tr>
<tr>
<td></td>
<td>Facilitator</td>
<td>27.35</td>
<td>.00</td>
</tr>
</tbody>
</table>

Using pairwise comparisons, the AABE mean score of students in classrooms of teachers using delegator teaching style was significantly higher than students in classrooms with teachers who used the other four teaching styles. The AABE mean score of students in classrooms of teachers using facilitator teaching style was significantly higher than students in classrooms with teachers who used the personal model teaching style. Other than delegator and facilitator, teaching styles expert, formal authority, and were not statistically different.

Research Hypothesis 2

RQ2: Do teachers’ years of teaching experience make a statistically significant difference in upper elementary school students’ mathematical achievement scores?
H2: Teachers’ years of teaching experience will make a statistically significant difference in upper elementary school students’ mathematics achievement scores, as measured by the AABE.

H\textsubscript{02}: There will be no difference in the mathematical achievement scores of upper elementary school students who are taught in classrooms with teachers with varying years of teaching experience.

The number, mean, and standard deviation for student AABE scores by their teachers’ years of teaching experience are reported in Table 13. The range of AABE mean scores across years of teaching experience was 154.7. Teachers with more than 20 years of teaching experience had students with the highest AABE mean; however, only two participating teachers had more than 20 years teaching experience. The lowest AABE mean was students who had teachers with five or less years of teaching experience.

Table 13

<table>
<thead>
<tr>
<th>Years of Teaching Experience</th>
<th>n</th>
<th>AABE M</th>
<th>AABE SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td>245</td>
<td>591.9</td>
<td>91.3</td>
</tr>
<tr>
<td>6-10</td>
<td>296</td>
<td>649.0</td>
<td>91.2</td>
</tr>
<tr>
<td>11-20</td>
<td>274</td>
<td>640.3</td>
<td>96.3</td>
</tr>
<tr>
<td>21\textsuperscript{+}</td>
<td>40</td>
<td>746.6</td>
<td>75.2</td>
</tr>
</tbody>
</table>

The result of the ANOVA test is reported in Table 14. H\textsubscript{02} was rejected since the difference in the AABE mean score by years of teaching experience category was statistically significant (p = .00).
Table 14

One-Way Analysis of Variance of Achievement Scores by Years of Teaching Experience

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>1,019,111.9</td>
<td>3</td>
<td>339,704.0</td>
<td>39.94</td>
<td>.00</td>
</tr>
<tr>
<td>Within Groups</td>
<td>7,239,021.3</td>
<td>851</td>
<td>8,506.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>8,258,133.2</td>
<td>854</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Since a statistically significant difference was found using the one-way ANOVA, the Tukey HSD procedure was conducted using the SPSS. The results of the Tukey HSD procedure are reported in Table 15. The mean difference was calculated by subtracting the mean achievement score for Years of Teaching Experience J (second column in Table 15) from the mean achievement score for Years of Teaching Experience I (first column in Table 15). Using pairwise comparisons, all comparisons of the AABE mean scores of students in classrooms of teachers with 0-5 years of teaching experience were significantly lower than the AABE mean scores of students in teachers with more than 5 years of experience. The AABE mean scores of students in classrooms of teachers with 21+ was significantly higher than the AABE mean scores of students in classrooms of teachers with 20 or less years of experience. The AABE mean scores of students in classrooms with teachers with 6-10 and 11-20 years of teaching experience were not significantly different.
Table 15

*Tukey HSD Pairwise Comparison of Achievement Scores by Years of Teaching Experience*

<table>
<thead>
<tr>
<th>Years of Teaching Experience I</th>
<th>Years of Teaching Experience J</th>
<th>Mean Difference (I-J)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5</td>
<td>6-10</td>
<td>-57.1</td>
<td>.00</td>
</tr>
<tr>
<td>11-20</td>
<td></td>
<td>-48.4</td>
<td>.00</td>
</tr>
<tr>
<td>21+</td>
<td></td>
<td>-154.7</td>
<td>.00</td>
</tr>
<tr>
<td>6-10</td>
<td>11-20</td>
<td>8.7</td>
<td>.67</td>
</tr>
<tr>
<td>21+</td>
<td></td>
<td>-97.6</td>
<td>.00</td>
</tr>
<tr>
<td>1-5</td>
<td></td>
<td>48.4</td>
<td>.00</td>
</tr>
<tr>
<td>11-20</td>
<td>11-20</td>
<td>-8.7</td>
<td>.67</td>
</tr>
<tr>
<td>21+</td>
<td></td>
<td>-106.3</td>
<td>.00</td>
</tr>
<tr>
<td>1-5</td>
<td></td>
<td>154.7</td>
<td>.00</td>
</tr>
<tr>
<td>21+</td>
<td>6-10</td>
<td>97.6</td>
<td>.00</td>
</tr>
<tr>
<td>11-20</td>
<td></td>
<td>106.3</td>
<td>.00</td>
</tr>
</tbody>
</table>

**Research Question 3**

RQ3: Do teachers’ teaching styles make a statistically significant difference in the frequency of upper elementary students making AEP in mathematics?

