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What are the Effects of Curriculum Compacting on Students' Ability to Use Higher Order Thinking?

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by

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DEDICATION

First, I would like to thank my Lord and Savior, Jesus Christ. Philippians 4:13 says, "I can do all things through Christ who strengthens me." I am certain that He was my strength throughout this process. This project and my degree are dedicated to Kiara. This accomplishment started from your vision. Throughout the many trials, you held down our home and ensured that our children were well taken care of, and I appreciate you. To my two beautiful children, Amahri and Brielle, I love you. You two are my reasons for living. My time now belongs to you! To my parents, thank you for your love throughout the years. Mom, I am grateful for every sacrifice you made raising me as a single parent. You are my heart! Granny and Pop, I could not have asked for better grandparents. You two guided me, loved me, and stood in the gaps to ensure that I could pursue my dreams. I love you both! I could not have done with this without your support. This accomplishment is for my siblings, whom are all very successful. Your success inspired me. We do not compete, we celebrate all wins. I love you all. To my baby brother, Aareyun, I miss you, and I will continue to live for you.

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ABSTRACT

This action research study was a presentation of a problem of practice involving a perceived underdevelopment of higher-order thinking skills of gifted (GT) children. I identified a weakness in the previous current third-grade math curriculum that appeared to hinder the development of higher-order thinking skills. This observation led to the development of an intervention that included alternate teaching materials and strategies. The intervention aimed to address the effect of curricular modifications using a different teaching approach called *curriculum compacting.* Curriculum compacting (Reis, Burns, & Renzulli, 1993; Renzulli & Reis, 1994) is an instructional strategy that has been used to streamline learning activities for students who demonstrate proficiency on curricular objectives before teaching. The present study was guided by the following research question: What are the effects of curriculum compacting on students' ability to use higher-order thinking to solve complex math problems? The findings suggested that curriculum compacting was an effective intervention to increase higher-order thinking for gifted, third-grade students.

Keywords: action research, curriculum compacting, gifted, critical thinking, higher-order thinking, place value, and anxiety.

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CHAPTER ONE: Introduction

Identifying and finding the most effective ways to educate gifted learners has intrigued almost every society in recorded history. Today, civilizations and academic institutions across the globe continue to search for their gifted. Yet, educators and other stakeholders have struggled to come to a consensus on a definition for the term *gifted* as well as the most appropriate measures to identify it. Some individuals were considered gifted if they possessed unique abilities (Renzulli & Reis, 2017), while others were considered gifted if they were amongst the highest academic achievers (Biddick, 2009). Despite the ambiguity of a single definition, scholars declared that giftedness was one of the most precious resources any civilization could possess (Sternberg and Davidson, 2005); which is why America must aim to produce and develop its brightest students (Colangelo & Davis, 2003).

Colangelo and Davis (2003) contended that nurturing the skills of the gifted and talented (GT) was one of the most exciting, yet challenging issues in a diverse society. Over the last century, gifted education has endured an uneven history in America (Renzulli, 2011). For many years, decision-makers in the United States appeared hesitant to address the needs of gifted and talented students (Stephens, 2011). While some mandatory education laws were enacted in the mid-1800s, gifted practices in the United States were scarce and inconsistent for another century (VanTassel-Baska, 2018). It was not until the Soviet Union launched Sputnik in 1957 that Americans began to embrace the idea of recognizing and challenging its most capable learners (VanTassel-Baska, 2018).

Today, gifted education has reached one of the biggest turning points since the mid-1970s, as the field has grown at the local, state, and federal levels (Flinders & Thornton, 2013). Unfortunately, society's outlook and opinion on gifted education continues to swing on a proverbial pendulum between the goals of equality versus excellence (Colangelo & Davis, 2003). In one respect, society appreciates the aptitude and resolve of people who achieve greatness despite dire circumstances. In another respect, our nation has deep roots in egalitarianism, echoed in that powerful expression from the Declaration of Independence in which it proclaims, "all men are created equal" (Gentry & MacDougall, 2008).

When excellence was at the core of the discussion (e.g. when the Russians beat the United States into space), it shook the American educational system, and programs for the gifted quickly increased (Colangelo & Davis, 2003; Gallagher, 2003). When equality was the focal point in schools, as in the 1960s and 1970s, gifted programs were eliminated, and students of all ability levels were placed in heterogeneous classrooms, because many believed that diversity would be stimulating to the social and academic growth of all students (Lambert, 2013).

Conclusively, it can be debated that the United States has been slow to address the needs of gifted and talented students (Stephens, 2011). The dichotomy between equity and excellence in education was and continues to be a deeply rooted issue in American society, and most acknowledge the inherent value in both doctrines. Despite an increased focus on GT students in recent years, their needs remain largely overlooked within the mainstream classroom. Colangelo and Davis (2003) argued that the American educational system has routinely alienated gifted learners and their advocates by ignoring their special needs. Gifted learners comprise a large portion of an underserved population in today's academic arena (Colangelo & Wood, 2015). The literature has shown that the impact of ineffective curriculum, unaccommodating teachers, and socio-emotional difficulties can extinguish the level of achievement of gifted learners (Colangelo & Davis, 2003). As a teacher and researcher, I recognized that as education moves towards an inclusion model, meeting the needs of gifted students has become more challenging (Bradshaw, 2015). I desired to further investigate the research of experts in the gifted field in order to provide a meaningful experience for my students.

Statement of Problem

Action research requires that the teacher-researcher identifies a weakness in their teaching methods and materials that has an adverse influence on the learning of their students (Mertler, 2014). In this case, the population of GT students in a pull-out gifted class that I taught struggled to engage in higher order thinking skills. The students struggled to engage in higher order thinking because the materials used were mundane and did not promote higher-order thinking (Renzulli & Reis, 1997). Gentry (2008) noted that the relationship between using appropriately stimulating materials and an engaging teacher were the components needed to move learners beyond concrete thinking and to cultivate higher-order thinking skills. This was especially true in mathematics (Thompson, 2011).

Kloosterman (2010) argued that the ability to think at higher levels was deemed a critical instructional goal of education and a driving force behind efforts to transform mathematics education. In 1982, the results from a national assessment revealed that the cognitive capacities of high school students in the United States were deficient (VanTassel-Baska, 1992). Darling-Hammond (1990) noted that only fourteen percent of students understood straightforward inference and deductive analysis thereby forcing educators to acknowledge the need to enhance higher-order thinking skills and aid students to practice additional sophisticated thinking methods. The poor performances of US students on national and international assessments echoed research results which revealed that most US teachers found it challenging to teach and assess for higher-order thinking (Ravitch, 2010).

Since the middle of the twentieth century, America has shifted to a credentialing culture that gauged process by entrance exams, achievement tests, and measures of aptitude in basic skills (Eisner, 2004; Pierce, 2016; Renzulli, Smith, & Reis, 1982). Thompson (2011) argued that tests are ubiquitous and are administered in schools, colleges, and many other contexts. They are not only an essential tool for the assessment of abilities and efforts, but tests can also have beneficial therapeutic and developmental effects, such as enhancing memory (Karpicke, Butler, & Roediger, 2009).

However, there are downsides to testing as well. The concept that educators should "teach what is tested" became popular during the test accountability era and has minimized the opportunity for creativity, higher-order thinking, erudition, and problem-solving by marginalizing educators and students to meet target scores (Eisner, 2004). Furthermore, American educators found teaching higher-order thinking in the midst of testing mandates was cumbersome (Kloosterman, 2010). Winebrenner (2000) argued that due to their ability to score high on state proficiency assessments, various stakeholders have mistakenly assumed that these students are learning, but very little new knowledge is gained beyond what they are showing on tests developed to assess the average student.

Additionally, schools in fear of facing penalties as a result of low standardized test scores often focus on low-performing students and neglect the learning needs of their brightest students (Kaplan, 2004). To their detriment, many GT students enter the first day of school with the ability to master a majority of the content for the year and receive "busy work" to keep them occupied (Stamps, 2004; Winebrenner, 2000). Often, GT students spend most of their school day drilling and practicing the content and skills they have already mastered rather than learning new, challenging content (Stamps, 2004). These students sit in classrooms bored and disengaged, thereby increasing the gifted underachievement rate (Reis et al., 1998; Renzulli, 2011).

Early in the twentieth century, Dewey (1938) emphasized his concept that education must be experienced-based. As educators and institutions look for innovative ways to educate this population, they must remember that GT students excel at constructing meaning, not just discovering it. Eisner (1988) and Tomlinson (2008) suggested that the objective should be to create meaningful, higher-order thinking experiences for these students. Brulles and Winebrenner (2012) reasoned that without adequate challenges over time, students could become complacent and lose their fervor for learning new content. Through her research, Dweck (2000) concluded that the brains of gifted and talented students became accustomed to the lack of challenges presented in their classroom. Furthermore, when not appropriately challenged, many students resorted to maladaptive behaviors that impeded their academic performance (Tsui & Mazzocco, 2007). Based on the literature, an intervention to challenge, yet scaffold the learners to the next level of mastery was necessary.

As the researcher of this study, I taught math to GT third-grade students in a pull-out program in a public school. I observed that the students mastered the subject matter quickly but struggled to engage in higher-order thinking skills to solve complex math problems. Based on these observations, I concluded the factors that contributed to the students' disengagement in higher-order thinking were likely due to a) mundane nature of the instructional materials, and b) teaching strategies used in the mainstream classroom did not develop higher-order thinking (Renzulli & Reis, 1997c).

Before my intervention, the prescribed curriculum and materials were intended for middle learners but assigned to my GT class. The curriculum moved ahead rapidly, transitioning from skill to skill as opposed to an emphasis on an in-depth understanding and application of the skills. The prescribed curriculum followed the district's curricular scope and sequence that left little or no time to explore concepts at a deeper level. I believed that GT students' thinking could go beyond that which was prescribed in the current text (Gavin et al., 2007). For my GT students, the lack of time to explore concepts at deeper levels was detrimental to their innovative and creative attitude as well as to their overall academic performance. For many of the math GT students in this study, this was the first time in which they were not experts in the content area. In order to become an expert in this subject matter, the content required higher-order thinking skills.

The intervention was a rarely used strategy called curriculum compacting (Troxclair, 2000). Curriculum compacting requires the educator to remove all previously mastered content. Once the content's rigor level is beyond the students' current ability, the educator meets the students at their academic level and scaffolds them until the next level of mastery is achieved (Troxclair, 2000; Stamps, 2004). The compacted unit of study on place value, *Unraveling the Mystery of the MoLi Stone*, was the winner of the National Association for Gifted Children Distinguished Curriculum Studies Awards (Gavin et al., 2006). It explored place value and multiple numerations system in depth. The three big ideas are patterns, groupings, and symbols that help students develop critical thinking skills (Gavin, et al., 2006; Sutton, 2010).

Study Rationale

The ability to reason at higher levels was deemed a critical instructional goal of education and remained a driving force behind efforts to improve mathematics education in particular (Thompson, 2011). Mathematics is an area of the curriculum that demands the attention of educators, policymakers, and other stakeholders (VanTassel-Baska & Hubbard, 2016). National Council of Teachers of Mathematics (NCTM) (2000) suggested that a nation's success was partially based on the mathematical competencies of the population. The literature indicated that the needs of precocious math students must be strengthened and their talents cultivated through a rigorous curriculum, acceleration, and breadth of conceptual mathematical understandings. NCTM (2000) argued that gifted students differ in mathematical ability based on the pace at which they learn, the depth of understanding and that an early onset of mathematical interest and understanding must be nurtured. The Third International Mathematics and Science study asserted that most United States mathematics curricula were "a mile wide, an inch deep" because they covered too many themes that were disjointed and failed to challenge students intellectually (Gonzalez et al., 2004).

Additionally, Thompson (2011) noted that affectively, many gifted learners are highly impatient. Thompson argued that their academic quickness and awareness could be altered into boredom and frustration when they are restricted in a regular classroom situation, or when they are subjected to a start-and-stop method of instruction and being forced to wait until the rest of the class catches up. When there is a disconnection between appropriate pacing, materials, and strategies, their frustration is heightened (Reis & Renzulli, 2017). Renzulli (2011) argued that gifted learners have a passion for constructing knowledge for themselves, and an ability to create novice ideas and to artistically synthesize existing concepts. Due to the curricular misalignment and lack of academic opportunities for GT students, schools become places where exceptional students grew to dislike and where they exerted minimal effort (Brulles & Winebrenner, 2012; Kennedy, 1995). Curriculum planners for the gifted need to be mindful of the optimal match between learner's capacity and level of experiences provided (VanTassel-Baska, 2003).

The problem of practice began when I identified that when place value and numeration were taught in with an inept curriculum, many students became bored and disruptive due to the lack of rigor. During assessments in their general education classes, the study's participants mastered activities requiring recall that resulted from the recency effect of instruction; however, they struggled to apply this knowledge to other concepts (Berry, Waterman, Baddeley, Hitch, & Allen, 2018). What was missing was an in-depth understanding of place value and numeration. With a more in-depth understanding, the skills became more ingrained in their neural schemata and remained there for long-term memory recall at later times (Marzano, 1993). In sum, this study focused on an innovative approach to teaching called curriculum compacting to improve students' academic performance. Curriculum compacting takes a topic from simple memorization to a level of higher-order thinking. It is believed that when students reach a high degree of understanding, they will be better able to apply that concept to other areas by becoming more capable of analyzing, evaluating, drawing generalizations, and transferring knowledge from one discipline to another.

Purpose of the Study

The egalitarian philosophy that has dominated the educational policy arena led to the creation of the No Child Left Behind legislation in the early 1990s (Hodgkinson, 2007). Hodgkinson (2007) emphasized that this legislation contributed to a system that generated low-level schooling and one-size-fits-all implementation standards in many schools. Hodgkinson posited that while acceleration, enrichment, and counseling were the primary interventions used with gifted learners for the past century, it remained unclear which practices and conditions were most beneficial for gifted learners. Beyond these methods, curricula for gifted learners remained inadequate regarding rigor, depth, and pace, especially regarding mathematics (Hodgkinson, 2007). I agreed and began to formulate a study to focus on higher-order thinking skills to solve complex math problems.

The purpose of this study was to measure the difference between the pre- and posttest scores of third-grade gifted students when instructed using the curriculum compacting strategy to teach place value and numeration. The intervention took place in a GT pull-out math class, once a week, for nine weeks. The curriculum used in the study came with a pre- and posttest which measured the levels of higher-order thinking and problem solving as they related to place value. The specific purpose of this study was to measure the effects of using curriculum compacting on the participants' ability to utilize higher-order thinking to solve complex math problems.

As a gifted specialist in the district, the role required me to act as a consultant on both the district and building level. In this capacity, when asked to recommend alternate materials and practices, it was imperative that the recommended materials or strategies were viable and practical and had statistical results that were applicable to the district's student population. Along with other educators, my concerns about the type of instruction provided to the gifted population were voiced. The program coordinator provided curricular resources, Project M^3's unit of study on place value, *Unraveling the Mystery of the MoLi Stone.* This unit was the winner of the National Association for Gifted Children Distinguished Curriculum Studies Awards (Gavin et al., 2006). This curriculum added to the depth of learning gifted students received. With this unit, I sought to demonstrate that curriculum compacting methodology was a viable solution to assists GT students in enhancing their higher-order thinking skills. The findings of this teaching method and the study were shared with others within the district.

This quantitative study was to measure student knowledge on place value before and after the implementation of the unit lessons. The instructional period lasted nine weeks and included the application of curriculum compacting in the third-grade unit of study on place value and numeration systems. A one-group pretest and posttest method was applied. A research-based pre- and posttest were utilized to measure the individual growth in higher-order thinking that may have resulted from the intervention.

Research Question

One overarching research question evolved: What are the effects of curriculum compacting on students' ability to use higher-order thinking to solve complex math problems?

Theoretical Framework

The theoretical frameworks that guided this study were Bloom's (1956) taxonomy Vygotsky's (1978) sociocultural theory of learning, and Tomlinson's (2000) differentiated instruction. In combination, these theories supported the notion that the development of higher-order thinking was a progressive step that was vital for gifted learners (Bloom, 1956, Herr & Anderson, 2005, Resnick, 1987).

Bloom's (1956) taxonomy of critical thinking begins with *remembering knowledge and understanding* information; the two basic levels of thinking are assumed to be attainable by most individuals. However, for students with the gifted and talented designation, there can be expectations that they can perform at a higher level than their contemporaries (Barrouillet, 2015; Piaget, 1952). This study focused on a gifted and talented third-grade, pull-out math course, and, therefore, higher levels of thinking were the goal of instruction. Through previous assessments and classroom observations, it was determined that these students were capable of moving beyond the concrete knowledge level of thinking on numeration systems and place value. It was believed that GT students could surpass the first two levels of thinking and engaging in higher-thinking skills of analysis, evaluation, and synthesis (Bloom, 1956).

