EFFECTS OF MATHEMATICS ACCELERATION ON ACHIEVEMENT, PERCEPTION, AND BEHAVIOR IN LOW-PERFORMING SECONDARY STUDENTS

Jennifer Head, Ed.S
Math and Least Restrictive Environment Instructional Coach
Department of Math, Science, and Special Education
Hawkinsville High School

Dawn Lambeth, Ed.D
Department of Middle, Secondary, Reading, & Deaf Education
Dewar College of Education
Valdosta State University

Abstract-*This study evaluated acceleration used as a differentiation technique and its effects on achievement, perception and time on-task compared with the current method of remediation in low achieving mathematics students in a support classroom setting. The intervention consisted of a 6-week period. Students were equitably divided into two groups of eight between the acceleration and remediation groups. All participants were given the same pre/post mathematics computerized achievement tests, Mathematics Perception Survey, and attention to task was observed using the same instrument. Results of the study showed statistically significant gains in mathematics achievement of the acceleration group. However, results of the survey were inconclusive and differences in the percent of time on-task were minimal. The researcher concluded that the use of acceleration in similar groups should increase mathematics achievement more than the use of remediation.*

Keywords: *acceleration, achievement, mathematics, high school, students.*

1. INTRODUCTION

Will acceleration in math support class raise achievement, perception, and time on task for students in Mathematics I to increase the percent of students on track for graduation at a middle Georgia high school? Although math teachers believe remediation should be the main strategy implemented for struggling students in support and core classes, neither this or other non-standards-based strategies have helped to reduce the number of students failing high school mathematics classes.

1.1 Area of Focus

Rodheaver, a math specialist with the Georgia Department of Education (GaDOE) [1], proposed at a secondary math consortium meeting in March 2011 that support classes should focus on accelerating content from the core math class to increase achievement for support students. Although her claims were shared with the faculty by the academic math coach, there is a lack of research tying acceleration to increased achievement in low-performing students, so they are not convinced enough by her suggestion to implement this strategy. The purpose of the study was to determine if academic skill deficits, perception, and behavior can be improved for students enrolled in Mathematics I as a core class that also take Math I Support as an elective, by offering accelerated instruction during their support class. If math achievement was increased for students in the Math I Support class that received acceleration, then the following school year, fewer students would be off-track for graduation.

1.2 Justification

According to the 2009–2010 Report Card [2] (Governor's Office of Student Achievement, 2010) of the 1,482 students enrolled in the system, 65% were eligible for free/reduced lunch. Within the system, 52% of the students were White, 39% were Black, 5% were Hispanic, and 1% was Asian. Enrollment was 448 students with an 80.6% graduation rate, and the school met Adequate Yearly Progress (AYP). Most classrooms at the high school contained enough space for 25-30 desks, four student computers, a projector, and some brand of Interactive Whiteboard or Sympodium. Students attended six classes per day, four of which were usually academic, leaving two electives. Most classes were structured as a traditional period comprised of 54 min each, but fourth period was a 90-min block. Information from the 2009–2010 Personnel Report [23] (Governor's Office of Student Achievement, 2010) reported 28 full-time teachers, nine male and 19 female, of which 25 were White and three were Black.

On July 8, 2010, the research site became one of 10 schools added to the School Improvement Grant (SIG) allocations for a total of 26 schools qualifying for grant funding over the next three school terms to transform the culture of the school. This grant was awarded by the Georgia State Board of Education according to the Georgia Department of Education (GaDOE) [1]. The changes at the beginning of the year were difficult for many teachers to understand, and many of them were very resistant to the process. However, now that teachers have seen a positive impact on student achievement, many teachers have embraced the change. One of the most critical areas of need identified in the grant was student achievement in ninth grade. In the SIG application for the research site the Ninth Grade Data table reported the number of ninth-grade students off track for graduation rising steadily from 10 (8%) in 2007–2008 to 23

(18%) in 2009–2010. Also, the total number of overage ninth-grade students rose from 37 in 2007–2008 to 50 in 2009–2010. The research site implemented a plan in the 2010 – 2011 school year to address the lowest achieving eighth-grade students for a specific intervention before entering ninth grade to help decrease the number of students in ninth grade off track for graduation. This program was called "grade eight and one-half." The student's in the program all struggled in the areas of math and reading and were placed in a 90-min block class to target their deficiencies in mathematics. At the end of the 2010–2011 year, every student remaining in the program passed the retest of the Criterion Referenced Competency Test (CRCT) in Reading, but all scored below proficiency on the CRCT in Mathematics. As a result, the math program curriculum and implementation was reevaluated for the 2011–2012 school term. During the 2011–2012 school term, the 34 students that did not pass the math portion of the eighth-grade CRCT after remediation in the summer school program were placed in Mathematics I and were dual enrolled in Math I Support as an elective course.