H3: One or more teaching styles will make a statistically significant difference in the frequency of upper elementary students making AEP in mathematics.

H03: There will be no difference in the frequency of upper elementary students making AEP in mathematics in classrooms with teachers with different teaching styles.

The frequency counts and percentages of students making AEP versus not making AEP across teaching styles are reported in Table 16. The percent range of students making AEP by teaching style was 13.3%. Teachers with the Expert teaching style had the highest percentage (88.1%), and teachers with the delegator teaching style had the lowest percentage (74.8). However, the number of students in Expert teachers’ classrooms was 42, compared to 258 in delegator teachers’ classrooms.
Table 16

*Frequency Count and Percent of Students Making vs. Not Making AEP*

<table>
<thead>
<tr>
<th>Teaching Style</th>
<th>AEP</th>
<th>Did Not Make AEP</th>
<th>Made AEP</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>5</td>
<td>11.9</td>
<td>37</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>16</td>
<td>15.5</td>
<td>87</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>14</td>
<td>21.9</td>
<td>50</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>59</td>
<td>15.2</td>
<td>329</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>65</td>
<td>25.2</td>
<td>193</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>159</td>
<td>25.2</td>
<td>696</td>
</tr>
</tbody>
</table>

Cross tabulation was used to show the relationship between participating teachers' predominant teaching style and the number of students in those teachers’ classrooms who made AEP in mathematics. SPSS computed the expected value for each cell, based on the assumption that the two variables—teaching style and AEP—were independent of each other. The Chi-Square Contingency Table on teaching style and AEP (did not make AEP vs. made AEP) is presented in Table 17.

Table 17

*Chi-Square Contingency Table on Teaching Style and AEP (Did Not Make It vs. Made It)*

<table>
<thead>
<tr>
<th>Teaching Style</th>
<th>Did Not Make AEP</th>
<th>Made AEP</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>experiment</td>
<td>5 [7.8]</td>
<td>37 [34.2]</td>
<td>42</td>
</tr>
<tr>
<td>formal authority</td>
<td>16 [19.2]</td>
<td>87 [83.8]</td>
<td>103</td>
</tr>
<tr>
<td>personal model</td>
<td>14 [11.9]</td>
<td>50 [52.1]</td>
<td>64</td>
</tr>
<tr>
<td>facilitator</td>
<td>59 [72.2]</td>
<td>329 [315.8]</td>
<td>388</td>
</tr>
<tr>
<td>delegator</td>
<td>65 [48.0]</td>
<td>193 [210.0]</td>
<td>258</td>
</tr>
<tr>
<td>Total</td>
<td>159</td>
<td>696</td>
<td>855</td>
</tr>
</tbody>
</table>

*Note:* Numbers in brackets represent expected values for the Chi-Square.
To be certain that the assumptions of the expected cell values were met, the researcher analyzed the 5 x 2 Chi Square with teaching style and AEP (did not make AEP vs. made AEP). None of the expected cell counts were less than five. Preliminary observation indicated that many observed values and expected values were different. The greatest discrepancies were for the delegator teaching style (17.2%) and the facilitator teaching style (13.2%). The Chi Square test of independence was used to assess if the observed values deviate significantly from the corresponding expected values. A Summary of the Chi Square test is reported in Table 18.

Table 18

*Summary of Teaching Styles by Students Making AEP in Mathematics Chi Square Test*

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Value</th>
<th>Df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi Square</td>
<td>12.70</td>
<td>4</td>
<td>.01</td>
</tr>
<tr>
<td>Likelihood</td>
<td>12.44</td>
<td>4</td>
<td>.01</td>
</tr>
<tr>
<td>Linear-by Linear Association</td>
<td>5.33</td>
<td>1</td>
<td>.02</td>
</tr>
<tr>
<td>Valid N</td>
<td>855</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The Chi Square result indicated that a statistically significance difference \((p = .013)\) in the observed values and the expected values of students making AEP by teaching style, indicating that teaching styles and students making AEP are not independent of each other. Since the Chi-Square statistic is largely dependent on the dimensions and sample size, comparisons of one Chi-Square with another can be misleading. To correct for this, Pearson suggested the Phi (\(\Phi\)) statistic and Cramér’s V statistic (Ary et al., 2006; Green & Salkind, 2008) to measure the strength of the association between the variables. The result of both the Phi and Cramer’s V were statistically significant \((p = .013)\), which indicated that the association of the variables is strong.
Summary

Data collected from 29 teachers were used to analyze the three research questions in this study. A causal comparative research design was utilized to investigate the existence of a statistically significant difference in mathematical achievement scores of students in classrooms of teachers using different teaching styles and having different number of years experience.