Educators and researchers alike, believe the social constructivist learning theory plays a significant part in instructional enhancement and revitalization of classrooms (Subban, 2006). This theory is grounded on the premise that the learner must be educated in a specific social and cultural context which is required for the development of higher-order functions, and such functions can only be attained and refined after social interaction (Subban & Round, 2015). Subban and Round (2015) further espoused that Vygotsky's (1978) zone of proximal development was a key point of emphasis in his theory. The zone of proximal development connects that which is known to that which is unknown (Vygotsky, 1978).

Tomlinson (2000), a leading expert in differentiation, defined differentiated instruction as a philosophy of teaching that is constructed on the principle that students learn best when their teachers adapt to the differences in their abilities, interests, and learning profiles. Tomlinson (2015) maintained that differentiation is not just an instructional approach, nor is it a formula for schooling; rather it is a novel way of thinking about teaching and learning. Differentiated sees the learning experience as a shared, social experience which reflects Vygotsky's socio-cultural theory (Tomlinson, 2005).

Application of Theory

Dewey (1938) argued that thinking does not occur randomly, but must be evoked by problems, unresolved questions, or uncertainties. Students must understand that many real-life issues are often complicated and multifaceted. Teaching higher-ordering thinking in the subject matter curriculum of math provided the students with applicable life skills that could help them deal with difficult situations they may encounter in life

(Henriksen, Good, & Mishra, 2015; McDavitt, 1993). Mirzaee and Maftoon (2016) emphasized that higher-order thinking should be non-algorithmic and intricate, produce several solutions, and employ the application of self-regulation when facing uncertainty. This emphasis on higher order thinking led to the implementation of an intervention that encouraged students to use higher-order thinking.

The teaching strategy and intervention, called curriculum compacting, was designed to move students into higher levels thinking. Piaget (1952) recognized that the average learner at eight or nine-years of age is at the concrete level of thinking. However, most gifted students' intelligence quotient (IQ) is typically above average. With a higher IQ, combined with advanced levels of achievement, it was feasible that the GT third-graders would advance to higher-order thinking. Students should aim to advance to a deeper level of thinking by *analyzing, evaluating, and synthesizing* information to the depth where they would be able to *create* new meaning (Anderson, Krathwohl, & Bloom, 2001).

The pedagogical proposal of this concept was that the educator presented content and materials responsive to the learner's current developmental level. Vygotsky's (1978) zone of proximal development emphasized that a learner-expert collaboration, which exposes the learner to an expert's theoretical advancement, thrusting them beyond their existing developmental level until they are autonomous in their learning of the subject (Armstrong, 2015). Vygotsky (1978) emphasized the purpose of shared interaction with an expert may include steering, modeling, and conversations between the students and the expert (Hodson & Hodson, 1998). To move students beyond the lower levels of Bloom's taxonomy, educators should use Vygotsky's zone of proximal development (ZPD) by providing content slightly too difficult for students to do on their own, but simple enough for them to do with assistance. Our teaching will be more effective if we teach in this ZPD. It allows us to understand and enable learning (Vygotsky, 1978; Chaiklin, 2003).

A fundamental belief of the differentiated model is that teachers must engage students (Tomlinson, 2000a). Research suggested that curricula should be planned to engage students, it should have the capacity to link their lives and positively affect their levels of motivation (Tomlinson, 2015). By knowing their students, educators can determine their strengths, thus helping them make progress (MacGillivray and Rueda, 2001). Actively engaging students in the learning process and the content provides an opportunity to see patterns developing, to see the connection between disciplines, and to see learning as a collective whole (Coleman, 2001). Tirri and Kuusisto (2013) emphasized that a goal of differentiation is to adjust the pace of learning. Sometimes gifted students need to move quickly through familiar or minimally challenging content (Tomlinson, 2005). This form of acceleration is called curriculum compacting (Colangelo & Assouline, 2009).

Nature of the Study

The nature and scope of the study are bound by the delimitations of one intact classroom in which I was the teacher. To respond to the research question, what are the effects of curriculum compacting on students' ability to use higher-order thinking to solve complex math problems? A quantitative study approach was employed.

Action Research

Action research, like other forms of research, was frequently utilized to advance the use of theories that guided the best practices in education (Johnson, 2008). Typically, action research occurred in the natural setting where the phenomena were researched and analyzed (Brighton & Moon, 2007). Action research provided an opportunity for the investigator to experiment with innovative ideas (Eden & Ackermann, 2018) that incorporated a focus on how diverse populations function in a heterogeneous setting (Brighton & Moon, 2007; Kirova, Massing, Prochner, & Cleghorn, 2016; Tomlinson, 1995). Good pedagogy has always involved a systematic examination of the instruction process and its effects on student learning (Mertler, 2014). Rigor in action research is typically based on procedures of checking to ensure that the results are not biased or that they truly reflect an individual's perspective (Stringer, 2007). Research is also comprehensive and must include not only a change in teaching strategy but must also assess how students are adjusting to the new strategy.

It is practical for teachers and schools to analyze realistic and relevant issues and quickly respond with action (Brighton & Moon, 2007). A key component of action research is for the researcher to become a part of the study and is often referred to as the teacher-researcher (Mertler, 2014). Effective educators must attempt to reduce the gap between academic theory and the actual practice of pedagogy (Brighton & Moon, 2007; Mertler, 2014). Parsons & Brown (2002) equated the gap with the following analogy: Research happens in the ivory towers, while practice develops in the trenches. In short, experiments in labs do not adequately reflect or represent the curriculum, instruction, and student learning in each classroom throughout American classrooms (Johnson, 2008). It is vital to remember that researchers in action research can make mistakes and should readjust their focus occasionally (Melrose, 2001; Mertler, 2014). It was essential that upon completion of the intervention, I reflected on the process and the results (Mertler, 2014). Due to the constant evolution of an action research study, it is tough to make a generalizable conclusion. Therefore, the results were primarily for improving the learning that takes place in a particular setting (Mertler, 2014).

Action research is by nature cyclical. The cyclical nature of the research is essential because each cycle teaches the researcher more and credibility is gained (Melrose, 2001). This study followed the cyclical action research model as described by Mertler (2014) for planning, acting, developing, and reflecting. The first phase, planning, is comprised of (a) identifying and limiting the topic, (b) gathering information, (c) reviewing related literature, and (d) developing a research plan (Mertler, 2014). Acting, the second phase, is comprised of implementing the plan and collecting data (Mertler, 2014). Developing an action is the third phase (Mertler, 2014). The fourth phase is reflecting, which is comprised of sharing the results and reflecting on the process (Mertler, 2014). Inspired by the work of Parsons and Brown (2002), employing action research was imperative to actively participate in the classroom, not merely to observe the learning process, but to take action to develop an intervention.

Assumptions

I assumed that third-grade gifted students could engage in higher-order thinking skills. It was also assumed that the use of curriculum compacting was an appropriate method for enhancing GT higher-order thinking skills. It was anticipated that the GT students would develop concerns when challenged beyond their comfort levels. As their teacher, I would support their academic attainment. This theory will be further defined in Chapter Two. An assumption was made that the parents of the GT students in the class would support the implementation of the intervention.

Limitations or Potential Weaknesses of the Study

A limitation of this study was the small sample size. The study began with fifteen participants, but only twelve students remained through the intervention. Several students of military families moved out of the district before the conclusion of the study. This disruption interfered with sample size and test results. Also, I had a limited time frame in the field, and the study's timeframe had to coincide with the approvals required to initiate this study. Furthermore, if a parent or student decided that they do not want to participate in the study, an alternate subject area plan was used for that student, and the student was provided a different curriculum while the intervention took place.

Delimitations

The study was delimited due to the intact classroom where the I taught. No other classroom or teaching space was used in this study. I understood that if the study yielded findings substantiating the value of using curriculum compacting to enhance higher-order thinking, other teachers might decide to implement the strategies tested in this action research.

Significance of the Study

The study findings were significant in understanding the academic development of GT students. The students demonstrated their capability of learning at a higher level when instructed by a GT trained teacher at their level of instruction using curriculum compacting. The primary significance was embedded in how GT learners adapted to a new curriculum or new teaching strategies.

From my perspective, the study findings show how new knowledge can be generated using an action research approach. It is imperative to pilot and try out new techniques before endorsing them to peers. The findings were significant to share with colleagues because I am responsible for informing other educators about new practices that have been met with success.

Knowledge Generation

Characteristics and needs perceived as significant for the identification of the gifted are also vital for curriculum design. In the cognitive domain, the ability to manipulate abstract mathematical functions far greater than their same-age peers rejects lockstep, incremental parts-of-a-whole instructional process, which is often applied in general classrooms (VanTassel-Baska, 1992). The pace and rate of gifted students' ability to ascertain material and the manner in which they can consume and process vast quantities of information detail the need for advanced work (VanTassel-Baska, 2003). For many gifted learners, they learn at an accelerated pace, and their abilities are often operationally two to six years ahead of their same-age peers. VanTassel-Baska (2018) contended that the intellectual prowess of gifted learners enables them to grasp ideas and systems of thought holistically rather than fragmentary, decreasing the time required to teach them any given topic.

Often gifted math students were placed in settings that lacked differentiated instruction at an accelerated pace, and that matched their ability levels (Gavin et al., 2007). The literature suggested that high-ability students in mathematics required a setting and curriculum that provided opportunities for complex mathematical analysis (Gavin et al., 2007). Mirzaee and Maftoon (2016) suggested that many educators resorted to moving students to the next grade level, but this did not ensure that the students would be given a curriculum that evoked higher-order thinking that can aid in their intellectual development (Gavin et al., 2006). The knowledge gained from this study may apply to other gifted classrooms both within the school system used for this study and beyond. Additionally, the data was used in three ways: 1) to revise and improve my instructional competencies, 2) to motivate colleagues to use new practices, and 3) and to share with others at gifted conferences and academic journals.

Professional Application

Despite a consensus that there is a significant need to differentiate instruction to match gifted students' abilities, many mainstream teachers lack a strong foundation to push the students beyond their current knowledge to scaffold their learning to a higher level (Gavin et al., 2007; Vygosky, 1978). Educators must understand that students need opportunities to have mathematical conversations and higher-order thinking activities that match their ability levels. It is vital for a teacher to interact and engage students in activities promoting higher-order thinking.

As a practitioner, this study helped me expand the knowledge and understanding of the general education teachers on best ways to teach gifted students in classrooms. The findings of this study led to the implementation of professional development workshops in the district and perhaps at other venues/conferences offering teacher enhancement work sessions. Through instruction, these opportunities could heighten one's level of understanding and professional development. An additional goal was to publish the findings in journals suitable for teachers of the gifted. Possible journals where this study's findings can be published are the *Sage Journal, Journal for the Education of the Gifted, Parenting for Gifted Children, Teaching for High Potential, Gifted Child Quarterly,* and *Diverse Teaching Strategies for Diverse Learners (ASCD).*

Social Change

As society becomes more diverse, it is vital for all administrators and teachers to recognize as well as support the needs that exist for all groups of students regardless of their ethnic background, disability, socioeconomic status, linguistic, or intellectual abilities (Grensing-Pophal, 2017). Oppressed by society's deeply rooted biases and notions of intelligence and giftedness, too many marginalized groups, fail to reach their potential in American schools (Ford & King, 2014). Gifted students in these subgroups were nearly three times less likely to be recognized for their achievements than that of their white counterparts (Grensing-Pophal, 2017). Due to these differences, a number of gifted students were marginalized and struggled to identify and define themselves in the context of our present society (Herr, Castro, & Canty, 2012).

The rigor of education and access to an equitable education, including gifted programs, are linked to racial stratification and exclusion (Ford & King, 2014). Historically, racially and socioeconomically segregated programs have operated to accommodate and placate whites to prevent "white flight" from school districts across the country (Kohn, 1998). Ford and King (2014) argued that for several decades, educators, policy makers, curriculum writers, and legal representatives have ignored and failed to attract minority students of all sub-groups. However, when identified as gifted, minority students still lag behind their white contemporaries (Ford & King, 2014).

The findings of a United States Department of Education study revealed that minority students were severely underrepresented in programs designed to serve gifted and talented students (Herr, Castro, & Canty, 2012). Standardized tools typically used to assess student ability and qualify students for program entry are culturally biased toward the white middle-class student. Biased testing measures have led to an uneven balance of white students being served in gifted programs. This testing bias phenomenon has resulted in the exclusion of non-white students from racial, ethnic, or family orientation who may have different experiences than those portrayed in the assessments (Grensing-Pophal, 2017).

In the mid to late 20th century, researchers such as Samuda (1975) started a movement to denounce the culturally biased tests used to identify gifted students. Notwithstanding the testing bias reason(s) for underrepresentation, unfair access to gifted education still exists (Ford & King, 2014). Beleaguered groups such as African Americans and Hispanics tend to score lower than their white counterparts on standardized measurement (Herr, Castro, & Canty, 2012). Research reviews suggested that traditional assessment methods, including standardized IQ tests, teacher recommendations, and parent questionnaires, are inadequate in identifying gifted minorities (Atnafu, 2012).

Also, minority gifted and talented students are restricted by misconceptions as well as a lack of support (Grensing-Pophal, 2017). Hispanic and black students make up forty percent of the educational population, but only nine percent of those in gifted and talented programs (Grensing-Pophal, 2017). Dreadfully, the numbers for Native Americans and Pacific Island student enrollment in gifted programs were lower (Grensing-Pophal, 2017). Inclusion in gifted programs gives these students a boost in the social and economic hierarchy, a system reserved for social privilege, class privilege, and white privilege (Ford & King, 2014). Mueller and Haines (2012) identified several additional issues that are significant to gifted minority students such as:

- Low cultural expectations for achievement, revealed by little reassurance or support.
- Peer rejection, particularly for young black males.
- Conflict produced by cultivating one's potential and succeeding in the "majority" culture and exiting one's cultural group to do so.

Furthermore, expectations in the families of low SES students can be impractical, hindering the flow of appropriate communications between home and school (Atnafu, 2012). Herr, Castro, and Canty (2012) contended that whether the discussion is about minority students or poor white students form rural areas; one issue remains common to each group: they exist outside the mainstream systems that offer access to educational advantage. This knowledge is crucial to converting high aspirations into creative, productive achievement at various stages of development (Atnafu, 2012). Educators must be proactive, intentional, and meticulous about removing intended and inadvertent barricades to desegregating and integrating gifted education for minority students (Ford & King, 2014).

The unit used during this intervention was supported by the Jacob Javits Gifted and Talented Students Education Act (Javits) (Gallagher, 2015); which places a number of resources on identifying and serving students who are customarily underrepresented in gifted programs. The program aims to help reduce the achievement gap and promote equity in educational opportunities for all students (Gallagher, 2015).

The unit incorporated multiple assessment opportunities for all students, instead of the typical language-based assessment (Gavin et al., 2007). The curriculum allowed my students to display their level of mastery in multiple ways. They were able to use manipulatives, compute equations, respond verbally, and through writing. By providing verbal and nonverbal measures, it increased the success of minority students (Naglieri & Ford, 2015). Naglieri and Ford (2015) argued that the equitable and culturally responsive reasons of nonverbal measures of general ability, is to measure general ability without the muddling the influence of knowledge, access, linguistic ability, opportunity, socio-economic, and other inequalities confronting minority students (Ford, 2010).

This is an issue that I am sensitive to and carefully selected this curriculum to compact because of its emphasis on resources for diversity appreciation (Gavin et al., 2007). I aimed to improve the development of ability, achievement, social, and economic progress of any marginalized gifted student in my classroom. It was vital that I had an accurate picture of how marginalized students struggle for recognition of their talents. I believe that using culturally sensitive learning experiences and resources could have a positive impact (Grensing-Pophal, 2017).

Definition of Terms

Included in this section are definitions of the terminology that, although they may be commonly known by those in the field of teaching GT students, are important to define. The meanings as to how they are used in the context of this action research on gifted students are presented in this section.

Critical thinking. A form of contemplation involving identifying critical parts of statements and relative relationships, deducing information correctly, discerning the appropriate conclusions, and evaluating the results (Pascarella & Terenzini, 1991).

Curriculum compacting. An instructional technique used to adjust curricula as needed in any area and for any grade level. Curriculum compacting is accomplished by outlining the goal of the unit, recognizing and documenting the students who have previously achieved the desired goals, and supplying more challenging alternatives for the material already mastered by those students (Reis & Renzulli, 1995).

Differentiation. The process of altering instruction in a classroom based on the variance of learners in attendance to establish an ideal learning experience for all students (Tomlinson, 2000).

Gifted students. Students who can exhibit a high capability of achievement in various categories including creativity intellectuality and leadership (National Association for Gifted Children, n.d.).

Heterogeneous classroom. A classroom comprised of students at various learning levels (Penny, 2005).

High-stakes tests. When the results of an analysis are employed to make a choice impacting students, instructors, administrators, and communities (Au, 2007).