Another disheartening statistic for ninth-grade students at the research site was in the area of behavior. According to the School-wide Information System (SWIS) reports, implemented in the 2010–2011 school term with funds provided by the SIG, the ninth-grade class represented the highest number of office referrals, making up 36% (517) out of the 1,435 total referrals during the 2010–2011 school term [3]. If acceleration increased students' time on-task, an indirect result would be less time off-task for inappropriate behavior.

1.3 Deficiencies

There was a lack of specific research providing evidence that accelerating content in low-achieving students increases mathematics achievement, although this strategy was recommended by the GaDOE [1] for use in elective support math classes at the secondary level. As was evident in the school statistics stated previously for ninth-grade students off track for graduation, the traditional approach being used to remediate instruction through drill and repeated practice for students in support math classes has not provided the achievement increases needed. These low-achieving students continued to get off track for high school graduation even though they were enrolled in a core and elective math class concurrently.

1.4 Audience

The target population for the study was students in Math I that are also enrolled in Math I Support at the research site. There were a few students in the support classes that had Individualized Education Plans (IEP) or 504 Plans, but the majority of the students did not qualify for any special services and were considered by the research site guidelines as "slow-learners." The Math I Support classes for 2011–2012 were comprised mainly of the 34 students placed in Math I and Math I Support after summer school. These students were the lowest performing eighth-grade students at the feeder middle school. There was a lack of current research in the area of this study which focused on the use of content acceleration to increase achievement in low-performing students. This study offered a knowledge base that future research can build on in the area of acceleration being used as a differentiation strategy to improve success in low-achieving students, rather than its typical use in advanced placement and honors classes. Therefore, findings from the research benefited students at the research site and statistically similar schools across the state and nation.

2. Review of Literature

Mathematics intervention studies reported using differentiation strategies to increase achievement, which caused a decrease in the achievement gap for minority students. Finnan and Kombe [4] supported the idea of using acceleration as a specific differentiation technique to introduce new content to low achieving math students first. Using this technique should increase achievement and build confidence in students' perceived math abilities.

2.1 Acceleration to increase achievement.

In the case study completed by Finnan and Kombe [4], the authors shared students' attitudes toward an intervention in one school with the goal being to get them back on track for graduation. The school implemented an acceleration plan allowing middle school students older than their on-track peers to complete 2 years of course work in 1 year. Students enrolled in seventh grade at the beginning of the year who successfully completed the program were promoted to ninth grade at the end of the year. Students in the program received math and language arts instruction in separate 90-min blocks, but science and social studies shared one extended block. Students enrolled in the Accelerated Program often said they felt a sense of belonging and could count on each other. Instruction varied within the program, including service projects, field trips, and classes provided by a full time guidance counselor, such as "Stop the Drama," to help students understand the cause and effect relationship of their actions. In 2008–2009, 42% of the first cohort in 11th grade and 52% of the second cohort in 10th grade were on track to graduate within 4 years of entering 9th grade. Both of these cohorts were low-achievers who were considered old for their grade. This case study had positive results on increasing academic success for students by increasing the number of students on track for graduation. However, the findings by Finnan and Kombe were disappointing in that only about one-half of students in either cohort remained on track in high school a few years later. These results support closing the achievement gap similar to the other case study cited by [5].

2.2 Closing the achievement gap.

Olszewski-Kubilius [6] said the largest educational problem in the United States (US) is the gap in achievement between majority and minority students that has existed since the beginning of desegregation of public schools in the US. The authors discussed a particular program implemented in one suburban district to increase the number of minority students in the gifted program. Project EXCITE was developed to close the achievement gap in this district and took place mainly outside of regular school hours. Project partners encouraged teachers to set high classroom expectations, and ensure all children had equal access to advanced education programs. Students became eligible for the program in third grade by being minority students that demonstrated the ability and desire to perform at high levels and came from families that did not have a history of post-secondary education. The program was entering its 5th year at the time the article was published, and out of each cohort 88% to 100% of students achieved at the proficient level in standardized state testing for both reading and math, which was much higher than the districts average for minority students.