The findings of this study revealed that there was a statistically significant difference in the AABE mathematical achievement scores of students who were taught in classrooms with teachers who reported delegator or facilitator as their predominant teaching style. The remaining three teaching styles did not show statistical significance. There was also a statistically significant difference in the AABE mathematical achievement scores of students who were taught in classrooms with teachers who possessed 21 or more years of teaching experience from this study. However, there were a comparatively small number of teachers in this experience category and further research should be noted. The AABE mean scores of students who were taught in classrooms with teachers who had 0-5 years of experience were significantly lower than students in classrooms of teachers with more than 5 years of teaching experience.

The findings of this study also revealed a statistically significant difference in the observed and expected values of students making AEP by teaching style. The number of students who made AEP in mathematics who were taught in classrooms with teachers who reported using the facilitator teaching style exceeded the number of students who were expected to make AEP in those classrooms. The findings are discussed and conclusions drawn in the following chapter.
CHAPTER FIVE: DISCUSSION

The previous chapter presented data analysis for the one-way Analysis of Variance (ANOVA) to determine if a statistically significant difference existed in the mathematical achievement scores of students in classrooms of teachers with different teaching styles and different years of experience. The previous chapter also presented data analysis for the Chi Square to determine if students in classrooms of teachers using certain teaching style or styles are more likely to achieve AEP. The chapter also presented descriptive statistics for teaching style, assumption testing that demonstrated the appropriateness of parametric testing, and data analysis to test each of the research hypotheses.

The purpose of this chapter is to review the findings of the previous chapter and discuss them in light of related literature and the theoretical framework that guided the study. This chapter is organized into the following sections: summary of the findings, discussion of limitations/delimitations, implications, recommendations, and conclusion.

Summary of Findings

The major findings from the study were guided by three research hypotheses. The three research hypotheses were addressed by determining if each null hypothesis was accepted or rejected.

Research Hypothesis 1

Research Question 1 asked if the AABE scores of students in classrooms with teachers with varying teaching styles are statistically different. The researcher hypothesized that the mathematical achievement scores of students in classroom with teachers with different teaching style would be significantly different. The one-way ANOVA showed that this hypothesis was correct, \( F(4,850) = 9.56, p = .00 \), and the null hypothesis was rejected.
Research Hypothesis 2

Research Question 2 asked if AABE scores of students in classrooms with teachers with varying numbers of years of teaching experience are statistically different. The researcher hypothesized that the mathematical achievement scores of students in classrooms with teachers with different years of experience would be significantly different. The one-way ANOVA showed that this hypothesis was correct $F(3, 851) = 39.94, p = .00$, and the null hypothesis was rejected.

Research Hypothesis 3

Research Question 3 asked if students in classrooms with teachers with certain teaching styles are more likely to make AEP than students in classroom with teachers with other teaching styles. The researcher hypothesized that students in classroom with teachers using certain teaching styles would be more likely to make AEP. The Chi-Square result, $\chi^2(4, N = 855) = 12.70, p = .01$, indicated that teaching styles and students making AEP are not independent of each other.

Discussion

As indicated in Table 9, the AABE mathematics scores of students in classrooms with teachers with different teaching styles were significantly different. The result of the Tukey HSD procedure showed that the AABE mathematical scores of students in classrooms with teachers using facilitator and delegator styles of teaching scored significantly higher than students in classrooms of teachers using other teaching styles (expert, formal authority, and personal model). As research suggests, the strongest predictive power for students’ achievement are found with the teaching styles most preferred by the students (Li-Fant, 2008). Perhaps the significance with these two teaching styles can be explained by noting the similarities between the two teaching
styles. Grasha (2001) described both the facilitator and delegator teaching styles as exhibiting student centered instructional strategies, which may be preferred by students more than the traditional teacher centered styles modeled by the other three styles (formal authority, expert, personal model). Formal authority, expert, and personal model teaching styles focus on outcome-based products and do not encourage divergent thinking among the learners (Grasha, 1996). This indicates that students will perform at a higher academic level when they are personally involved in guiding their own learning and allowed time to explore content which is more likely to occur in the classrooms of teachers using facilitator and delegator teaching styles.