Higher-order thinking. A thought processing method in which a person will rely on new data and comparative stored memory to devise solutions to a given problem or situation. This lends to decisions such as what to believe, methods of creating new objects, and guessing outcomes (Lewis & Smith, 1993).

Normalized gain (Average of gains). A measure of the effectiveness of teaching methods. The equation is g-average =⟨(Posttest %-Pretest %) (100%-Pretest %)⟩ (Madsen, Sayre, & McKagan, 2017).

Number sense. An understanding of numbers and mathematical constructs and the ability to work flexibly with numbers. Which includes the capacity to make estimations, determine the rationality of calculation, and utilize numerical benchmarks to direct measurable activity (Sowder & Schappelle, 1989).

Place value. Comprehensive and analytical knowledge of the various parts of multi-digit numerals (McGuire & Kinzie, 2013) and the ability to deconstruct and reconstruct those numbers (Walkowiak, 2016).

Scaffolding. Scaffolding is the support, guidance, advice, prompts, direction or resources a learner is given that enables them to complete a task otherwise out of reach (Davis & Miyake, 2004). The scaffolding enables students to learn to do these tasks independently. As students become more independent in doing a task, the scaffold is removed (Wass & Golding, 2014).

Test anxiety. Test anxiety has been described as a negative emotional or cognitive response to situations in which performance is being measured or assessed (Cassady & Johnson, 2002). It is comprised of two dimensions: a cognitive and an emotional component (McDonald, 2001).

Conclusion and Summary

Reis and Renzulli's (1992) study revealed that educators and students viewed curriculum compacting activities as more challenging than the standard instructional method. This led to an increase in achievement for GT students. Gifted students need to be energized and encouraged to use the higher thinking skills inherent in their advanced IQ levels. Teachers should avoid administering "more of the same" work to students who complete tasks early and quickly. Instead, educators should assign differentiated, more complex work to promote the advancement of GT students who have the potential to be future leaders (Stamps, 2004). Educators can begin to construct comprehensive curriculum practices for gifted learners, backed by research on the latest development in pedagogy, motivation, and child development (VanTassel-Baska, 2003). This action research study was an attempt to inspire GT students to achieve higher positions in life where they can make the most of their higher-level abilities.

In summary, Chapter One provided a presentation of what is known and what is not known about a teaching strategy for gifted students. The problem for this research was that students' comprehension was limited to a superficial understanding of place value and numeration. When challenged, my students struggled to engage in higher-order thinking. The action background of the problem was presented and supported by the literature. The purpose and rationale of the study were discussed which led to the study's research question: What are the effects of curriculum compacting on students' ability to use higher-order thinking to solve complex math problems? The literature review in Chapter Two supports the study proposition and illuminates what already exists in the literature and what is yet to be known. Theoretical frameworks were established and will be used to create triangulation processes for the methodological section in Chapter Three and lend support to the findings.

CHAPTER TWO: Literature Review

The purpose of this chapter is to provide a historical and theoretical foundation for readers to understand how introducing curriculum compacting to third-grade gifted students influences their ability to utilize higher-order thinking (HOT) skills (Mirzaee & Maftoon, 2016). As a gifted and talented specialist, I identified that the prescribed math curriculum used prior to this study lacked rigor and, therefore, was an area of concern. The materials did not adequately address the depth of understanding or cultivate HOT as depicted by Bloom's Taxonomy for gifted (GT) students. The problem of practice for this study was that students' understanding of numeration systems and mathematical place value was superficial. Students recognized the positionality of multiple digits, but had difficulty engaging in higher-order thinking to solve complex problems.

Bloom (1956) stated that when assessing for higher-order thinking, the math problem must be new, unfamiliar, or in some way atypical from those utilized in instruction. Based on the literature, a different instructional technique was sought to engage and challenge gifted students, namely curriculum compacting. I conducted an exhaustive review of the published literature on the problem of practice and became more knowledgeable of all the materials and strategies needed to conduct the research. For instance, I examined information significant to this study including curricula and strategies that have already been used to enhance higher-order thinking and the methodological approaches to measuring the effectiveness of such programs. Seminal studies were reviewed and discussed in the literature review and provided baseline information to support this study. The strengths and weaknesses of the studies were noted and used to enhance the effectiveness of the proposed action research intervention.

This research project included an investigation of curriculum compacting for gifted and talented third graders. It was important not to underestimate their abilities, but also to not overestimate them either. Effective research also included opposing views of a topic. Therefore, the research comprised views on gifted students in the regular classroom and assessments providing differentiated instruction (Tomlinson, 2005; Vantassel-Baska, 2003; Winebrenner, 2003).

Context of Gifted Education

Unfortunately, researchers have discovered that high ability students did not receive the support they needed; instead, they were pushed through a rigid curriculum that promoted using the same pace, similar materials, and without differentiation (Gentry, 1999, 2016). To further complicate the matter, many students who were academically ahead of their peers were forced to complete tedious assignments or assist struggling students; which often amplified the students' underachievement (Stamps, 2004). Renzulli (2011) noted that many teachers felt guilty and discouraged for overwhelming gifted students with previously mastered work instead of providing them with new, complex assignments. Nonetheless, Bradshaw (2015) argued that teachers must work hard to meet the needs of all their students on a daily basis. Gentry (1999, 2016) contended that if teachers failed to include methods that included a differentiated curriculum and strategies, there would be great harm done to the entire GT field and the students they serve.

What is known is that many gifted children were ignored in heterogeneous classrooms because so much attention was given to struggling and below average students who were borderline proficient (Grgich, 2009). For some students, the lack of rigor and engagement can lead to temporary or chronic underachievement (MacCabe et al., 2010). If unresolved, chronic underachievement can lead to a lack of academic attainment (Peterson, 2015). Siegle, McCoach, and Roberts (2017) reported that ten to twenty percent of high school dropouts tested in the gifted range. Thus, creating an unlikely at-risk group. In any of these circumstances, a curriculum intervention was warranted (Rambo-Hernandez & McCoach, 2015).

Undoubtedly, the absence of curricular differentiation and academic rigor for the brightest students in America has been a significant issue within the educational system (Gentry, 2016; Reis & Renzulli, 1992). Based on the research of Renzulli (2011), it was apparent that GT students benefited the most when curricula and strategies were matched to their abilities. However, this task appeared to be insurmountable for some teachers (Gentry & MacDougall, 2008). To reach gifted learners, educators must remember that gifted students differ from their classmates in three aspects: learning pace, the complexity of their comprehension, and the topics they find attractive (Pomortseva 2014). In contrast, dissidents argued that differentiation should be used for all students; however, research has shown that despite the apparent impact of differentiation, it was seldom used (Taylor & Frye; Reis & Renzulli, 1992). Even when used, differentiation within traditional models of instruction has been largely unsuccessful in meeting the needs of gifted learners (VanTassel-Baska, 2018).

Through an intensive search of alternative pedagogical practices that would be better suited to enhance higher-order thinking, curriculum compacting was chosen for the current action research project (Reis, Westberg, Kulikowich, & Purcell, 1998; Sutton, 2000). The challenge was to initiate a high-interest level that would be sustained throughout the unit of study on numeration systems and place value (Pomortseva, 2014). Research has indicated that modification of the academic environment may meet with success in reversing underachievement in gifted students. VanTassel-Baska and Stambaugh (2007) asserted that without appropriate modification or differentiation, gifted students would "regress" in their performance or underachieve. The literature indicated that gifted underachievers and dropouts were not academically engaged. They were seldom on-task; chose to engage in disruptive behaviors (Baum, Schader, & Hebert, 2014).

Due to curriculum compacting being the approach selected for this intervention, it was necessary to review studies that used the curriculum compacting strategies and materials; and to identify in what contexts the materials were used. Reis and Renzulli (1992) posited that curriculum compacting was useful when teachers desired an alternative approach to differentiated instruction because the teacher could adjust the curriculum to the needs of the students. In a federal study of curriculum compacting, students who received compacting in science and mathematics scored remarkably higher on performance posttests than their classmates in the control group, implying the advantages of curriculum compacting for increasing achievement assessments (Gentry, 2016; Sutton, 2000).

As a teacher, I understood that as education moves towards an inclusion model, meeting the needs of gifted students has become more challenging (Bradshaw, 2015). I desired to further investigate the research of experts in the gifted field in order to provide a meaningful experience for my students. One of my goal was to avert negative behaviors and underachievement by meeting the needs of my students. Research has shown that inadequate curriculum, unsupportive educators, socio-emotional difficulties can extinguish the potentially high accomplishment of gifted children and adolescents (Colangelo & Davis, 2003). The research of Renzulli, Gallagher, Gentry, and others have provided further insights into how to meet the needs of GT students (Stamps, 2004).

The Underachievement of Gifted Students

Gifted students, by definition, exhibit potential for high scholastic success (Bush, 2001). Despite their potential, GT students presented some of the most significant challenges, and perhaps some of the most notable encounters for teachers. Nonetheless, Bennett-Rappell and Northcote (2016) espoused that GT children were considered national and global resources who possessed the potential to enhance our civilization in comprehensive ways. It would be advantageous for our school systems throughout the country to foster their talents so that they might improve the social fabric and economic well-being within their communities and globally (Rafidi, 2008). To effectively teach and meet the needs of GT students, teachers were prompted to consider the experiences of GT students which included how they were labeled, how they developed their identity, and how they experienced academic guidance (Coleman, Micko, & Cross, 2015).

In a longitudinal study by Hollingworth in the 1940s, he discovered that GT students were not always given the opportunity to maximize their abilities in school which stunted their academic potential and led to underachievement (Bennett-Rappell & Northcote, 2016). Ziegler, Ziegler, and Stoeger (2012) defined underachievement as a “substantial” discrepancy between a high degree of giftedness and a comparatively low degree of achievement. Siegle, McCoach, and Roberts (2016) noted that underachievement is one of the most exasperating and mystifying issues in gifted education. Gifted underachievers, as compared to achievers, manifest certain patterns of behavior: social immaturity, emotional problems, antisocial behavior, and low self-concept.

Coleman, Micko, and Cross (2015) maintained that underachievement appeared to be a major factor in assessing the dropout risk among GT students since it appeared to precede decisions to drop out of high school. Interviews with high-ability students who chose to leave high school without a diploma revealed that most did not put forth their full efforts nor were they adequately challenged (Landis & Reschly, 2013). Moreover, as with other dropouts, the potential these students have to contribute to society is often diminished or lost when they drop out (Rafidi, 2008). Gifted students who drop out experience many of the same adverse life outcomes as other dropouts, including reduced earnings and increased need for government assistance (Landis & Reschly, 2013).

Research in the general dropout literature indicated that there were promising dropout prevention strategies. Given the high aptitude for academics that GT students exhibited early in their academic careers, it stood to reason that intervening with this group had great potential for success. Thus, the importance of bringing gifted students and their curricular, social, and emotional needs into higher prominence in the dropout literature cannot be overstated (Landis & Reschly, 2013). To broaden the scope of discussion, it was useful to characterize dropping out of school as an extreme manifestation of underachievement, which has attracted more attention in recent years within the gifted education literature (Ritchotte, Rubenstein, & Murry, 2015).

Application of Curriculum Compacting

I was aware that the curriculum compacting strategy would be new to most stakeholders involved in the study. Unfortunately, the literature on curriculum compacting was limited and antiquated; most of the research found was over twenty-years-old. In the 1980s and 1990s, studies revealed that curriculum compacting had been advantageous in gifted classrooms (Renzulli & Reis, 1985; Troxclair, 2000). Despite the limited research, past studies have shown curriculum compacting to be an effective strategy to combat issues that were associated with acceleration, because this method did not impose on the succeeding year's curriculum (Bailey, 1992; Reis, Westberg, Kulikowich, & Purcell, 1998).

Compacting was efficient in adjusting the curriculum for gifted students since it enabled the teacher to attend and monitor the needs of all the students in general education or GT classrooms (Goree, 1996). The teaching method was intended to amend the standard curriculum to meet the needs of gifted learners by removing content that the students mastered and accelerating content that they may master quickly (Chall & Conrad,1991). This required teachers to move quickly through objectives that were easily mastered, avoid repetition of similar skills, and move into a metacognitive approach that challenged students to think more deeply (Renzulli, Smith, & Reis, 1982;

Sutton, 2000). Mostly, with curriculum compacting, more time was given to the challenging concepts of higher-order thinking (Anderson, Krathwohl, & Bloom, 2001). Curriculum compacting is another iteration of differentiated instruction (Tomlinson, 2015).

Theoretical and Conceptual Frameworks

The theoretical and conceptual frameworks that underpin this proposed study were Bloom's (1956) taxonomy, Vygotsky's (1978) Socio-learning theory, and Tomlinson's (2000) differentiated instruction. Bloom's (1956) taxonomy constructed the framework for how thinking could emerge at higher levels. Bloom's taxonomy (1956) consists of six levels of concepts that proceed in academic settings. The graduated levels are: remember, understand, apply, analyze, evaluate, and create (Eber & Parker 2007). Thompson (2011), a math specialist, emphasized that the thinking skills of *knowledge, organizing,* and *applying* are considered lower-order thinking (LOT) while *analyzing, evaluating,* and *creating* are considered higher-order thinking (HOT) skills. The use of Bloom's taxonomy has been shown to enhance student mastery of skills, concepts, and higher-order thinking (O'Flaherty & Phillips, 2015). It is a tool that can broaden the depth of their students' learning (Eber & Parker, 2007).

Research has found that many academic experiences for GT students are grounded in low levels of thinking such as memorizing concepts; however, if Bloom's taxonomy is adequately used, experiences can be incorporated to help students advance through higher levels of cognitive growth (Moffett, 2015). Jones, Olds, and Lisciandro (2016) stated that when teaching GT students, it is of little value to tell them that they are right or wrong on an assessment; however, it is more beneficial to let them know where they fall on the continuum to assess where they are and what they need to achieve. For these reasons, Bloom's (1956) taxonomy shaped the framework for how thinking could emerge at higher levels.

Essential to Vygotsky’s (1978) perspective is the concept of the zone of proximal development (ZPD), a domain in which learning settings can be enhanced through the identification of aptitudes that the learner could develop with the proper assistance. With suitable stimulus, the student reaches outside their existing level of development to learn something new; the educator must guide the learner to circumvent the plague of boredom (Armstrong, 2015). Armstrong (2015) argued to reduce the gap between the student’s present development and where they could be with assistance, learning experiences must be carefully thought out and inspire the student to pursue assignments outside their present competences. In sum, the student observes the expert’s actions by interacting with someone more informed, their logical process developing upward toward the experts. Once foundational components are fully absorbed, the learner gradually becomes more autonomous (Hodson & Hodson, 1998).

Tomlinson (2015) explained that differentiation for gifted learners was and remains vital. The aim of differentiated instruction is to cater to a broad spectrum of learners (Tomlinson, 2008). In a differentiated classroom, learners can access the curriculum in multiple ways and at their instructional level (VanTassel-Baska, 2003). Differentiation is a teaching method in which curricula, teaching strategies, resources, and activities are routinely modified by the teacher to maximize the learning potential (Tomlinson, 2015). In this era of inclusive schooling, most GT students found themselves faced with a mainstreamed curriculum that lacked sufficient depth and complexity (VanTassel-Baska, 2003). GT students require a suitable level of challenge to motivate and engage them, and to prevent boredom and underachievement (Tirri & Laine, 2013).

Higher-order thinking

The capacity to engage in higher levels of thinking in mathematics is necessary for the 21st-century workplace including the development of future mathematicians, engineers, and scientist (Partnership for 21st Century Skills, 2008). Thompson (2011) noted that a number of educators worried that a majority of state exams concentrated on lower-order thinking (e.g., procedural skills, symbol manipulation) skills at the expense of higher-order thinking (e.g., problem-solving; reasoning) skills. Yen and Halili (2015) distinguished lower-order thinking as the recall of data or the application of knowledge to familiar situations and contexts. Warner and Kaur (2017) specified that lower-order thinking tasks expected students to merely recall facts, execute easy operations, or solve common problems; it did not necessitate students work beyond their comfort level. Yen and Halili further explained that lower-order thinking test items did not require justification or proof and limited to only one correct response. In contrast, Colley & Windschitl (2016) defined higher-order thinking as the use of multifaceted, non-algorithmic reasoning to decipher problems in which there is not a predictable, well-rehearsed method explicitly suggested by a task, task instruction, or a worked-out example. Warner and Kaur (2017) further explained that higher-order thinking test items involve problems where no algorithm has been taught, where justification is required, and where multiple answers are possible.

In today's data-driven society, students must become critical thinkers by developing higher-order thinking skills to make sound decisions in and outside of the classroom (Koksal, 2014). Research has shown that critical thinkers tend to be unbiased, question all information, understand complex ideas, efficiently connect their thoughts, and possess a keen perception of metacognition (Paul & Elder, 2008; Kenney, 2013). When confronted with unfamiliar problems, doubts, questions, or anomalies, intelligent individuals trigger their higher-order thinking skills to search for resolutions (Costa & Kallick, 2008; King, Goodson, & Rohani, 2010; Santín & Torruella, 2017).