Olszewski-Kubilius [6] recognized another program that identified traditionally underserved students and provided a type of acceleration to increase student achievement. The difference in Project EXCITE and many other methods aimed at decreasing the achievement gap, was Project EXCITE's purpose to target minority students for identification and acceleration for advanced placement opportunities. This study showed that acceleration can increase achievement in minority students and therefore help reduce the achievement gap commonly seen in public schools.

2.3 A blended approach.

Beecher and Sweeny [5] wrote an account of how one elementary school put theory into practice by using a blended approach of differentiation and enrichment to decrease the achievement gap among various ethnic groups and socioeconomic levels within the school. The case study analyzed a suburban school that was not meeting state progress indicators using data from state required documents and standardized tests, along with notes from staff meetings and professional development for 8 years. The case study focused on how enrichment and differentiated instruction were used to help reduce the achievement gap in minority students. The school reduced the gap by creating a strategic plan for school improvement including a rationale for school-wide enrichment and differentiation across the curriculum.

Teachers' differentiated curriculum and provided enrichment through the use of higher order questioning techniques, tiered assignments, flexible grouping, learning centers, compacting, technology, experimentation, demonstrations, and other strategies and activities. They incorporated a 3-year staff development program and also offered afterschool classes that focused on enrichment. The afterschool classes were offered in 8-week sessions and were based on academic needs and student interest. The high interest classes focused on skills for math, science, social studies, and the arts. To track the success of the program, the teachers' used ongoing assessment in the form of informal and formal formative and summative tests to adjust instruction as needed for individual students. Students' scores also increased on standardized tests, while they became engaged learners and overall had more positive attitudes toward school.

2.4 Results of the blended approach.

Scores were analyzed from 1997 to 2004 on state achievement tests. The results showed improvements for students in all subject areas and all levels of proficiency. The achievement gap decreased from 62% in 1997 to 10% in 2004 with all ethnic groups showing gains. Students in the remedial band from the lowest socioeconomic levels decreased by 28%, with only 4% of students remaining at this level, and out of these, none were Asian or African American. All of "this provided evidence that the belief in building upon students' strengths with a differentiated approach to instruction and enriched learning experiences could help close the achievement gap between the rich and poor and among different ethnic groups" [5]. Unfortunately, the results of this article may be limited and only generalized to schools containing students with similar ethnic and socioeconomic populations.

2.5 Bloom's contributions.

Guskey [7] also researched possibilities of reducing the achievement gap for minority students by reviewing Bloom's contributions, beginning in the 1960's, and discussing his Mastery Learning Theory using Bloom's Taxonomy. Bloom hypothesized that in order to reduce achievement variations in students; teachers must provide variations in their instruction.

This strategy required teachers to vary both their methods of instruction and the time students were allowed to master the content. Bloom isolated criteria from individual instruction and tutoring that could be transferred to classroom group instruction. He analyzed the similarities and differences among students to determine what made some students more successful than their peers.

Bloom concluded in 1976 that teachers should use classroom assessment as tools for adjusting instruction, progress monitoring, and providing feedback on errors. As some students perform well the first time, they should be offered enrichment while corrective measures are provided for the others. Subsequently, a second formative assessment should be given to the low-performing students in order to identify improvements in learning and to analyze the effectiveness of the corrective measures. Bloom believed this model increased learning for all students. Guskey [7] determined that mastery learning provides individualized differentiated instruction if implemented correctly through feedback, enrichment, and remediated instruction as needed.

Guskey [7] believed teachers who use this approach will increase content coverage in later units, because misconceptions were corrected in early units. Guskey agreed with other researchers, believing that if Mastery Learning is implemented correctly, it can be especially effective with higher-level goals including problem solving and decreasing achievement gaps. Guskey provided evidence that students can benefit from remediation and enrichment. Differentiation needed for individual students based on formative assessments is also crucial to the Mastery Learning strategy. Using formative assessments to guide differentiation for increased student achievement is a common theme throughout all of the articles cited so far. However, this article supported remediation to increase achievement while providing enrichment only to those students who understand the concepts the first time.