Perhaps the fact that facilitator and delegator teachers provide direct sensory experiences (relational understanding) for students to construct new schemata explains why students in classrooms with teachers exhibiting these teaching styles scored significantly higher on the mathematics AABE. As addressed in the literature review, Skemp (2006) detailed two distinct types of learning: instrumental and relational. The expert, formal authority, and personal model teaching styles tend to be more instrumental in the sense that the teacher distributes the information directly to the student. The facilitator and delegator teaching styles are more representative of relational learning since students are prompted to make their own discoveries and conclusions. Relational learning, such as what may be found in facilitator and delegator classrooms, encourages the construction of schemas that build networks for achieving newly formed and complex knowledge (Skemp, 2006). Whereas, instrumental learning, such as what may be found in expert, formal authority, and personal model classrooms, enlists the recall of information shared directly by other individuals, and often lacks the appropriate schema for true understanding (Skemp, 2006). If expert, formal authority, and personal model teachers provide instruction that often leads students to learning rules without reasoning (instrumental
understanding), then new schemata are not formed and abstract thought, as required in mathematics, becomes difficult for students.

As indicated in Table 12, the AABE mathematics scores of students in classrooms with teachers with varying numbers of years of teaching experience are significantly different. The result of the Tukey HSD procedure showed that the AABE mathematics scores of students in classrooms with teachers with over 20 years of teaching experience scored significantly higher than students in classrooms with teachers with less than 20 years of teaching experience. Additionally, results of the Tukey HSD procedure showed that the students in classrooms with teachers with five or less years of teaching experience scored significantly lower than teachers with more than five years of teaching experience. Research suggests that teaching experience is associated with greater teacher efficacy (Cheung, 2008) and more experienced teachers hold higher expectations for students (Rubie-Davies, 2008). Vygotsky (1935) believed that teachers were capable of honing their skills to the point that they could learn appropriate strategies that would guide each specific learner to greater depths of knowledge. Experienced teachers develop the ability to prompt students to use questioning techniques to create their own learning path, rather than merely dispensing informational tidbits to the students (Vygotsky, 1935). Likewise, Bruner (1966) believed that teachers had the potential to either succeed or fail to provide students with the proper opportunities that would build complex thought patterns. One can surmise from Vygotsky and Bruner that experienced teachers are skilled and confident in their instructional practice and capable of introducing the methods best suited for each learner.

As indicated in Table 15, the number of students making AEP is not independent of teaching style. The number of students who made AEP in mathematics who were taught in classrooms with teachers who reported using the facilitator teaching style exceeded the number
of students who were expected to make AEP in those classrooms. According to Gifford and Latham (2013), lower achieving students typically display passive learning traits. Perhaps the facilitator teaching style has greater success with student achievement since facilitative instruction is student centered, focuses on individual student’s needs, and encourages students to take responsibility for their own learning (Grasha, 2001). Students in a facilitative classroom are guided by probing questions and encouraged to explore options in order to independently arrive at solutions. Bruner (1966) charged educators to facilitate the exploration of learning in order to encourage complex thought and problem solving. Likewise, the teacher that exhibits the facilitator teaching style exemplifies what Vygotsky (1935) referred to when he documented the ZPD, which suggests that students may indeed be capable of achieving higher levels of learning with instructional practices that encourage them to extend their knowledge base.

**Limitations and Delimitations**

**Limitations**

The findings from this investigation exposed several limitations, which include the research design, use of only upper elementary teachers, self-reported survey, population in one school district, and lack of randomization. A discussion of each limitation follows.

The research design is one limitation in this study. The research design did not include a research treatment because the researcher wanted to base teachers’ style of teaching on their self-reported natural teaching style. Without a treatment, no control group could be used. Therefore, the researcher used a self-reporting teaching style survey to identify the teachers’ natural style of teaching mathematics content to children. Therefore, the researcher is not able to establish cause, but only which teaching styles appear to have higher achieving students in mathematics.

A second limitation of this study is that the participants included only upper elementary
mathematics teachers. This researcher focused on those teachers who were certified at the elementary level and who had similar number of college hours in mathematics in their certification program. Also, these teachers’ preparation include preparation to teach all content areas in the elementary curriculum.

A third limitation was the use of a self reported survey to identify each participant’s teaching style. The teaching style of each teacher was based on his or her response to the questions on Grasha’s TSI. Thus, the self-reported data could have an effect on the internal validity. Research on self-reported data has been conducted and it has been determined that self-reported data can be considered valid if the participant understands the questions (Brener, Billy, & Grady, 2003). For this reason, participants in this study were instructed to respond to the questions on the TSI with consideration to their teaching methods while teaching mathematics only.

A fourth limitation of this investigation was the population. Although the population had sufficient numbers, it was limited to one urban school district. This study focused on this school district because of its student diversity. However, the information gained from using additional school districts and school districts in more than one geographical area could have resulted in different findings.

A fifth limitation of this study was the lack of randomization assignment of students to classrooms. This use of nonequivalent groups could have contributed to lack of internal validity. While no particular control was put in place to limit the effects of a lack of randomization, school officials in this school district strive to distribute students fairly into classrooms. Students were assigned in classrooms with equal representation of behavior, ELL status, disability, academic performance (based on state testing), and gender (B. Seiz, personal
communication, May 19, 2014).