Sadly, many educators struggle to embrace the idea of teaching beyond the average learner (Kenney, 2013). To prevent gifted students from falling short of their potential, educators must understand the needs of GT students and implement curricula and activities that match and maximize their aptitudes (Dixon et al., 2004; McCollister & Sayler, 2010). Research has shown that developing higher-order thinking improves academic performance through questioning, problem-solving, evaluating, and executing (McCollister & Sayler, 2010). Dixon (1996) emphasized that students and teachers were most successful when effective curricular differentiation was blended with higher-order thinking activities.

The work of McCollister and Sayler (2010) supported my proposed action plan because the findings corresponded to what I presupposed. The premise was that curriculum compacting extended higher-order thinking beyond the immediate lesson. Higher-order thinking skills, once developed, could evolve, mature, and transcend into other subject areas. Johnson (2001) and White (2010) emphasized it was essential for educators to know that higher-order thinking was not an innate talent, and it needed to be taught overtly on a daily basis. The integration of higher-order thinking skills was imperative for all learners, not just the gifted (McCollister & Sayler, 2010). Educators who are attuned to their students' needs should discover that students are highly likely to learn how to be consumers of knowledge and critically think as they begin to integrate higher-order thinking into their daily instructions and activities (Kenney, 2013; Koksal, 2014). I desired to be a teacher who cared enough about students and, therefore, sought to find ways to meet their unique needs and provide them with the higher-order thinking abilities required to fulfill their potential.

Impact of Education Environment

The Kenney (2013) study was particularly important to me because it supported my original thinking that when high-ability students were left in an unstimulated classroom, they lost focus, worked quickly and thoughtlessly, and eventually developed disruptive behaviors. When I received several students who turned to these nonproductive behaviors, I discovered that the problems were difficult to correct. Searching for ways to re-motivate and help them to reconnect with a desire to learn, I decided to find the means to accomplish that task. The proposed study was the result.

Altintas and Ozdemir (2015) conducted a quantitative study to analyze the effect of developed differentiation approach on the achievement of students. This study's method employed convenience sampling and consisted of 68 gifted and 60 nongifted students. It was conducted with the help of teachers and administrators at the testing site. A pre- and posttest assessment design was used in both the treatment and the control group following the research methodology. Altintas and Ozdemir concluded that there was a significant difference in scores between the control and experimental group after the application of an enriched curriculum. These findings show that curricula and activities that were centered on elaboration, higher-order thinking, and multiple intelligences could increase students' academic achievements.

In 2005, Tieso conducted a study that applied a pretest-posttest, a quasi-experimental design employing a stratified random sample of 31 different classrooms. The participants consisted of 31 fourth and fifth-grade teachers and their students from four New England school districts who received professional development assistance from scholars at the University of Connecticut's National Research Center on the Gifted and Talented. Despite major constraints of the study, the results indicated that adapting instructional strategies for gifted education, including differentiated curriculum, coupled with flexible grouping, could have a substantial positive impact on students' mathematics achievement. The results of this study may be vital to researchers and educators in the gifted field as the current emphasis is on preparing students for standardized testing, and the impact of No Child Left Behind legislation on the social and academic needs of gifted and talented students (United States Department of Education, 1993). Since it was unlikely that one strategy operating in isolation was as effective as multiple interventions, I investigated the combined outcomes of grouping systems and curricular modifications on elementary students' mathematics achievement.

Other researchers conducting quasi-experimental studies outside of the class suggested that consistent gains could occur in students' academic achievement when teachers implement practices used in gifted education, such as ability grouping arrangements (Tieso, 2005). Tieso (2005) recognized that scholars in the field of gifted education have long advocated for heightened and differentiated curriculum for high-ability students (Kaplan, 2004; Renzulli & Reis, 1994). However, Tieso argued that little action research existed within the field, but several researchers (Gentry, 1999; Renzulli & Reis, 1994; Tomlinson, 2008) have compared the effects of curriculum revision or differentiation on student achievement. Tieso's remarks were encouraging with regard to the need for additional action research.

Similar to the current proposed study was the empirical study conducted by Reis, Westberg, Kulikowich, and Purcell (1998). This study was grounded in direct observations and experiences of manipulating a phenomenon**.** Reis et al., (1998) intended for this study to provide support for elementary teachers who needed empirical evidence for eliminating content their which students had mastered. The researchers examined the effects of curriculum compacting on achievement test scores of national samples of 336 high-ability students. In the study, the approach utilized for measurement was a pre- and posttest to examine student achievement. This research proposed that teachers can pre-assess students' schema related to the content, eliminate segments of the curriculum that students already mastered, and substitute those sections with multiple types of interdisciplinary instructional and learning activities. The researchers concluded that teachers should be assured students' achievement test scores would not decline.

Unlike the previously mentioned studies that utilized several sampling methods to produce large samples, this study consisted of the students in my classroom. Most of the studies analyzed were on the effects of curriculum compacting on test scores. This study was an investigation of the impact of curriculum compacting on higher-order thinking skills. The test scores were treated as a by-product of learning.

Challenges in Gifted Education

Gallagher (2003) argued that educating gifted and talented students in the United States is a "trendy problem." He further emphasized that one of the most troublesome challenges for educators was the constant realization that our best students were not adequately competing with other countries in disciplines such as mathematics and science. VanTassel-Baska and Hubbard (2016) expressed displeasure with the decline in the interests of teaching the gifted students at their level of instruction and began pushing to recreate an emphasis on gifted education (VanTassel-Baska 1992; Flinders & Thornton, 2013). For the current study, I sought to discover ways to overcome this rationale during my initial work on this proposed action research plan.

Sisson and Sisson (2015) argued that the absence of curricular adjustments could be the best explanation for the underachievement of gifted students. Without meaningful challenges, the system robbed gifted students of a challenge and failed to prepare them for future complex situations (Hiebert, 2011; Toth, 1999). Teachers and students shared in the frustration from the lack of curriculum adjustments for those who have mastered most of the content or could quickly become proficient in less time than other students (Reis & Renzulli, 1992). Gentry (2016) suggested that high-ability students who have mastered the curriculum's content at an augmented pace should be fast-tracked and receive enrichment opportunities. Winebrenner (2014) postulated that gifted students need to be challenged on a daily basis and it is unfair for them to be in a heterogeneous classrooms without differentiation. Unfortunately, many educators believed curricular adjustments or compacting were the exceptions instead of the rule for educating gifted students (Sisson & Sisson, 2015).

Sternberg (1995) argued that gifted students in the United States faced many barriers and received limited opportunities to cultivate and optimize their talents. Dixon et al. (2004) acknowledged that gifted students were deprived of essential activities that met their unique needs and caused these students to lose confidence in their talents and abilities. Furthermore, students who mastered content quickly become bored, distracted, underperformed, and were at-risk to develop behavior issues (Fisher & Frey, 2014). Dixon et al. (2004) noted that many GT students believed that school was a waste of their time and became lethargic and uninterested which created barriers to them reaching their full potential. McKeachie, Pintrich, Lin, and Smith (1986) recommended that gifted students should have opportunities to vacillate over multiple possibilities, engage in constant dialogues about metacognitive strategies, and participate in activities focusing on problem-solving.

Coleman and Cross (2001) espoused that one of the key problems with gifted education was that the field lacks examples of differentiated curricula backed by research. Coleman and Cross (2001) argued that educators should engage GT students through effective differentiation, but pressure from the administration and other stakeholders to meet testing standards reduced the scope and depth of instruction. Research has shown that providing identical academic experiences for all students coupled with a misaligned curriculum will systematically halt the potential and progress of GT students (Reis et al., 1998). Tomlinson (2005) argued that the primary goal in creating an effective curriculum and instruction for gifted learners is to ensure that it is meaning-making and rich. Effective curriculum and instruction for gifted learners should respond to their readiness levels, interest, and modes of learning (Tomlinson, 2008). This goal was guided by the premise that schools should maximize student potential, not merely bring students to an externally established norm on a test (Tomlinson, 2008).

Effects of testing on gifted education. The issuance of A *Nation at Risk* (National Commission on Excellence in Education, 1983) was widely viewed as the spark for the high stakes testing and standards movement that paved the way for legislations such as No Child Left Behind (Lefkowits and Miller, 2006). *A Nation at Risk* (National Commission on Excellence in Education, 1983) mentioned that American students struggled with higher-order processing skills and could not think critically. The report further argued that a significant problem began with the educational system's failure to value thinking. With the emphasis on accountability for student achievement, teachers began to focus instruction on the correct answer rather than the understanding of concepts (Struck, 2003). Vogler and Virtue (2007) argued that the increasing utilization of high-stakes assessments at the federal level had propagandized the notion that testing will advance the educational system. However, that was not the case. It has caused a departure from active learning, and student-focused methods such as collaboration, role play, independent studies, and practical dialogue (Vogler & Virtue, 2007). Nonetheless, as a means to an end, teaching to the test eliminated opportunities for creativity, critical thinking, problem-solving, and imagination by solely focusing on a test score (Eisner, 2004).

Shortly after his inauguration in 2001, President George W. Bush issued the No Child Left Behind Act (NCLB), one of his first major policy initiatives (Bush, 2001). Meier and Wood (2004) emphasized that NCLB proposed to provide an efficient and fair education, but the educational system became fixated on test scores. Meier and Wood further maintained that instead of the best practices to teach meaningful content, thus infecting the quality of curriculum and instruction. Despite its intent, NCLB obstructed the talents of gifted children, and mostly it forced teachers to leave gifted students to support themselves in heterogeneous classrooms (Grgich, 2009).

Subsequently, districts and schools did not feel obligated or encouraged to provide opportunities to develop individuality, diversity, innovation, creativity, or personal aspirations—all things that strengthened the American educational system and country (Gentry, 2006). Recently, stakeholders in education acknowledged that it was vital for all students to learn to reason, effectively solve problems, create knowledge, and produce information (Newman, 2008). Willis (1995) argued two paramount factors that impeded this logic involved the inclusion philosophy and issues with funding.

The inclusion philosophy proposed that all children receive their education in general classrooms and that the teacher should prepare lessons and centers that could meet the individual needs of each student by differentiating their instruction (Tomlinson, 2005; Winebrenner, 2001). However, Toth, (1999) reasoned that when left in the regular classroom, students of high ability did not have their instructional needs met. Researchers have found that despite this knowledge, little differentiation of the curriculum was attempted (Haberlin, 2016; Reis & Renzulli, 1992).

Another major fallout from NCLB revolved around the funding of gifted programs. School districts were forced to evaluate rising demands and inadequate resources. Since gifted programs served a small number of students, they were usually the first to be dropped (Toth, 1999). Most schools and districts depended on pullout enrichment programs to meet the needs of gifted children (Toth, 1999). Due to NCLB'S failure to focus on the academic needs of gifted children and educators that support them, many districts have eliminated their gifted programs and transferred the resources to remedial programs to avoid government sanctions if students' test scores do not improve (Golden, 2004).

Furthermore, many gifted students are taught in heterogeneous classrooms, thus lacking resources and content suited to meet their interests, capabilities, needs, and their uniqueness (Westberg, Archambault, Dobyns, & Salvin, 1993). Newman (2008) argued that most teachers were not equipped to meet the needs of gifted students, and many argued that NCLB and other policies had limited their opportunity to plan and develop learning experiences for their brightest students. In these situations, most teachers resorted to strategies such as assigning extra and identical work or accelerating the regular curriculum to occupy students' time (Sisk, 1988). Additionally, previous research detailed that educators limited their curricula around themes and simple assessment questions (Grant 2006; Yeager & Davis 2005; Vogler 2005). Tomlinson (1995, 2005) believed that if teachers were trained in differentiated instruction techniques, they might be better equipped to teach the gifted as well as students at risk for failing.

Conclusion

The reviewed research supported and uncovered weaknesses for the proposed study and bore direct influence on the methodological alignment to my proposed action research on gifted education. Theoretical and historical based studies enlightened on what was known and what was not known in a field that has seen its ascending and descending trends in interest. This proposed study was further inspired by Renzulli's (1982) work with gifted students. Renzulli (2011) supported the notion that all children, regardless of test scores, who could complete the standard curriculum content in a more condensed and streamlined order should be given a chance so that acceleration did not cause unnecessary stress or emotional problems for the child. Lastly, I was encouraged by Reis & Renzulli's research (1997), where the authors noted that when a mathematics curriculum was compacted, students scored notably higher than their contemporaries on the concept's posttest.

I examined supportive as well as conflicting evidence for this study utilizing curriculum compacting to enhance higher-order thinking in my gifted math class. The completion of exhaustive research on gifted education and current needs of gifted students has significantly prepared me to expertly create, implement, and measure the effectiveness of this unique study on teaching critical thinking skills to third-grade students' instruction on numeration systems and place value.

Summary

The literature review focused on informing me on the various theoretical perspectives used in studies on gifted education. Moving from that perspective, the literature review was focused on methodologies, and supported the use of action research as a viable approach to implementing change in a classroom. Finally, the historical overview provided closure to the literature review by bringing gifted education back into the forefront after decades of time when gifted education had lost its relevance and importance to educators. Chapter Three is an in-depth presentation of the methodology used in this study.

CHAPTER THREE: Action Research Methodology

Chapter Three is a discussion of the methodology that was used in this study. The specific purpose of this study was to determine the impact of curriculum compacting on the development of higher-order thinking among gifted students. Growth was measured by subscribed tests. The research question that drove this action research was: What are the effects of curriculum compacting on students' ability to use higher-order thinking to solve complex math problems?

This action research study sought to modify the curriculum to deepen the understanding of numeration systems and place value by implementing curriculum compacting as an alternative teaching strategy. Using an action research methodology was the most appropriate approach to answer the research question, because it involved a systematic examination of the proposed instructional process and its effects on student learning in its natural setting (Mertler, 2014).

Initially, action research was viewed as a raw alternative to the traditional, linear model of scientific research (Sawyer, 2013). A practitioner's involvement in the study was a key component because the research could be immediately applied and tested in the natural setting of the school (Sawyer, 2013). Simms (2013) proposed that teacher-researchers should utilize this inquiry approach to support their development as practitioner researchers. For these reasons, action research required me to identify an area of weakness in the teaching processes and/or materials that were used with my students. The key idea was to identify processes that had an adverse influence on students' learning and remove them (Mertler, 2014).

Action research by design is participatory; whereby, I reflected on personal practices in the classroom and identified ways to enhance student learning by adopting an alternate teaching strategy. This design supported the transformation of three mutually dependent views, Bloom's (1956) theory of critical thinking, Vygotsky's (1978) zone of proximal development, and Tomlinson's (2000) differentiated instruction.

Methodological Approach

For this study, action research was used to determine if curriculum compacting was an effective teaching method to improve gifted students' ability to process higher-order thinking and transfer it to other content areas. Curriculum compacting was a new teaching strategy for the class of students used for this study. Compacting the curriculum of a unit of study on place value and numeration required teaching students to not only calculate answers but to go a step further and explain how they conducted the calculations. The second part of this questioning technique was aimed at deepening the students' understanding of what they did by providing them the opportunity to go beyond rote memory and use their higher-order thinking skills to respond at a deeper level. As the unit of study in math progressed, I was able to make immediate adjustments to the instruction as needed (Mertler, 2014).

Phase one. To effectively compact a curriculum, I had to be knowledgeable about its content and learning objectives (Reis & Renzulli, 1995). Also, this phase required me to identify what content was mastered and then determine which adjustments were needed. By examining pretest results, I chose suitable instructional materials exercises that were beyond the students' level of mastery and scaffolded the student to the next cognitive level (Reis & Renzulli, 1992). The strategies used for this study involved a multitude of creative approaches to teaching numeration systems and place value to third-grade gifted students which will be discussed in Chapter Five.

Phase two. Throughout the instructional phase, I recorded and measured the students' progress in their ability to use higher-order thinking. The lessons moved students from knowing and understanding place value to problem-solving beyond a superficial understanding of numeration systems by using higher-order thinking skills (Struck, 2003; Stella, & Fleming, 2011). At the conclusion of the second phase, the students were given a posttest to assess their ability to use higher-order thinking on the place value subject matter.

Research in Context

The proposed action research was teacher-implemented and student-centered. It was classroom-based and intended to make a change within the natural setting of my gifted pull-out program classroom (Mertler, 2014). This action research did not focus on rigor and generalizations because the study intended to improve my teaching practices and increase my students' ability to think critically. I sought to share the results with other educators within the district.

This study was conducted at a public school in South Carolina. The school is nestled in a rural, upper-middle-class neighborhood in Richland County. Due to its close vicinity to a military base, a large portion of the school's population is comprised of students from military families. Districts that are highly populated with military families receive both the benefits of their diverse learning experiences as well as the problems that can occur with program enrollment. This point was critical to note because enrollment in all programs, including my gifted program, were affected by transient students' unpredictable attendance and enrollment. For instance, the study began with 15 students, but only 12 students remained in the district until the end of the intervention.