**Delimitations**

All upper elementary students in this district were taught using the Arkansas Mathematics Curriculum Frameworks (ADE, 2005) and took the same AABE formatted subtest in mathematics. Since the state of Arkansas excludes first year English Language Learners (ELL) and students with severe disabilities who complete an Alternative Portfolio Assessment, these same two groups of students were excluded from this study.

**Implications**

This study contains valuable information for educators, administrators, higher education faculties, and government entities. Initially, educators might consider encouraging different instructional strategies as more effective for specific content subject; thus, recognizing that the same strategy may not always be equally effective for all content areas.

This study provides implications for classroom educators as they address the transition to the Common Core State Standards (CCSS). The research from this study reveals that allowing students the freedom to inquire, explore, and investigate their own solutions in mathematics is still more effective than teacher directed instructional strategies. The CCSS expects students to have a greater depth of understanding of mathematics and to apply that understanding in solving problems in context. The research from this study reveals that students are not as effective in learning to solve problems using a direct teaching model as they are if the teacher guides students to solve problems.

This study has significance for administrators as they evaluate mathematics teachers. As administrators evaluate mathematics teachers, less value might be placed on the direct teaching model, which has been so prevalent in the past, and more value placed on student centered
instructional strategies, such as those demonstrated by teachers who use the facilitator and delegator teaching styles.

The findings of this study have implications for administrators or curriculum specialists with the responsibility of planning and providing professional development for mathematics teachers. If students in classrooms of teachers using facilitative or delegator teaching styles have higher mathematics achievement, then the teachers might be encouraged to attend professional development that embraces those styles or school districts might consider providing more professional development training that promotes and models those styles to their teachers.

Moreover, an implication from this study suggests higher education institutions could better prepare education majors as they enter their educational methods courses and begin their teaching practicum. With much of undergraduate education courses focusing on subject content and a depth of understanding their content area, today’s education majors require a greater concentration of study on the actual methods, practices, and styles of teaching. If novice teachers entered the classroom more knowledgeable about their own teaching tactics, less burden and expense would be placed on school systems as they prepare to train and mentor less experienced teachers. Students would likewise bypass the disadvantage of having a less experienced teacher with limited teaching skills.

The findings of this study have implications for elementary administrators and their focus on new hires. First, in the screening of new applicants, administrators or leadership teams might include questions on applications and/or interview that address more student centered strategies. Secondly, the results of this study found that students in classrooms of teachers with five years or less of teaching experience scored significantly less than students in classrooms of teachers with more than five years of teaching experience. The implication for elementary administrators is to
fill vacancies in teaching staff with teachers with more than five years of teaching experience rather than beginning teachers. Additionally, greater effort should be made to decrease teacher turnover and provide opportunity to improve current staff. Also, students in classrooms of teachers with more than 20 years of teaching experience scored significantly higher than students in classrooms of teachers with less than 20 years of teaching experience. However, due to the small number of teachers with over 20 years of teaching experience, additional research should be done to use this result as an implication.

The findings of this study have implications for administrators in the local school district where the study was conducted. The NCLB (2001) Act requires that all schools make AYP for all students by 2014. With the Arkansas Waiver of 2012 (ADE, 2012), schools in Arkansas now have until 2017 to make AYP. In 2013, three of the five schools in this urban school district did not make their AMO. Thus, these three schools were identified as “needs improvement” schools. The results of this study indicates that more students might make AEP if teachers used student centered instructional strategies, as exemplified in facilitator or delegator, compared to a teacher centered or a more direct teaching strategy.

Perhaps the greatest implication gained from this study pertains to the need for teacher retention. School districts and state education departments must develop policies and procedures that encourage teachers to stay in the classroom and hone their skills for developing mathematics instruction that most effectively reaches students. Students are short changed when teachers don’t continue with the teaching or decide to transition frequently in and out of different educational settings without spending the time to truly master the art of teaching. This study most certainly suggests one way to greatly improve students’ mathematics performance is to
keep teachers in the field. Teachers, ultimately students, benefit from the years of experience spent examining instructional practices and the student outcomes garnered from those practices.

**Recommendations for Future Research**

The teaching style of each teacher was identified using a self-reporting survey. Future research should utilize an unbiased individual to observe in each classroom and identify the teaching style of the participating teacher in order to confirm the self-reported teaching style. Using observations of another individual could contribute additional information regarding a mathematics teachers’ teaching style and their effectiveness at developing mathematical thinkers with measures other than paper pencil assessments.

Although the results from this study revealed a significant difference in years of teaching experience, further research is needed with a larger population of teachers, especially with more teachers in the category of more than 20 years of experience. Instead of investigating years of experience, years of teaching experience might be limited to years of teaching mathematics. This study was limited to grades three through five teachers of mathematics. Further research is needed at other grade levels, especially at the primary and middle grades.

Indeed, the teaching style of a teacher encompasses many personal characteristics. Perhaps additional research with a concentration on specific traits will prove whether those attributes of the teacher are linked (directly or indirectly) to their instructional practices and ultimately factor in to student achievement.

Students in classrooms of teachers with less than five years of teaching experience performed below students in classrooms of teachers with more than five years of teaching experience in this study. This interesting aspect of research proposes the need for future research study on novice teachers and holds implications for educational programs in higher education.
This finding may indicate the need for more emphasis to be placed on educational methods courses so education majors graduate with adequate preparation for teaching mathematics. For students to be successful in the mathematics classroom, individual school districts take the responsibility of providing professional development for their novice teachers. However, any training may prove to be more effective after beginning teachers have gained experience managing their own classroom.
REFERENCES


doi:10.5539/ass.v8n16p30


in Mathematics Undergraduate Studies, 21(8), 732-751.


United States Department of Education, Institute of Educational Sciences National Center of


doi:10.1080/01421590120091000


# APPENDIX A
Arkansas Department of Education Consolidated State Accountability Plan

## Starting Points and Annual Expected Performance Levels (AEP)

<table>
<thead>
<tr>
<th>Starting Points Year</th>
<th>Grade 3-5 Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006-2007</td>
<td>47.50</td>
</tr>
<tr>
<td>2007-2008</td>
<td>55.00</td>
</tr>
<tr>
<td>2008-2009</td>
<td>62.50</td>
</tr>
<tr>
<td>2009-2010</td>
<td>70.00</td>
</tr>
<tr>
<td>2010-2011</td>
<td>77.50</td>
</tr>
<tr>
<td>2011-2012</td>
<td>85.00</td>
</tr>
<tr>
<td>2012-2013</td>
<td>92.50</td>
</tr>
<tr>
<td>2013-2014</td>
<td>100.00</td>
</tr>
</tbody>
</table>
APPENDIX B

Grasha's Teaching Style Inventory

http://longleaf.net/teachingstyle.html
APPENDIX C
Reliability

WINSTEPS, an analysis software program, calculated the AABE conditional standard error of measurement (CSEM) for each cut score using item response theory and the information function (ADE, 2013b, p.66). The equation for the standard error at each value of theta (ability) was given by

\[
\text{SE} (\tilde{\theta}) = \frac{1}{\sqrt{I(\theta)}}
\]

where \( I(\Theta) \) was the information function for a test at \( \Theta \). For the RASCH model, the information provided by a test at \( \Theta \) was the sum of the item information functions at \( \Theta \). Interpolation of the raw cut scores were used to derive the CSEM from the standard error associated with the theta at each cut score (ADE, 2013b, p.66).

Readers of the open response assessment items were held to the same agreement standards on live scoring as they were required to meet during the qualifying process (ADE, 2013b, p.67). Readers for the AABE Mathematics were expected to uphold an agreement of 70-80% with their peers (ADE, 2013b, p.67). The average reader agreement scores across grades for the AABE Mathematics subtest was 86 percent (ADE, 2013b, p.67).
APPENDIX D

Validity

Ary et al. (2006, p.244) described content validity as the degree to which the sample of items, tasks, or questions on a test cover the curricular standards to be measured. Arkansas educators reviewed the AABE for mathematics in order to measure what was believed all students should know and be able to achieve mathematically in each specified grade (ADE, 2013b). Assessment results indicated how Arkansas students and schools are performing when compared with the Arkansas mathematics frameworks (ADE, 2013b). Each test was carefully constructed in order to affirm the specifically intended detailed description of the mathematical content measured (ADE, 2013b, 70).

For the AABE, content validity evidence was of the utmost importance. The ADE forms annual review committees to examine new and field-tested items. These assessment review committees were comprised of educators, AABE development experts, and ADE personnel (ADE, 2013b). The professionals on the assessment review committee had the opportunity to offer suggestions for improving or eliminating any assessment items. This assessment review committee also provided insight into the interpretation of the state frameworks as they were addressed on the assessment (ADE, 2013b).

In addition to providing information on the difficulty, appropriateness, and fairness of these items, committee members provided a needed check on the alignment between the items and the frameworks that were intended to measure. When items were judged to be relevant, that provided evidence to support validity of inferences made with AABE results. When items were judged to be inappropriate for any reason, the committee could either suggest revisions or elect to eliminate the item from the field-test item pool (ADE, 2013b, p.70).
The assessment review committee ultimately verified the alignment of the test items with the objectives and measurement specifications to ensure that the items measured the state content appropriately (ADE, 2013b). Those continued review practices provided strong evidence for the content validity of the AABE.