Site of intervention implementation. The school site used for this action research was established in 2011 and is considered to be a state-of-the-art facility both from an innovative instructional perspective as well as meeting the technology curve. Every classroom is equipped with an interactive SmartBoard, and all students in grades two through five are supplied with Google Chromebooks. The total school enrollment was school approximately 500 students. The student to teacher ratio was 13:1 which was considerably lower than the state and national average for all American elementary schools (South Carolina Department of Education, 2016).

It was interesting to note that during the school's first year in 2011, it received an "excellent" absolute rating on its first-year school report card. The school maintained an "excellent" rating for the next three years (South Carolina Department of Education, 2016). However, during the last three years, the school's overall performance and growth have steadily declined. The school came down from an "excellent" to a "good" absolute rating and has since declined to "below average" (South Carolina Department of Education, 2016). Although it was not the aim of this action research to increase the school ratings and enrollment, the results of this action research were offered as a possible strategy to improve classroom outcomes one class at a time.

Administrative and parental support for the implementation was requested and received. A written explanation outlining the nature of the study, the type of activities, and the length of the study were presented to the school administrators for their written consent. A meeting was held to acquire informed consent signatures from the parents. Mertler (2014) noted that informed consent protects the privacy of students and parents. During this study, I was forthcoming about the purpose of the study, procedures for data collection, and how the data would be used and kept. Both administration and parents were apprised of progress at various intervals.

Participant description. The student-participants qualified for the GT program based on scores from the Measures of Academic Progress, RAVEN's Progressive Matrices, and Otis-Lennon School Ability Test® Eighth Edition (OLSAT 8®) assessments and teacher recommendations. There were 15 student participants in the third-grade gifted math class; however, three students exited the program before taking the final assessment. The group was ethnically diverse but homogeneously grouped for ability. The ethnic breakdown was: one multiracial student, four blacks, one Hispanic, and six white students. There was one child who qualified as an English as a Second Language (ESL) student.

Protecting participants. Parents were asked to sign a permission form authorizing their consent for me to include their students in this study. If they opted out, I respected their wishes and provided an alternate assignment for the student and found another location for the student to work outside of the classroom during the time of implementation. It was equally important for the students in this study to know what I was doing and why. From the onset, I included them in conversations explaining the process and informed them that if they felt uncomfortable, they could approach me privately for discussion. As a dedicated teacher, I had established a strong rapport with administrators, parents, and students. It was, for this reason, I did not anticipate that anyone would object to this study which was aimed at increasing students' higher-order thinking skills. Furthermore, everyone agreed to participate in the study. Unfortunately, three students left during the study.

Role of researcher. I am a specialist in the GT field. Additionally, I was trained in designing and selecting appropriate differentiation strategies for diverse groups of exceptional students and then sharing these activities with other teachers in a lead-teacher capacity. I was responsible for maintaining ethically appropriate practices throughout the study. As a participant in the study, I implemented the study with the highest level of integrity. In my role as a teacher, I implemented the strategy, and, in the researcher role, I monitored student progress.

My role as the researcher was to maintain a dual role of teacher-researcher. In the teacher role, I was looked closely at the work of students generated in my classroom. For this study, I targeted higher-order thinking skill development for gifted students. I developed an intervention using a curriculum compacting strategy to enhance the higher-order thinking levels of the third-grade gifted math class. I created an appropriate action research plan to be applied. I engaged in evaluative and reflective practices to measure success, modify strategies, and assess student progress (Mertler, 2014).

Validity and Authenticity

Action research validity. Action research is teacher implemented and student-centered. It is classroom-based and intended for making a change within the natural setting of my gifted pull-out program classroom (Mertler, 2014). This action research did not focus on rigor and generalizations because the aim was more on individual selfimprovement rather than on how to improve larger scale processes and enable change within the gifted programs.

Limited generalizability. Armed with an understanding that action research results are not conclusive and generalizable beyond my immediate classroom, I developed plans that likely increased the value of the study to similarly constructed classrooms. Moving beyond this study, I plan to replicate this study using different subject areas and grade levels. Until more defined credibility and reliability are established, I can share findings with peers and perhaps share the results as positive intervention outcomes in teach and instructional journals.

Internal validity. A researcher can strengthen the action research design if specific processes are incorporated. First, internal validity can be increased if expert researchers in the field provide input. If they agree on the careful assessment by the university, then experts in research will ensure alignment of the problem, purpose, design, and research questions.

Design of the Study

Almalki, (2016) emphasized that an action research plan can produce a more comprehensive and fluid view of the phenomenon. I followed the action research cycle of planning, acting, developing, and reflecting to answer the study's research question (Mertler, 2014).

Planning. Mertler (2014) branded the first step in action research as the "planning" phase. During this phase, I identified the problem of practice in my classrooms, examined related literature, and developed an appropriate research problem, purpose, and research question. As part of the approval for the study, I identified the problem and proposal for an intervention to the University. Simultaneously, I obtained the support and approval of the appropriate administrators at the research location. Once approvals were acquired, I began to develop the implementation strategy. To develop the most suitable strategy, I engaged in a thorough literature review of best practices in teaching the gifted students.

As part of the planning stage, I met with the students' parents. During this meeting, I explained that this study was an action research project to attain a doctoral degree. I supported the rationale for the intervention with relevant research emphasizing the need to challenge the thinking of gifted students and moving them beyond routine math skills. The parents were informed that their input would be requested following the nine-week long intervention

Acting

Mertler (2014) indicated that the second phase of the action research process is the acting stage. During this stage, the objective was to implement the study, collect and analyze data (Mertler, 2014). For this study, I collected quantitative data in the form of pre- and post-intervention assessments. The assessments were directly linked to the lessons taught and were part of the materials supplied with the curriculum (Gavin, Chapin, Dailey, & Sheffield, 2006). Based on the structure of the curriculum, the optimal time to begin the study was during the beginning of the fall or spring semester.

Implementation of the Intervention. The intervention began on a unit of study on place value. The first step was to administer a pretest to the students before beginning the curriculum compacting strategies. The prescribed test was included in the administrator's manual for the curriculum and was used as both the pre and post assessment. In the unit of study on place value used in this proposed action research, *Unraveling the Mystery of the MoLi Stone,* students explored the numeration system in depth. The Three Big Ideas were patterns, groupings, and symbols that helped students develop their higher-order thinking skills (Gavin, Chapin, Dailey, & Sheffield, 2006; Sutton, 2010). The nine weeks of instruction were included along with the objectives.

Week one. The participants were assessed using the prescribed test. During the first week, the students deepened their understanding of regrouping in a place-value system by renaming two-digit numbers through the game, *Maneki Neko Bank* (Gavin, Chapin, Dailey, & Sheffield, 2006). The participants substantiated all possible dime and penny combinations for 52¢ by creating an in-depth list and then looking for patterns to generalize about regrouping two and three-digit numbers (Gavin et al. 2006).

Week two. During the second week, the students played *Some Sum* to understand the significance of place value in adding and subtracting two-digit numbers. The participants used the game to determine strategies to create the largest sum or smallest difference (Gavin et al., 2006).

Week three. During the third week, the participants played the *Land of Treble* to investigate addition and regrouping in base three numeration systems. By playing the game, the participants learned to regroup in order to add more value to a given number or equation (Gavin et al., 2006).

Week four. During the fourth week, the participants played *Land of Treble Subtraction,* and investigated regrouping and subtraction in a base three numeration system (Gavin et al., 2006).

Week five. During the fifth week, the participants played *The Race in a Base* and evaluated adding and subtracting in base three and base ten to compare the similarities and differences (Gavin et al., 2006).

Week six. In the sixth week, the participants played, *Ancient Egyptian Numerals,* in order to understand the values of the Egyptian numeration system symbols (Gavin et al., 2006). The students compared the Egyptian symbols with the base-ten digits in our number system (Gavin et al., 2006).

Week seven. During the seventh week, the participants played, *Egyptian Sums and Differences,* to add and subtract in the Egyptian system to evaluate the role of zero in the American numeration system (Gavin et al., 2006).

Week eight. In the eighth week, the participants played, *A Mysterious Number System,* to understand the Chinese numeration system and compare it with the American numeration system as they gained a deeper understanding of expanded notation (Gavin et al., 2006).

Week nine. During the final week, participants played, *Creating Your Own Numeration System,* in order to generate and assemble their numeration system addressing groupings, place value, and symbols (Gavin et al., 2006). The posttest was given to the participants to assess their academic growth.

Developing

The purpose of action research was grounded in the philosophy that some action will result from your research study (Johnsson, 2008). Brighton and Moon (2007) emphasized that a teacher-researcher must make sense out of the data. Typically, the developing stage consisted of strategies for future implementation of treatments, interventions, modifications, and improvements to curriculum and instructional methods. Since the data revealed a possible connection between curriculum compacting and improvement of higher order thinking skills, the findings were available to other general and gifted teachers.

Data Collection

I used the pre- and post-assessments constructed by Project M^3 that required students to explore the core concepts of place value: patterns, groupings, and symbols (Gavin et al., 2006). Gavin et al., (2006) noted higher-order thinking occurred when students investigated the differences between place value, various bases, and other number systems (Chinese and Egyptians) concepts that are taught at higher grade levels. I used the rubric attached to the assessment for scoring (Gavin et al., 2006). Upon completing the required instructional activities, I used the final phase of the compacting process which required cooperative decision making and creativity from the teacher and colleagues. I received enrichment resources from colleagues, the librarian, the media specialist, content specialist, and other gifted specialists.

Instrument of Measurement. The pre- and post-assessments (See Appendix D) were constructed by Project M^3 requiring students to explore the core concepts of place value: patterns, groupings, and symbols (Gavin et al., 2006). M^3: Mentoring Mathematical Minds stemmed from a five-year Javits research grant project in which curriculum units were crafted with elements that were advantageous for gifted elementary students. Gavin et al. (2016) described Project M^3 as a combination of the best teaching practices of gifted education with the content as well as process standards promoted by the National Council of Teachers of Mathematics. Project M^3's subject matter at each level was at least one to two grade levels above the typical curriculum. The highlight of the pedagogy encouraged students to practice as professionals by accentuating verbal and written communication. That means that the students are taught not only how to find the answer, but also how to explain the answer, which is an essential learning component (Gavin et al., 2006). Gavin et al., (2006) noted higher-order thinking occurred when students investigated the differences between place value, various bases, and another number system (Chinese and Egyptian) concepts taught at higher grade levels.

Reliability and Validity of Instrument. To ensure reliability and validity, the Project M^3 staff utilized student responses on the pretests to identify roughly five samples for each question varying in levels of complexity; they then used a rubric to score them (See Appendix E). They used the various samples during the professional development meetings before the instruction of each unit to guide teachers on how to score the tests. Also, teachers also scored the pretest and posttests using the same rubrics. Project M^3's research team scored all pre- and posttests twice. If the first and second set of scores on any subcomponent of any question did not match, another staff member scored it a third time. Afterward, expert scorers discussed any discrepancies until a consensus was reached, thus ensuring inter-rater agreement.

Data analysis. According to Cochran-Smith, Barnatt, Friedman, & Pine (2009), conducting an action research intervention is complex and challenging because the teacher-researcher takes on multiple responsibilities; they plan, implement, collect and analyze data, and upon reflecting on the findings, they also critique and revise the intervention. To assess the impact of curriculum compacting, I employed a quantitative approach to the action research. Data was in the form of numbers instead of narrative.

Quantitative methodology is advantageous for studies that involve numbers, such as pre- and posttest that measure achievement gaps between groups of students or assessing the effectiveness of a curriculum.

For analysis, I applied a pre-posttest design to be analyzed with the use of normalized gains. I utilized normalized gain to analyze the data because using this measure strongly differentiated between teaching methods, but according to Hake (1998) allowed for "a consistent analysis over diverse student populations with widely varying initial knowledge states." Naturally, it appeared to be useful for independent members of the population or pretest scores, which allowed me to compare each student's academic growth (Hake, 1998). The scores were charted using graphs to identify any growth and any possible outliers that may skew the data.

Reflecting

The final phase, reflecting, was defined by Mertler (2014) as when the action researcher engages in summarizing the results of the study and reflects on the impact of the results as it relates to student outcomes. At this stage, the researcher begins to formulate plans to create a strategy for sharing the results with the administration, parents, other teachers and in private one-on-one conferences with each of my students. Afterward the study, I reflected on the entire process and considered ways to improve the intervention and the assessment.

Attributable to the nature of action research, no generalizations were made nor were control groups used. One single class of a diverse group of gifted students comprised the participants. It could be said that if the intervention was replicated on the same age and type of students and the same instructional materials and activities are used, the results might be comparable provided that all the same conditions were met. When this unit is taught to another group of similarly gifted students, comparable results might be expected. The replication and acquisition of similar results could increase the reliability of the study as described. However, this was not the goal.

Parents and other school personnel were invited to observe the intervention and asked to provide an outsiders-look into the process. For the purpose of gathering information, I collected the required information from the other stakeholders by conversing with them during a focus-group session to discuss and critique the intervention after they observed. Afterward, I gathered all the data used in this reflection and analyzed the stages of the study. After a thorough review, when all the possible glitches are removed, the teacher-researcher will proceed to the presentation and publication stage of his study. The gifted and talented organization, National Association for Gifted Children (NAGC) meets every year and welcomes the proposal for presentations. Other sources for publication may be The Gifted Child Today, Gifted Child Quarterly, and Teaching Children Mathematics.

Ethical Considerations

A discussion on ethical considerations in any study primarily focuses on the fidelity of the researcher’s work. However, there was a broader scope of ethics that acted as an overall umbrella and has further reaching importance. I began with a discussion of the ethical delivery of education to all students and their right to be taught at their level of instruction.

Mertler (2014) stressed that honesty should be displayed by the action researcher at all times. He further emphasized that researchers must be truthful about the purpose of the study and ethical handling of the data collected (Mertler, 2014). The National Forum on Educational Statistic (NFES, 2010) noted that educators should avoid the release of data that could lead to physical, mental, or emotional harm to others. Additionally, NFES (2010) instructed researchers to establish and enforce security procedures and mechanisms necessary for protecting all sensitive data from inappropriate release and use. The guaranteed protection for each participant was my top priority. Mertler (2014) asserted that no participant should be forced into participating in any study and should have the ability to withdraw at any given time without consequences. To guarantee anonymity and confidentiality, pseudonyms were used when disclosing information within this action research study. All quantitative data were coded to comply with the confidentiality agreement.

Concerning the personal ethical responsibilities in implementing this intervention, I was obligated first and foremost to safeguard the wellbeing of the students. I maintained this obligation throughout the study, but during the implementation of a new strategy in this action research project, my daily ethical responsibilities increased and reached beyond the classroom. I began this process by gaining all appropriate approvals from both the university, district offices, and from the parents and students as well.

It was the ethical responsibility of the teacher to provide differentiated instruction to gifted students in order to meet their unique instructional and interest levels. Charged with this responsibility as a teacher of the gifted, I felt strongly committed to this cause. A plan was developed to tap into the higher-order thinking skills of my gifted students and met them at their appropriate level of instruction.

Summary

This chapter was a presentation of the methodology used for the current study's action research. My role as a researcher and the context of the study was discussed. The demographics of the sample participants were defined. The components of curriculum compacting and how it was utilized in the study intervention were detailed. Plan for data collection and data analysis were explained

Chapter Four is a presentation of the descriptive and inferential statistical analysis. After the completion of this dissertation, I will move forward to implement a new action plan. At this post-doctoral stage, several iterations of the intervention will be implemented. Each implementation will include appropriate adjustments until there is a statistical confidence level worthy for publication and presentations.

CHAPTER FOUR: Findings from the Data

Chapter Four is a discussion of findings. The data from this study was gathered through an implementation of curriculum compacting to teach mathematical place value at an in-depth level to a third grade gifted and talented class of 12 students. The findings of the pre and posttests from the place value unit of study preceded the narrative findings that described the students' growth and experiences. The narrative information was followed by statements from the participants regarding their emotionality after the pre- and posttest on the curriculum's unit on place value. The specific purpose of this study was to measure the difference between the pre- and posttest scores of third-grade gifted students when instructed using the curriculum compacting strategy to teach place value. A by-product of using higher-order thinking was to increase engagement and attainment while decreasing underachievement.

Most eductors found teaching gifted students to be a tricky task. If the work is not engaging or challenging enough, GT students can become easily bored. Ironically, if they become accustomed to a lack of challenges, when faced with one, they begin to develop unfavorable emotional responses. The problem of this study began in my students' general education classroom. Several of my GT students developed behavior and academic issues while in their classroom. My GT students stated that the subject matter and materials used were useless and boring. Many of my GT students mastered every standard on place value, easily. Since the teacher's instruction covered what they had mastered, many of them resorted to off-task and disruptive behaviors in the classroom. The teacher approached me to seek advice on curricula and strategies that she could use to mediate their off-task and unruly behaviors.