The ADE contracted many former Arkansas educators and educators from other states to write assessment items that specifically measured objectives of the state frameworks for the AABE. Utilizing a varied team of independent contractors for assessment writing reduced single source biases in the assessment development (ADE, 2013b).

The AABE had the same validity for all students since the assessments were provided to all students under the same standardized conditions (ADE, 2013b). Since the AABE measured what subject content was required for all students to know at each grade level, the ADE went to great efforts to ensure that the AABE’s assessment items were fair and free from ethnic or cultural biases (ADE, 2013b).

The ADE staff, the professional test developers, and measurement and assessment experts from Questar, provided strong content-related expertise with assessment development (ADE, 2013b). These assessment experts offered additional evidence of the AABE’s content validity by ensuring that the AABE assessment items were accurate for the specific objectives they measured (ADE, 2013b, p.71).
November 21, 2013

Dear Mrs. Stanford:

After our conversation on Thursday, November 21, 2013, it is a great privilege for me to grant you permission to conduct a doctoral research in the Hot Springs School District. The results of this information will be invaluable to me as we move toward academic excellence.

Sincerely Yours,

[Signature]

Superintendent of Schools
APPENDIX F

Internal Review Board Approval Letter

LIBERTY UNIVERSITY
INSTITUTIONAL REVIEW BOARD

January 10, 2014

Angela Stanford
IRB Approval 1745.011014: The Effects of Teaching Style and Experience on Students’ Mathematical Achievement

Dear Angela,

We are pleased to inform you that your above study has been approved by the Liberty IRB. This approval is extended to you for one year. If data collection proceeds past one year, or if you make changes in the methodology as it pertains to human subjects, you must submit an appropriate update form to the IRB. The forms for these cases were attached to your approval email.

Please retain this letter for your records. Also, if you are conducting research as part of the requirements for a master’s thesis or doctoral dissertation, this approval letter should be included as an appendix to your completed thesis or dissertation.

Thank you for your cooperation with the IRB, and we wish you well with your research project.

Sincerely,

[Signature]

Professor, IRB Chair
Counseling

(434) 592-4054

LIBERTY UNIVERSITY
Liberty University | Training Champions for Christ since 1971
APPENDIX G

Permission to use Grasha’s Teaching Style Inventory

Due to the death of Dr. Anthony Grasha, author of Grasha’s Teaching Style Inventory, permission to use the Teaching Style Inventory is noted from a previous doctoral study (Andrews, 2004).

Hello [name]:

Thanks for the information you sent. I appreciate it. Unfortunately the web has turned into a "free for all" and any information that is in an electronic format can be posted with or without the author's position. I understand the norms currently in existence and basically am curious about where people have come in contact with the instrument more than anything else. Very little one can do to stop someone from posting it so I basically monitor things to make sure no one is selling it online.

I've never sold any of the instruments I've developed. They are available to use for free of charge and all that I've asked is that people give me a summary of the outcome of their study. My work is done not only for my personal curiosity as a psychologist but it's "for the people." I see no need to set up barriers to people using it.

I am familiar with the Glenda Short dissertation and had several communications with her. There's a lot of interest in the concepts outside the US including thesis work in the Philippines, Turkey, Spain, Malaysia, Singapore, Hong Kong, Australia, Thailand, and other places. As I tell people, the instrument is a work in process and the underlying model and concepts benefit from what people do with it. I am just delighted that others are interested.

If you want to use the TSI in your study, you certainly have my permission to make copies and do so. Just send me a summary of your outcomes.

Take care,

Tony Grasha
APPENDIX H

Participants’ Letter

January 6, 2014

Third, Fourth, Fifth Grade HSSD Teacher
Hot Springs School District
Hot Springs, AR 71913

Dear Teacher:

As a graduate student in the Education department at Liberty University, I am conducting research as part of the requirements for a doctoral degree and I am writing to invite you to participate in my study that is entitled: The Effects of Teacher's Teaching Style and Experience on Elementary Students' Mathematical Achievement.

The purpose of this study is to explore relationships among teachers' teaching styles and experience on students' mathematical achievement.

An informed consent document is attached to this letter. The informed consent form outlines the facts, implications, and any possible consequences for this study. Upon reading the document and agreeing to participate you are indeed providing your consent to participate in this research study.

As a participant in this study you will be asked to complete a Teaching Style Inventory (TSI) on a Survey-Monkey web link. It should take approximately 15-20 minutes for you to complete the questionnaire. Your identity will not be revealed during this study and only the last 4 digits of your Arkansas Teacher Identification number will be utilized in order to connect your teaching style to your students’ scaled mathematics scores.