Nevertheless, literature for gifted education and mathematics suggested support for a curriculum that is both enriched and accelerated with an emphasis on cultivating conceptual understanding and mathematical thinking. After investigating a few alternatives, I found a curriculum, M^3 Mentoring Mathematical Minds, that aligned with the compacting strategy. For this study, the quantitative approach was appropriate to measure the differences in the students' pre- and posttest scores. After the implementation of the prescribed instructional activities, the same assessment was used to gauge the progression or recession of higher-order thinking skills. Student scores revealed the influence of a curriculum compacting intervention on higher-order thinking skills. A description of the pre and posttests used before and after the curriculum compacting is in Table 1. Table 2 displays the raw scores and growth of each participant. Table 3 displays the statistical calculation of the normalized gain.

Research Question

The research question that guided this study was as follows: What are the effects of curriculum compacting on students' ability to use higher-order thinking to solve complex math problems? This study's data was grounded in Bloom's (1956) taxonomy, Zygotsky's (1978) zone of proximal, Tomlinson's (1995) development differentiated instruction.

Data Collection

The curriculum compacting intervention took place over nine weeks. The process began with a pretest taken from the Project M^3 end-of-unit assessment. Both the pre- and posttests were the same. Practice effect was eliminated due to the nine-week span of time between the two testing sessions. The pretest scores were recorded for each student. For the next seven weeks, the curriculum compacting strategy was used to teach the unit on place value. At the end of the instruction, a posttest was given, and the students' scores were recorded. During the pretest, many of my students unexpectedly had adverse emotional responses to the assessment. I noted any emotional episodes and interviewed them for responses. During the posttest, I noted any changes in the emotional responses of the students as well.

Instrumentation and Scoring Criteria

Project M^3 prescribed assessment comprised of three questions and was given to all students. Each of the three questions had either two or three sub-questions. The point values for each question are described in Table 1. The point values increased as the level of higher-order thinking and analysis increased. The students had to solve the computation as well as justify their answers through writing. The objective of using curriculum compacting was to deepen the analysis and evaluation levels of higher-order thinking.

Discussion of Findings

Before the implementation of the curriculum compacting strategy, the students were given the pre/posttest. The students were allowed to take as much time as possible. The prescribed assessment contained three questions, each with two additional sub-questions (See Appendix E). The initial questions required the participants to solve an equation. The following questions required the participants to build on the previous answer and justify their reasoning through writing. The following will be a narrative of each test item.

Table 4.1
Scoring values for each question on the Project M^3 unit test on numeration

Question 1 A (1 point)	B (2 points)	C (4 points)
Focus: Understanding of place value and computation.	Focus: Understanding of place value where the digit 5 has a value of 50 and the digit 6 has a value of 60. Although the commutative property is correct (1-point answer), the understanding is not as advanced as the 2-point answer.	Focus: Understanding of place value where the digit 4 has a value of the 40 and the digit 5 has a value of 50 and placing the 7 in the tens place increases the value of the sum by a multiple of ten (versus by ones if placed in the ones place). Replacing the would increase the sum by 30 and replacing the would only increase it by 20.
Question 2 A (2 points)	B (2 points)	C (2 points)
Focus: Understanding of place value and regrouping for addition.	Focus: Understanding of place value, regrouping for addition and representing trades.	Focus: Understanding of place value, regrouping for subtraction and representing trades.
Question 3 A (1 point)	B (1 point)	C (4 points)
Focus: Understanding of symbolic numeration system.	Focus: Understanding of symbolic numeration system and the representation of zero.	Focus: Understanding of zero in our place-value system (i.e., base ten), and how to justify ideas using both examples and words.

Question 1(a) provided four digits: 5, 2, 4, & 6. The students were required to create the largest sum using all four digits. The students needed an understanding of place and computation to solve this problem correctly. This was a one-point question. According to Bloom's (1956) taxonomy (BT), this was at the understanding and applying level. Before instruction, sixty percent of my class successfully completed the computations. After instruction, ninety-two percent successfully completed the computations.

Question 1(b) required the students to find the largest sum they could make using all four digits. To solve this problem, the students needed an understanding place value and the commutative property to get the highest sum. This question was worth two points. According to Bloom's taxonomy, this type of question was at the applying and analyzing levels. Prior to instruction, only thirteen percent of my students were able to solve this problem, but all were successful after instruction.

Question 1(c) required the students to analyze the addends 56 and 42. The students were given the digit 7 and required to replace one of the digits in the addends to create a larger sum. After finding the correct answer, the participants had to explain why they chose to replace that digit with the digit 7. This question was worth four points. According to Bloom's (1956) taxonomy, this question was at the analyze, evaluate, and create levels. Prior to instruction, thirteen percent of my students were able to solve this problem, but all were able to solve this problem after instruction.

Question 2(a) focused on place and regrouping for addition while using a base-3 number system. For clarification, a base is a number that identifies the grouping for the base system and the exponent tells students how many times the base will be used (Hayes, 2001). In a base-three system, there are only three digits 0, 1, and 2. To regroup in a base-three system, one must collect a set of three to trade for one three, just as we collect a set of 10 ones to trade for one ten in the base-ten system (Hayes, 2001). For this question, the students were informed that 3 “gickles” equals 1 “bickle” and 3 “bickles” equals 1 “rickle.” The students were given a mat and a die to find out how many tiles they need to collect and trade. The purpose of this activity was to reduce the number of tiles by regrouping, but still maintain the most statistically. The question was worth two points. According to Bloom’s taxonomy, this type of question was at the understanding, applying, and analyzing levels. Prior to instruction, forty percent were able to solve this problem, but ninety-two were able to solve this problem after instruction.

The next question, 2(b), required the students to analyze a given answer regarding the previously used mat and tiles. This question focused on understanding place value and regrouping for addition. The participants were asked to add five more tiles to Sara’s game mat and then regroup the total. The participants were required to use the terms gickles, bickles, and rickles. The question was worth two points. According to Bloom’s taxonomy, this type of question was at the applying and analyzing levels. Prior to instruction, twenty percent were able to solve this problem, but eighty-three percent were able to solve this problem after instruction.

The next question 2(c) focused on understanding place value and regrouping for subtraction. The participants were asked to remove five tiles from Raphael's game mat and then regroup the total. The participants were required to use the terms gickles, bickles, and rickles. The question was worth two points. According to Bloom’s taxonomy, this type of question was at the applying and analyzing levels. Prior to instruction, twenty percent were able to solve this problem, but seventy-four percent were able to solve this problem after instruction.

Question 3(a) focused on the understanding of symbolic numeration system. The students were given “Martian” symbols that had a specific number of values attached to them and asked to compare it to our number system. The participants were asked to write 527 using the Martian math symbols. This question was worth one point. According to Bloom’s (1956) taxonomy, this type of question was at the understanding, applying, and analyzing levels. Prior to instruction, seventy-three percent were able to solve this problem, but everyone was able to solve this problem after instruction.

Question 3(b) focused on the understanding of symbolic numeration system and the representation of zero. The zero is important in our place-value system because it allows us to represent when there is no value of a particular place-value group (e.g., in 102 there are no groups of ten). The participants were asked to write 3,605 using the Martian math symbols. The question was worth one point. According to Bloom’s (1956) taxonomy, this type of question was at the applying, analyzing, and evaluating levels. Prior to instruction, eighty-seven percent were able to solve this problem, but ninety-two percent were able to solve this problem after instruction.

Question 3(c) focused on the understanding of zero in our place-value system (i.e., base ten), and how to justify ideas using both examples and words. The participants were asked to recognize that the Martian system did not have a zero, but our number system does. Then they were asked to give two ways the zero was used in our number system. Afterward, they had to provide examples and justify their answers through written response. This question was worth four points. According to Bloom’s (1956) taxonomy, this type of question was at the analyzing, evaluating, and creating levels.

Prior to instruction, no students were able to solve this problem, but eighty-three percent were able to solve this problem after instruction.

Table 4.2
Descriptive Data on Pre and Post Test Growth

Participant	Pretest %	Posttest %	Growth %
Cameron	37	95	58
Elah	29	100	71
Bryson	0	68	68
Karla	26	89	63
Mary	26	100	74
Maggie	16	97	82
Erin	26	100	74
Langston	11	100	89
Zion	37	95	68
Shelly	13	89	76
Kira	32	95	63
Tara	32	100	68
Amerie	32	N/A	N/A
Lola	26	N/A	N/A
Kelly	32	N/A	N/A

The pre- and posttest calculations were performed using an Excel spreadsheet. In an attempt to determine the viability of curriculum compacting as pedagogy in a third-grade gifted math class, research results were combined from the one-group pretest-posttest method and summarized in Table 2 and Figure 1. In Table 2 and Figure 1, the participants' scores were listed. Many of the participants struggled on the pretest.

However, after the implementation of the intervention, nearly all of the students made substantial gains in their raw scores. The lowest growth amount was 58 points. Following the intervention, five students were able to earn perfect scores on the posttest. The students performed well on the posttest with all 12 students increasing their raw gain by at least fifty-five percent. The average combined raw gained for the entire class sixty-eight percent.

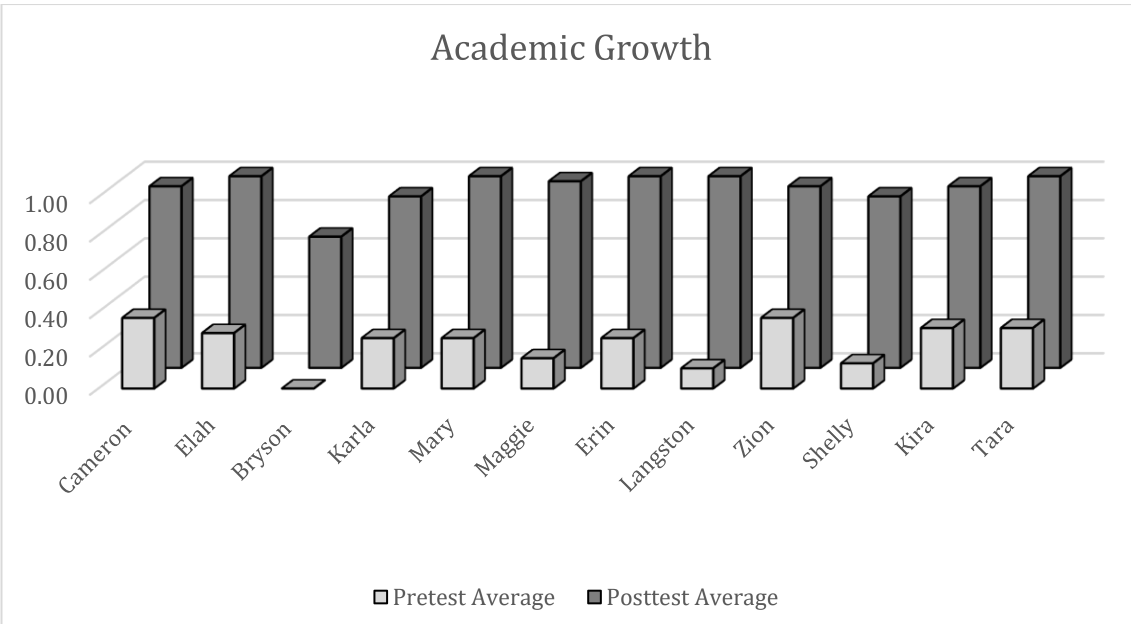

Figure 4.1. Growth in Project M^3 test scores comparing pre- and posttest scores

Table 4.3
Calculation of Normalized Gain

Student	*Pretest %*	*Posttest %*	*Growth %*	*Normalized Gain*
Cameron	*.037*	*.095*	*.058*	*0.137*
Elah	*.029*	*1.000*	*.071*	*0.129*
Bryson	*.000*	*.068*	*.068*	*0.130*
Karla	*.026*	*.089*	*.063*	*0.112*
Mary	*.026*	*1.000*	*.074*	*0.147*
Maggie	*.016*	*.097*	*.082*	*0.142*
Erin	*.026*	*1.000*	*.074*	*0.147*

Langston	*.011*	*1.000*	*.089*	*0.155*
Zion	*.037*	*.095*	*.068*	*0.137*
Shelly	*.013*	*.089*	*.076*	*0.108*
Kira	*.032*	*.095*	*.063*	*0.128*
Tara	*.032*	*1.000*	*.068*	*0.147*

For this unit, the students showed minimal normalized gains between the pretest and posttest. The students did, though, show an increased understanding of place value after the implementation of curriculum compacting. All of the students' normalized gains fell between 13% and 18%. Madsen, McKagan, and Sayre (2017) suggested that normalized gains have traditional boundaries: small gains are defined as less than .30, medium gains are defined as between .30 and .69, and large gains are defined as greater than .70. All of the students had a raw gain between fifty-three percent and eighty percent. The normalized gains for the class remained below sixteen percent that is considered small. Table 3 displays the normalized gain for each student. The low scores and the lack of deviations of the scores were typical characteristics of homogeneous gifted classrooms (Winebrenner, 2000). Though the quantitative results must be interpreted cautiously due to a low number of students in the study, the results suggested that curriculum compacting is a viable pedagogy for use in a gifted, third-grade math class.

Additional Observations and Insights

Curriculum compacting and this unit on place value were chosen because the questions were aimed at higher level thinking. The students were required to calculate the correct answer as well as write an explanation of how they did the calculation. This type of questioning was different for the students who had never been instructed with the curriculum compacting strategy. During the pretest, the students began to display emotional distress that led me to use observation notes to document the students' levels of distress after the Project M^3 testing. Gifted and talented students have, by nature, the propensity to perform well academically (Brulles & Winebrenner, 2012). The gifted student population does not take failure in stride as they seek perfection in all things (Gentry, 2016). Therefore, taking a test on place value prior to instruction could have caused them to experience stress and anxiety. While this was not officially a part of my study, I observed and recorded my student's responses here as additional insights. These insights are discussed more as implications for future research in Chapter Five.

Due to the content being beyond their level of mastery, it was essential to scaffold the students until they were able to solve the math problems independently. Vygotsky (1978) labeled this concept of taking a student's learning from an identified place of discomfort and scaffolding them to zone or space of knowledge as zone of proximal development (ZPD). Additionally, because the previous curriculum was far from challenging for them, this venture into the unknown was daunting and emotionally draining. Through my teaching strategies and supportive comments of assurance in their ability, the students were able to build their confidence and their mastery concurrently. Below is a description of some of the comments made by the students during and after the pre- and posttest.

Cameron: This participant scored thirty-seven percent on the pretest. The participant seemed frustrated with his inability to master the content. Cameron cried while taking the pretest. He stated, "I do not feel as confident when I take a test before I practice on the subject or learn more about that subject. I did not like it very much." After instruction, Cameron scored ninety-five percent and expressed more confidence.

He stated, “I overcame the challenges by learning the lessons, and it gave me a little bit of encouragement when I was doing something very challenging or difficult. Persisting helped me by keeping me from giving up, and it told me that I should keep trying no matter what."

Elah: This participant scored twenty-nine percent on the pretest. The participant became extremely emotional during the pretest. When I inquired about her feelings, she responded, “It is like riding a roller coaster; you are excited on the way up, then you fall all the way down. It is tough and scary.” After instruction, she earned a perfect score. She stated, “I applied past knowledge to a new situation and took responsible risks to improve my scores."

Bryson: This participant did not answer one question on the pretest. She threw the test in the trash. When I inquired about her feelings, she responded, “I feel kind of insecure, like I cannot do anything. It is like everyone is doing so good, and I am about to score an F. I know that sounds crazy, but that is how I really feel.” After instruction, she scored a sixty-eight percent. When I inquired about her feelings, she stated, “I remembered that I am smart. Persisting helped me not give up whenever things got hard, and I used my common sense.”

Maggie: The participant scored sixteen percent on the pretest. She became inconsolable and unable to finish the pretest. When I inquired about her feelings, she responded, “I feel a little uneasy. I feel out of place. I do not feel confident in myself. I do not like taking a test without learning or studying. Sometimes I feel okay, but most of the time I get frustrated or upset.” After instruction, she scored ninety-seven percent on the posttest. When I inquired about her feelings, she responded, “I persisted and stayed calm. I persisted in answering the questions, and I used ‘managing impulsivity’ to stop from showing that I was upset.”

Erin: This participant scored twenty-seven percent on the pretest. She became flustered during the pretest. When I inquired about her feelings, she responded, “I feel scared, unconfident, and surprised. I wanted to give up the second I saw the test. I felt like it was going to take me all day. I was so insecure and thought I could not do it.” After instruction, she earned a perfect score. When I inquired about her feelings, she responded, “I had to take a responsible risk and at least try. I knew I was going to cry, but I persisted. I applied past knowledge to new situations.”

Langston: The participant scored eleven percent on the pretest. He shut down emotionally and refused to take the assessment. When I inquired about his feelings, he responded, “I feel angry and upset because we did not even get to study and it is the beginning of the school year. We don’t know enough about the topic so how can I get a 100 on the test!” After instruction, he earned a perfect score. When I inquired about his feelings, he responded, “I just applied past knowledge to a new problem.”