If you chose to participate, please sign the informed consent document and return it to me within the two week deadline from January 6, 2014 to January 20, 2014. Upon receipt of the signed informed consent document, an email with the TSI’s web address found on Survey Monkey will be sent to you via school email. At that time, you will click on the TSI’ Survey Monkey web link and take part in the survey. Please have the last 4 digits of your Arkansas Teacher ID # available to when ready to begin the survey.

While responding to the teaching style questionnaire, it is pertinent you respond all the while considering your teaching methods and behaviors that are expressed when you are teaching mathematics only.

Contacts and Questions: The researcher conducting this study is Angela Stanford at astanford@liberty.edu. You may ask any question you have via email. For additional questions you may contact the researcher's faculty advisor Dr. Sandra Battige at slbattige@liberty.edu.

Sincerely,

Liberty Doctoral Student
Angela Stanford
APPENDIX I

Informed Consent Form

THE EFFECTS OF TEACHER’S TEACHING STYLE AND EXPERIENCE ON ELEMENTARY STUDENTS’ MATHEMATICAL ACHIEVEMENT

Angela Stanford
Liberty University
School of Education

You are invited to participate in a research study that will explore relationships among teachers' teaching styles and experience on students' mathematical achievement.

Because all schools in the state of Arkansas must meet AEP based on mathematical standards educators have been given the charge to increase students’ academic performance. These higher performance expectations encourage teachers to reflect upon their professional practice and pursue methods based on available research that constitutes effective mathematical instruction.

You were selected as a possible participant in this research study, because the population focuses on third-through fifth-grade elementary mathematics teachers in an urban Arkansas public school system. You work for one of the elementary schools within the school system of study.

Principal Investigator: Angela Stanford, School of Education, Liberty University.

Background Information: If specific teachers' teaching styles or years of experience are found to have a statistical significance to students' scores on the Arkansas Augmented Benchmark Examination, it may help determine the teaching style(s) most effective in promoting student success in mathematics.

Hence, in an effort to meet educational demands that enhance student learning, the possible information gained from this study may assist educators with knowledge that will further develop their own instructional effectiveness and in return increase student mastery in mathematical performance.

Procedures: Participants are asked to complete an online questionnaire consisting of questions about their instructional delivery and teaching practices while instructing mathematics. The online questionnaire will be set up on the Survey Monkey website and it is estimated to take approximately 15 to 20 minutes. The Survey Monkey website will collect the questionnaire response results. Participants will be identified by a coding system (last 4 digits of Teacher identification number) which will be held confidential by the researcher. Each teacher’s students’ scaled mathematics scores will be collected and labeled under their teacher’s identified teaching style category in order to determine if a relationship exists between student performance in mathematics and their teacher’s teaching style. The results of the study will remain confidential and participants’ records will remain private. If any part of the study is released, none of the participants will be identified.
**Risks and Benefits of Study:** This research study presents minimal risk. Since the principal investigator is a science facilitator in one of the schools of study, possible professional relationships exist between the investigator and participants, but there is no risk or threat to this relationship since this study involves mathematics and has no relevance to the science department of which the principal investigator is a part. Although there are no direct benefits for teachers participating in this study, there are potential benefits to society in the fact that teachers may develop effective teaching and learning outcomes. Teachers will also benefit by being privy to the latest research studies and results pertaining to this study. In order to meet students' increasing performance expectations teachers may benefit by building a greater awareness of their own teaching style and possibly enhance their own students’ learning outcomes.

**Compensation:** No compensation will be provided for participation in this study.

**Confidentiality:** The researcher will strive to ensure that all research data is secure and participants remain unidentified. The researcher will secure the account created by Survey Monkey by using an undisclosed username and password. The researcher will use a coding system in lieu of teachers’ names on records therefore; teachers' names will not be placed on any documents for the study. All research information will be stored on a password and firewall protected computer. Neither the school district's name nor any of the individual schools within the district will be identified by name, but rather referred to as "an urban public school system." After the completion of the research, the researcher will maintain the collected data for three years. After the three year period, all related research documentation will be destroyed through shredding.

**Voluntary Nature of the Study:** Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with Liberty University or Hot Springs School District. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

**Contacts:** If you have concerns or questions, you may contact researcher Angela Stanford @ astanford@liberty.edu. Or you may contact the researcher's faculty advisor Dr. Sandra Battige @ slbattige@liberty.edu. Additionally, if you like to talk to someone other than the researcher and advisor, you may contact the Institutional Review Board @ 1971 University Blvd, Suite 1582, Lynchburg, VA 24515, or email at irb@liberty.edu

**Statement** of Consent:

_____ I read and fully understand all the above information regarding this research study. I voluntarily consent to participate in the study.

Participant Signature: _______________________________ Date: ________________

Researcher Signature: _______________________________ Date: ________________

**IRB Code Numbers:** 1745.011014:

**IRB Expiration Date:** January 10, 2015