Zion: The participant scored a thirty-seven on the pretest. She did not show much emotion during the pretest. When I inquired about her feelings, she responded, “I feel confident about taking this test. I feel like I can do anything. I can feel confident about something and not do well. Sometimes, I study similar things for fun at home.” After instruction, she scored eighty-nine percent on the posttest. When I inquired about her feelings, she responded “I just think flexibly when doing the math. It helps me think outside-the-box to solve problems."

Reflection

This action research project aimed to identify an overall problem in the instructional methods used with gifted students in a third-grade pull-out class. Project M^3 was selected to augment the premise of this study that third-grade gifted students should be taught with a different curriculum than a generic program. The aim was to increase the level of higher-order thinking deemed by me as more appropriately meeting the instructional needs of the gifted. It was atypical for me to give a test on a subject matter the students had not been previously taught. The participants wanted to do very well on the pretest because it was an assessment, and they desire to do well academically. During the intervention a new problem emerged, many students developed and displayed test anxiety. This new issue prompted me to include anxiety as a factor to note.

Quantitative data were appropriate to measure growth in this study, but the emotionality demonstrated could not be dismissed. Observations were made throughout the intervention to note emotional responses both verbally and non-verbally. Also, the students were allowed to express their emotions through writing. It was logical to gain an insight on how GT students' felt and the potential role that anxiety played when new processes were assessed.

Hence, the descriptive data were not used to answer questions about how/when/why the characteristics occurred. That was not the focus of this study; however, the information was considered necessary because I was bound by ethical considerations for the health and welfare of the students participating in the study at all times. Based on the behavior patterns for gifted students, I understood there was a strong tendency toward anxiety associated with perfectionism. Due to this knowledge, I noted their emotional reactions throughout the study. Their emotional state could not be jeopardized in any way. When a few students began to cry out of frustration of being tested on material not already taught, I was quick to calm them down and inform them it was okay to cry, but that they would be fine. It was at this point that I decided to reemphasize to the students that the pretest did not count toward their grade. Brief excerpts of their verbalizations were documented. I noted that for some students their anxiety remained high while for others it decreased after they were instructed.

The viability of curriculum compacting was evaluated by calculating raw and normalized gains based on student scores on assessments in the place value unit of study. Higher raw and normalized gains indicated greater viability for curriculum compacting as a pedagogy for students in a gifted math class, because those measurements indicate that students have a better understanding of place value and numeration systems. This analysis was unique within literature pertaining to curriculum compacting for gifted third-graders due to there being limited previously published studies. As a result, this dissertation contributed to theoretical and experimental research in gifted education.

Conclusion

Chapter Four focused on the findings from the primary research questions, academic growth between the pre- and posttest, and my observational notes of students' anxiety behaviors before and after the pre- and posttests. Complementing my quest for knowledge on supporting the development of higher order thinking skills while caring for their emotionality was the implementation of both an actual data collecting test and observational notes. Chapter Five interprets the data found in this study. Also, ways to use the data to impart more in-depth thinking skills for gifted students is discussed.

CHAPTER FIVE: Discussion, Implications, and Recommendations

This study used an action research design to improve my teaching practices and increase my students' ability to use higher-order thinking. The problem of practice for this study was to determine the viability of curriculum compacting as an instructional methodology for gifted and talented students. To evaluate this problem of practice, I incorporated a unit of study on place value and numeration during a nine-week period.

To quantify the feasibility of curriculum compacting, students' pre- and post-instruction knowledge were assessed using a one-group pretest-posttest method. For this method, students were assessed by the Mentoring Mathematical Minds' unit assessment prior to the implementation of the treatment. The same assessment was used following the nine-week treatment to measure academic growth. Raw growth and average normalized gain were calculated with student scores on each assessment. This information yielded valuable information about the viability of curriculum compacting with gifted math students.

Additionally, student scores were graphed to display the relationship between the pretest and posttest scores for the assessment. Observation notes, student vocalized concerns, and responses were recorded to document student anxiety levels, thereby allowing me to record students' emotionality. The data gathered provided a critical baseline for information on the students' ability to use higher-order thinking as well as the role that test anxiety can play on their academic ability.

Research Question

What are the effects of curriculum compacting on students' ability to use higher-order thinking to solve complex math problems?

Overview/Summary of the Study

The purpose of this study was to measure the effects of curriculum compacting on students' ability to use higher-order thinking to solve complex math problems. Chapter Two reviewed existing literature on various aspects of gifted education: historical development of gifted education, the context of gifted education, theoretical and conceptual frameworks, application of curriculum compacting, and higher-order thinking. Chapter Three discussed the methodology of action researched to collect data. In Chapter Four, I thoroughly described and interpreted the data collected during the study such as students pre- and posttest as well as my observational notes.

The problem of practice for this study was that my third-grade gifted students had mastered the place value standard in their general education math class. As a result, many students became bored, disruptive, and needed a challenge. Over time, the students in this study became accustomed to the lack of rigor and struggled to utilize higher-order thinking skills when required. This led to the investigation of curriculum compacting and how challenging and scaffolding students could increase their academic success. The new method of teaching indicated that by taking the students beyond their academic ability and scaffolding them could increase their ability use higher-order thinking.

Major Points of Study

This study involved twelve gifted and talented 3rd-grade students in a pull-out math class. Quantitative data was collected to determine the level of impact the nine-week intervention would have on third-grade gifted math students' utilization of higher-order thinking. Throughout this action research study, I used curriculum compacting as an instructional model to help my students engage in higher-order thinking. The students were able to show that the strategies and content used in curriculum compacting were capable of improving their ability to use higher-order thinking. Through the activities, they were able to critically think and apply their knowledge to other tasks and content areas. Along with answering the research question, I addressed other elements that may have impacted my GT students' academic performance. Below, I detailed the major points that emerged during the study.

Point One: Effective curriculum to reduce underachievement. Historically, gifted students have not been considered at-risk for academic failure, but there has been a growing concern based on the recent trend of GT students dropping out of school (Colangelo, 2004; Renzulli & Reis, 1994). Rubenstein, Siegle, Reis, McCoach, and Burton (2012) argued that the impact of underachievement has been far-reaching. Underachievement can cause social-emotional damage as well as obstruct a child's life mission of efficacy (Rubenstein, Siegle, Reis, McCoach, & Burton, 2012). There is no universal definition of a gifted underachiever, but Reis, McCoach, and Burton (2012) provided a comprehensive one: underachievers are learners who display an acute discrepancy between expected attainment (as measured by standardized tests, assessments, etc.) and actual attainment (as measured by grades and teacher evaluations).

Mainstreamed curricula used in classrooms across the country sometimes failed to motivate students and were not engaging or lacked interesting and challenging experiences (Reis, 2011). No Child Left Behind (NCLB) has brought higher standards and more accountability into the classroom, but it has also thinned and narrowed the curriculum (Vogler & Virtue, 2007). Often, students who are gifted are not challenged to perform to their full capacity because they seem to be doing just fine. These students may never achieve full potential, because they have not had complex tasks and have never really learned to work (Winebrenner, 2014).

As previously mentioned, educating gifted learners can be a tricky task. To properly engage my students, I had to find the most appropriate instructional level and provide academic and socio-emotional support through zone of proximal development. Through engaging lessons and my constant encouragement, my students seemingly gained confidence and exerted effort to understand the content. By removing a number of barriers, my students were able to develop their higher-order thinking abilities. Through their constant engagement and practicing higher-order learning, we saw an incline in their academic performance in most subject areas, especially math. Thus, further reducing underachievement in this particular subject matter.

Point Two: Higher-order thinking. The National Council of Teachers of Mathematics (Coleman et al., 2017) characterized higher-order thinking as the ability to solve a non-routine problem. Hodgkinson (2007) argued that many gifted students could memorize the conventional algorithms needed to solve problems and even apply them but failed to understand the underlying concepts to think beyond the surface. Some of their struggles stemmed from the lack of opportunities to engage in higher-order thinking activities on a regular basis. A challenge for many educators was to identify appropriate curriculum materials and strategies that challenged students to use higher-order thinking and learn substantial mathematics.

Like all students, gifted learners require learning experiences that are valuable (Gentry, 2018). They require content that they can connect to their lives, activities that force them to process central ideas at a high level, and problems that cause them to mentally wrestle with meaningful problems and present defensible solutions (Tomlinson, 2015). Felton and Koestler (2015) discovered that the math curriculum that was accelerated and provided opportunities for complex mathematical reasoning was advantageous for gifted students. Winebrenner (2003) noted that to provide the necessary rigor, students needed units of instruction and projects that encouraged them to explore math concepts over an extended period.

Tomlinson (2015) argued that it is tough, if not impossible, to cultivate the talent of a gifted student with a lackluster curriculum and instruction. Howson (2016) argued that GT students benefit from learning experiences that are planned by essential concepts and principles of a discipline, such as math, rather than by simple facts. This unit allowed my students to explore place value and various base systems in depth. For many activities, my students used manipulatives, computed answers, justified their answers through writing, and verbalized their reasons when they solved problems. I believe the mandate to justify their answers helped my students become experts in the content matter. I knew that they mastered the content when they were able to compute the answer and explain how they came to that conclusion. Through these activities, the participants demonstrated the ability to use higher-order thinking.

Point Three: Socio-emotional barriers. Since the studies of Hollingworth (1942), researchers have considered issues and problems of gifted children regarding their social-emotional characteristics (Christopher & Shewmaker, 2010). Tsui and

Mazzocco (2007) defined academic anxiety in math as the feeling of tension and anxiety that interferes with the manipulation of numbers and the solving of complex mathematical problems. Often, this factor emerged before, during, and after an assessment (Cassady & Johnson, 2002). Although academic anxiety was typically linked with lower levels of academic achievement (Cassady & Johnson, 2002), some research purported that anxiety had an impact on the academic achievement of gifted learners (Cassady & Johnson, 2002).

Although this study did not seek to find a causal relationship between anxiety and academic performance, it was apparent and was considered in the discussion of the findings. It was interesting to note that curriculum compacting, by design, eliminated content that the students previously mastered. This strategy took the content slightly beyond their comfort level and expertise and could have contributed to their heightened anxiety levels. It was discernible that students' anxiety potentially inhibited their ability to utilize higher-order thinking skills and preferred to remain in their comfort zone. Through dialogue, several of my students claimed to be "perfectionists." These students reported that their desire to be perfect stemmed from their parents, teachers, and classmates. Some students felt an enormous amount of pressure from their families to be perfect in school. Also, my GT students reported that being placed in heterogeneous classrooms caused them to be constantly scrutinized by classmates and teachers. In these classrooms, the students believed if they made a mistake then the others would not think they deserved the GT label. My GT students felt that a lack of support from their teachers contributed to their anxiety. Many of these students believed that they must succeed on their own. However, as an advocate, I know these students need just as much support as their contemporaries. A major contributor to underachievement was the individual's socio-emotional health. Research indicated that there is a strong relationship between social-emotional development and school performance (Colangelo & Wood, 2015). Christopher and Shewmaker (2015) noted that problems such as low self-esteem and low self-efficacy often resulted in gifted underachievement. Through a deeper understanding of the association between socio-emotional obstacles and underachievement, educators should be able to adequately support the needs of gifted students (McCoach & Siegle, 2003).

Action Plan: Implication of the Findings of the Study

By its cyclical nature, the conclusion of action research is not an ending point for a practitioner; it is often the introduction to another research study. The implementation of curriculum compacting was intended to increase the gifted students' ability to use higher-order thinking to solve complex math problems. It was observed that there was an increase in the students' ability to use higher-order thinking to solve mathematical equations as well as to justify their answers. After analyzing the quantitative data, I desired to create a plan to continue to implement strategies that can improve higher-order thinking skills. Mertler (2014) emphasized that planning time for reflection was vital for teachers and researchers. By utilizing Mertler's method of action planning, I devised a plan to continue the present study and future research beyond my classroom. The plan consists of ongoing reflection following these phases:

(1) Replicate the study;

(2) Share the findings with stakeholders;

(3) Conduct research in various settings;

(4) Provide professional development for colleagues;

(5) Share findings in research journals.

In order to continue the study and implementation of curricula modifications with gifted students, I plan to replicate this study with a different Project $M^{3'}$s unit of study. Project M^3 has several mathematical units that address different mathematical concepts. Next, I plan to share the findings of the current study with stakeholders within the district. Through a presentation for my colleagues, administrators, and parents, I will define the purpose of the study, its method, and conclusions. Also, I plan to organize and share any feedback received from the participants during the presentation. A document for the stakeholders and parents will be provided and include graphic depictions along with the narrative of the results. I plan to request that the stakeholders and parents share all suggestions they may have in regard in increasing engagement and academic attainment for gifted students. I desire to cooperate with my colleagues to apply new ideas and strategies which could improve the implementation of curriculum compacting.

The next phase of my action research plan is to conduct another study using multiple groups of participants. I want to strengthen my results by implementing a controlled experiment, with one group receiving curriculum compacting strategies and another group that does not. I believe that this will provide stronger evidence on whether curriculum compacting has an impact on higher-order thinking and academic growth. Also, I desire to examine the impact of curriculum compacting on students that are not gifted identified. In doing so, I believe I will be able to better answer the research question: What are the effects of curriculum compacting on students' ability to use higher-order thinking to solve complex math problems? Again, the findings of these studies will be shared with others within and outside the GT field in order to gain additional perspectives and to strengthen the concerted efforts between general education and gifted teachers.

The fourth phase of this action plan will focus on my colleagues. I am constantly asked by general education teachers to help them effectively reach the gifted learners in their classes. It would be beneficial for all the general education teachers to learn effective strategies to meet the needs of all learners, especially their gifted students. Also, through the professional development sessions, I will conduct additional research with various types of students. Finally, after several iterations of the study occur, and statistical confidence levels between multiple iterations are ascertained, I will proceed to the presentation and publication stage of this study. The gifted and talented organization, National Association for Gifted Children (NAGC), meets every year and welcomed the proposal for presentations. Other sources for publication may be *The Gifted Child Today*, *Gifted Child Quarterly*, and *Teaching Children Mathematics*. The intention was to replicate this study with different age groups and in different subject areas. Replicating research can increase rigor and reliability.

Going forward, I plan to show the positive effects of curriculum compacting to the school principal and other third-grade teachers within the school district. Often, these teachers do not feel equipped with the proper curricula nor techniques suited for gifted students in their heterogeneous classes. The teachers will take part in professional development sessions to learn how to implement curriculum compacting into their classrooms.

Additionally, the socio-emotional development of gifted students was a critical point of emphasis. When anxiety interferes with the risk-taking that quality learning demands, it can keep a gifted student from achieving his or her full potential. I concluded that removing the emotional barriers could help gifted students excel in all settings. A possible strategy could be for educators of gifted learner implement the *Habits of Mind* (Costa & Kallick, 2008) curriculum to teach students how to deal with challenging academic and real-life situations. The *Habits of Mind* curriculum is a program that teaches students how to overcome adversity in and outside of the classroom (Costa & Kallick, 2008). The theoretical underpinning of the Habits of Mind is based on the framework mainly developed by Arthur Costa and Bena Kallick, and subsequently through the work of Robert Marzano (1992) with this creation of Dimension of Learning (Campbell, 2006). By its very nature, the HoM framework focuses attention on the processes and strategies that students' minds need to engage with for effective learning to occur. More information on the *Habits of Mind* will be shared in the following section.

Limitations of Current Study and Suggestions for Future Research

This present study was restricted by limited research, a small sample size, grade level, time constraints, academic designation (GT), and research design methodology. Future research is needed to find ways teachers can increase students' ability to engage in higher-order thinking in math, as well as other subjects, to maximize students' academic growth. As mentioned in Chapter One, acceleration, enrichment, and counseling were the primary strategies used with gifted learners. However, it was unclear which practices and conditions were most beneficial for gifted learners. Beyond these strategies, curricula for gifted learners remained inadequate, especially regarding mathematics (Hodgkinson, 2007).

Research Recommendation One: Identify effective strategies for gifted learners

Curriculum compacting is just one strategy that has shown to be effective for gifted students. It provides a setting that is stimulating and addresses the intellectual, physical, and socio-emotional needs of gifted children. It allows the students to advance quickly through the required curriculum content and move to more challenging content. This strategy provides academic rigor within the curriculum. Next, it is important to implement the multi-tiered and multi-faceted curriculum. By differentiating the curriculum, educators can address disparities in the depth and pace of learning. This allows students of all abilities to master a specific subject by generating projects at their ability level. Also, educators need to be flexible with the curriculum. With GT students, it is imperative to take advantage of real-life experiences that can be deciphered into problem-solving lessons.

Furthermore, educators must allow gifted children to take ownership of their learning by accelerating the curriculum. We must teach them to push beyond their ability levels and learn to request assistance when necessary. By helping GT students understand the worth of attaining knowledge in their lives, we inspire them to learn for its own sake, rather than emphasizing test scores as the ultimate accomplishment. Finally, we must be mindful that gifted children are very similar to their peers in heterogeneous classrooms. We must offer a favorable environment for them to grow and learn daily.

Research Recommendation Two: Implement a Socio-Emotional Curriculum

Costa and Kallick (2008) define a problem as any stimulus, question, task, phenomenon, or inconsistency; the explanation for which is not instantly identified. Costa and Kallick further emphasized that intelligent behaviors are performed in response to such questions and problems. The *Habits of Mind* are an identified set of 16 problem solving, life-related skills needed to effectively function in society while encouraging tactical reasoning, depth of learning, persistence, and creativity (Costa & Kallick, 2008). The focus on the processes of the mind is not a new phenomenon. The great philosophers such as Socrates, Plato, and Aristotle produced similar theories. The 16 habits are: persisting; thinking and communicating with clarity and precision; managing impulsivity; gathering data through all senses; listening with understanding and empathy; creating, imagining, innovating; thinking flexibly; responding with wonderment and awe; thinking about thinking (metacognition); taking responsible risks; striving for accuracy; finding humor; questioning and posing problems; thinking interdependently; applying past knowledge to new situations; and remaining open to continuous learning.

Costa and Kallick (2008a) argued that when teaching the habits of mind, educators must be concerned with how many answers students know but more importantly how students act when they do not know an answer. Hordvik, MacPhail, and Ronglan (2017) emphasized that educators must be observant in how students construct knowledge rather than how they merely replicate it. A significant feature of intelligent beings is obtaining information as well as knowing how to use it (Costa & Kallick, 2000). I desired to challenge and motivate my GT students to maximize their potential with curriculum compacting, but at the same time, I wanted to teach them how to cope with challenges with a more aggressive and unfamiliar teaching strategy. The Habits of Mind suited this purpose.

Research Recommendation Three: Increase Sample Size and Diversity

A significant limitation of the present study was the small sample and the lack of diversity in ability level among the participants. There were only twelve participants in the study. All of the students were in the third grade and labeled gifted and talented. Research shows that GT students are more likely to grasp a concept than the average student (Gentry, 2016). To fully see the impact of curriculum compacting, future research should consider using curriculum compacting with students with various academic abilities and multiple grade levels. Currently, a 1st-grade teacher in a Title One school with ninety-eight percent African American population desires to use this curriculum and the compacting strategy as an intervention with her general education students. The results of her study will be of great interests to me.

Research Recommendation Four: Mixed-methods design methods

Doyle, Brady, and Byrne (2009) emphasized that quantitative and qualitative research have weaknesses. McKim (2017) noted that quantitative research was weak in recognizing the context or setting in which data were collected. McKim further noted that qualitative research might contain biases and did not lend itself to statistical analysis and generalization. Mixed method strategies can offset these weaknesses by permitting discovery and analysis within the same study (Doyle, Brady, & Byrne, 2009). The present quantitative study found that curriculum compacting had a positive impact on students' ability to use higher-order thinking to improve academic growth. However, I believe a study would have more validity and reliability with the use of a mixed-methods study the could observe the direct impact of the socio-emotional component on the students' academic attainment. Also, the study was implemented over a nine-week period. Future studies could be conducted over an entire academic school year. I felt limited and rushed to get through every item before my window closed. I believe this expanded time frame would help researchers determine if the consistent use of curriculum compacting influences students' ability to use higher-order thinking.

Conclusion

The current action research study intended to identify if a curriculum compacting intervention would be beneficial to help gifted students develop their higher-order thinking skills. Higher-order thinking skills provide a pathway to help individuals learn how to problem solve, especially in mathematics. The findings of this study indicated that the gifted, third-grade math students did benefit from curriculum compacting by increasing their ability to solve complex problems and justify their answers. Through their actions, the learners became mathematicians rather than math students. Analysis of the data showed curriculum compacting could have a positive impact on all students, not just for gifted learners. This action research study has allowed the investigator the opportunity to observe the positive effects of curriculum compacting and affirms the need to apply this method in my classroom as well as to share it with other educators for the upcoming school year.

After the intervention and the analysis, I reflected on the entire process and considered ways to improve the intervention and the assessment process. Stakeholder insights were an essential aspect of this part of the study. Parents and other school personnel were invited to observe the intervention and were asked to provide an outside look into the process. To gather information, I collected stakeholder input with a survey and in a focus group session to discuss and critique the intervention as they observed. At that time, I gathered all data and observational notes to be further used in this reflection and re-developing stages of the study. Beyond the scope of the dissertation, replication studies will be put in place. Student population changes and curricular topics change, both of which yield unknown variables influencing the success of the initial intervention. Appropriate adaptations will be made.

Based on the research, the field of gifted education is constantly evolving. The perceptions of intelligence, and even giftedness, have transformed. Our perceptions of the delivery method for serving the gifted have transformed. Our population focus has also transformed. This transference offers a quandary but it also dares us to mature and advance as a field. Currently, more than ever, practitioners in the gifted field must seriously understand the need to collaborate with each other, school administrators, content specialist, and regular classroom teachers in new configurations that ensure the unique needs of gifted learners are appropriately met (VanTassel-Baska, 2018). If the gifted field aims to be meaningful for the students it serves, curriculum planners must be aware of the significance of sustaining a balanced viewpoint toward important issues.

Despite the variety of frameworks for the education of gifted math students, there is a lack of empirical data about this population. It is essential to conduct methodical, empirical studies on some curricula to gain a better understanding of their effectiveness and appropriateness for the fulfillment of the gifted students' mathematical potential. As educators, we need analytical reports of applicable strategies and programs for mathematically gifted students to help them reach their potential.

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APPENDIX A: Parental Consent Form (adapted from Mertler, 2014)

University of South Carolina
College of Education

College of Education
Columbia, SC 29208
(803) 777-3828

My name is Anthony James, and I am a graduate student at the University of South Carolina. I am conducting a research study to examine The Impact of Curriculum Compacting on Higher Order Thinking Skills of 3rd grade students. I intend to collect data through the PROJECT M3: MENTORING MATHEMATICAL MINDS unit, Unraveling the Mystery of the Moli Stone. It is an in-depth unit on the importance of base systems and place value. I am formally asking for your permission to allow you child to participate in this study.

If your child is permitted to participate, their identity will never be revealed; any identifying information will be removed for confidentiality purposes. I only intend to use information from this study to improve educational practices and make appropriate decisions for your child. Also, the information obtained from this study will be kept private and will only be reported in statistical evaluations. All data will be physically and/or digitally locked.

If you choose not to allow your child to participate in this study, it will not affect your child's grades nor their relationship with their teacher. You may choose to withdraw your child from the study at any time without penalty.

Do you have any questions? (Circle one) NO YES

If you have questions or concerns regarding your child's rights as a research participant, you may contact me at (803) 394-9857 or aljames@email.sc.edu.

Sincerely,

Anthony James

Please sign below if you give consent for your child to participate in the above-referenced study.

I AGREE DO NOT AGREE (circle one) to participate in this research study.

Participant's Name (please print): ________________________________ Date: ____________________

Participant's Signature: ____

APPENDIX B: Site Approval Letter

University of South Carolina
College of Education

College of Education
Columbia, SC 29208
(803) 777-3828

Ms. Jackson, Principal
Langford Elementary
480 Langford Rd.
Blythewood, SC 29106
RE: Permission to Conduct Research Study

Dear Ms. Jackson:

I am writing to request permission to conduct a research study at Langford Elementary. I am currently enrolled in the Curriculum and Instruction Program at the University of South Carolina, and I am in the process of writing my dissertation. The study is titled The Impact of Curriculum Compacting on Higher Order Thinking Skills. I request to use my ALERT students as participants in my study.

Families will be given a consent form to be signed by the parent or guardian (copy enclosed) and returned to the primary researcher at the beginning of the process. If the parent/guardian grants approval, student participants will complete a pretest in the classroom. The pretest results will be pooled for the research project and individual results of this study will remain absolutely confidential and anonymous. Should this study be published, only pooled results will be documented. No costs will be incurred by either Langford or the individual participants.

Your approval to conduct this study would be greatly appreciated. If you have any additional questions or concerns, I would be happy to address them. You may contact me at my email or phone (803-394-9857).

If you agree, please sign below and return the signed form. Additionally, if you don't mind, please send a signed letter of permission on Langford's letterhead acknowledging your consent and permission for me to conduct this study at your school. I appreciate your time.

Sincerely,

Anthony James

APPENDIX C: Richland School District Two's Approval Letter

RICHLAND SCHOOL DISTRICT TWO

January 31, 2018

Anthony James
aljams@email.sc.edu

Re: Research Request

Mr. James,

The Richland Two Research Committee has approved your application to conduct research in our district. You are authorized to invite the parents of Richland School District Two elementary ALERT students to allow their children to participate in this study. Parents must provide written affirmative consent and their participation will be voluntary and at their own discretion. You must maintain possession of the signed consent form(s) for a minimum of three years following the conclusion of your research.

Please provide a copy of this letter to the principals of Langford and North Springs so they will know that you have received permission from the Richland Two Research Committee to recruit families and teachers for participation. Please be aware that although the research has committee has approved you research request, Richland Two principals always have the final word on whether or not research may be conducted on their campus.

The committee reserves the right to terminate the study at any time if circumstances change or the members feel it is in the best interest of our students. You must complete all research activities in the district on or before June 30, 2018. If you need to conduct research activities beyond that date, you must ask the Richland Two Research Committee for an extension. Finally, you must submit a copy of all final reports, dissertations, or publications based on this research to me upon completion of your study.

Sincerely,

John G. Arnold

John G. Arnold, Ph.D.
Director of Accountability and Assessment

Location:	*Mail:*	*Contact:*
763 Fashion Drive	*124 Risdon Way*	*(803) 787-1910*
Columbia, SC 29229	*Columbia, SC 29223*	*www.richland.org*

APPENDIX D: UNIT ASSESSMENT

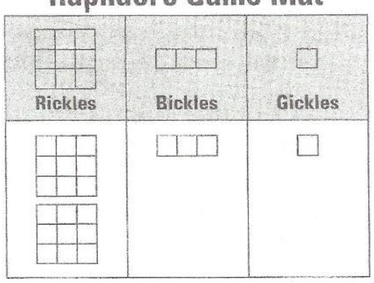
Name ______________________ Date ______________

2. Raphael and Sara are playing a grouping game. In this game:

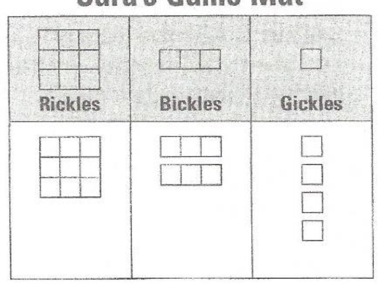
3 Gickles = 1 Bickle
3 Bickles = 1 Rickle

On each turn they roll a die to find out how many gickles to **ADD** to their game mat. They must regroup and trade if possible to have the **LEAST** number of tiles on their game mat.

Raphael's Game Mat



Sara's Game Mat



a. During Sara's turn she tells Raphael that she has a greater value of tiles on her mat. Is Sara right? Explain why or why not.

____

____

____

____

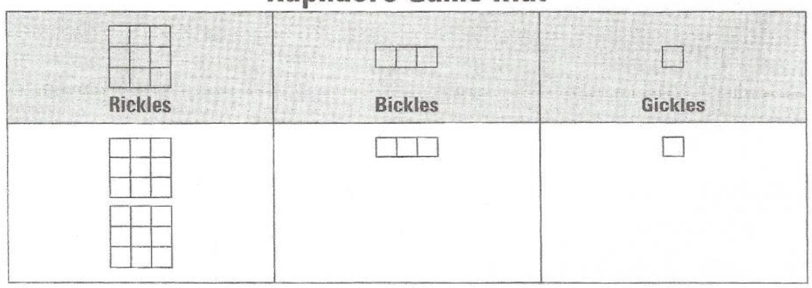
____

____

Name ______________________ Date ______________

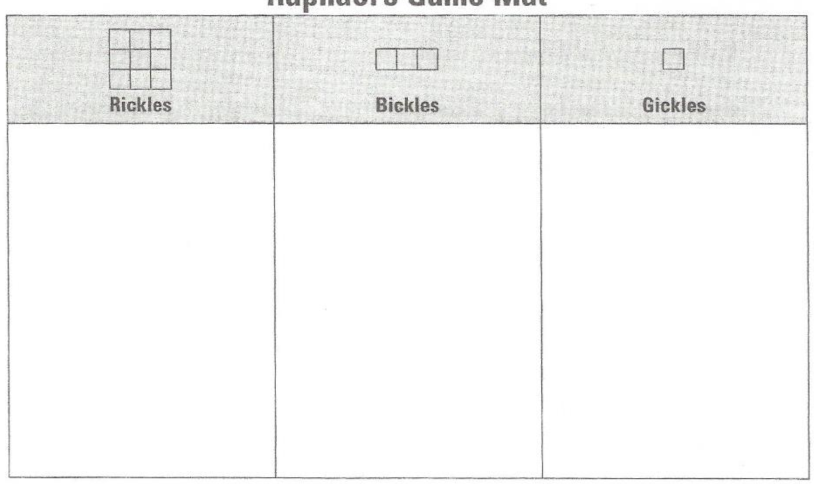
c. Sara and Raphael decide to change the game to use **SUBTRACTION.** This is Raphael's game mat before his turn.

Raphael's Game Mat



Raphael has to **SUBTRACT** five gickles from his mat. Draw a picture below showing how he should regroup and trade his tiles so that he will have the **LEAST** number of tiles on his mat.

Raphael's Game Mat



Answer: ______________ ______________ ______________

Number of Rickles **Number of Bickles** **Number of Gickles**

APPENDIX E: UNIT TEST RUBRIC

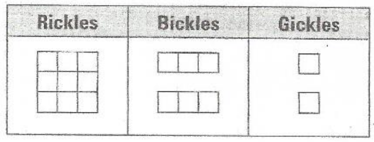
Unit Test Rubric: MoLi Stone — Question 1

Problem	Points	Expected Student Response
		Mathematical Focus
1a (max 1)		*Focus: understanding of place value and computation*
	1	116 is the largest sum, e.g. 52 + 64 or 62 + 54 = 116
1b (max 2)		*Focus: understanding of place value where the digit 5 has a value of 50 and the digit 6 has a value of 60. Although the commutative property is correct (1-point answer), the understanding is not as advanced as the 2-point answer.*
	2	Lists 52 and 64 as addends <u>and</u> 62 and 54 as addends (collectively listed in either 1a or 1b). For example, 52 + 64 and 62 + 54. --- OR ---
	1	Lists 52 + 64 and 64 + 52 <u>or</u> 62 + 54 and 54 + 62 (collectively listed in either 1a or 1b). *Note: It is assumed students have misconceptions if they include either any addends that do not add up to 116 or make a computation error. Therefore, 1 point should be deducted. The total score, however, should <u>not</u> be a negative value. For example, if a student lists 52 and 64 along with 62 and 54 (a 2-point answer) and also includes addends that do not add up to 116 (deduct 1 point), the total score for 1b should be 1 point.*
1c (max 4)		*Focus: understanding of place value where the digit 4 has a value of 40 and the digit 5 has a value of 50 and placing the 7 in the tens place increases the value of the sum by a multiple of ten (versus by ones if placed in the ones place). Replacing the 4 would increase the sum by 30 and replacing the 5 would only increase it by 20.*
	2	Replaces the 4 tens with the 7. --- OR ---
	1	Replaces the 5 tens with 7.
	2	Explains, "Four tens is less than 5 tens so replacing the 4 tens creates a larger value" or "I replaced the 4 with the 7 because it was the smaller value in the tens place." Must compare with replacing the 5 by indicating it is a larger value. ---OR--- Compares 118 with 128 (i.e., the resulting sums if the 7 replaces the 5 and 4 respectively). Must indicate that 128 is larger than 118. ---OR---
	1	Explains, "The tens place has a larger value than the ones place." ---OR--- States, "If I replace the 5 with the 7, I only get 118, and if I replace the 4 with the 7, I get 128," but no comparison between the sums 118 and 128 is clearly indicated.

TOTAL NUMBER OF POINTS: 7

2c (max 2)	*Focus: understanding of place value, regrouping for subtraction and representing trades*

2 — Clearly and correctly draws figures below:



---OR---

1 — Either correct value is represented on mat, but trades are incomplete OR correct value is represented on mat but is somewhat unclear OR regrouped correctly but made a careless copying mistake at the start of the problem.

Possible answers:

Rickles	Bickles	Gickles	Rickles	Bickles	Gickles
0	0	17	0	5	2
0	1	14	1	0	8
0	2	11	1	1	5
0	3	8	1	2	2
0	4	5			

TOTAL NUMBER OF POINTS: 6