2.6 Acceleration for all.

Spielhagen [8] a researcher at the College of William and Mary, hypothesized a different approach to closing the achievement gap. He examined if it was beneficial for all students to study algebra in eighth grade, and if offered would this help close the achievement gap for minority populations. To test his research problem, he implemented a mixed methods study using data from a large southeastern suburban school where students (n = 2,634) were tracked and only some were offered algebra in eighth grade. He asked three questions while examining the data: How were students selected for algebra in eighth grade?, Who was enrolled in eighth grade algebra?, and How did access to algebra in grade eight affect their future achievement?

Spielhagen [8] analyzed data using three criteria for both students in Grade 8 Mathematics and those enrolled in Algebra 1. First, he compared the ethnic make-up and socioeconomic status of students in both groups. Next, he compared standardized achievement results for mathematics. Lastly, he compared students' enrollment in secondary math courses. Results of the data did not indicate increased achievement for students that were tracked for the eighth grade algebra program. The standard deviation in scores on the state algebra test even showed significant overlap in the students who were enrolled in Grade 8 Mathematics compared with those in Algebra 1.

These results suggested that some students who were prevented from taking algebra in eighth grade may have succeeded and benefited from the program. Longitudinal analysis also showed increased benefits for those who took algebra in eighth grade due to the opportunities for more complex courses in high school. The researcher argued that this data supports offering algebra to more, if not all, eighth-grade students, a form of content acceleration proposed to help close the achievement gap for minority students. This study looked at acceleration a little differently than some of the previously cited studies, by suggesting the idea of acceleration, in this case algebra in eighth grade, for all students.

If we assume that students benefit from mathematics acceleration and provide them this opportunity, rather than waiting for them to fail and offer remediation, then they may rise to the challenge. This idea requires educators to have high expectations for all learners, rather than a select few. Essentially, this idea of expecting more is what the current Georgia Performance Standards (GPS) have done by raising the bar over the previous Quality Core Curriculum (QCC) in student achievement, with mixed results reported from standardized data (GaDOE,[1]). As the mathematics content for graduation has increased over the last few years, more students struggle with meeting high school mathematics graduation requirements than ever before.

2.7 Mathematics interventions.

Alloway, Banner, and Smith [9] administered four tests on working memory to 164 students in an urban public high school from the Automated Working Memory Assessment (AWMA; Alloway [10]) to extend current research on the link between the areas tested, cognitive styles, and achievement. The four areas assessed by the test included short-term memory, verbal working memory, visuo-spatial short-term memory, and visuo-spatial working memory. None of the participants had diagnosed impairments and all spoke English as their first language. Students ranged in age from 13 to 14 of which 45% were females. Learning preference was determined using the Cognitive Style Analysis [11]. Achievement was measured using SAT and one validated school based assessment.

The results showed that working memory was not significantly tied to learning styles except in one area, nor was there a significant correlation between learning styles and the achievement assessments. However, the results showed a significant correlation between working memory and achievement at the secondary level. One can conclude that early screening of working memory deficiencies would allow for individualized support to positively impact achievement [9]. This study was performed in England, and therefore results may not be generalized to students in the US.

These results provided support for explaining the relationship between working memory, cognitive styles, and attainment in adolescent students. Understanding how these two areas affect achievement provided support for the use of differentiated instruction. If instruction was differentiated based on student's needs, in this case, for those with deficits in working memory, then increased achievement should result. Unfortunately, this study did not show support for differentiation based on learning styles, because there were no significant correlations between learning styles and working memory or achievement tests. However, providing options for students based on their learning style can increase engagement in the learning process, which should indirectly contribute to improved achievement.

2.8 Successful mathematics interventions.

Maccini, Mulcahy, and Wilson [12] completed a literature review planning to extend the findings for successful mathematics interventions used for secondary mathematics students. They narrowed their search by including only studies from 1995–2006 that included students with specific learning disabilities in grades 6 through 12. The research had to measure math performance and include an academic intervention. The skills addressed by the studies ranged from basic computation, math facts, fractions and decimals, to word problems, geometry, and algebra. The researchers identified the number of students with learning disabilities (n = 384) from the total number of participants (N = 1,134).

The study divided the interventions into categories based on behavioral, cognitive, alternative delivery systems, or the nature of the dependent variable. Some instructional strategies shown through the research to increase academic math performance in students with specific learning disabilities included modeling first, then providing guided practice, and independent practice last, or monitoring performance and providing effective feedback.

Five educational implications were listed in the review, including effective teaching principles, a graduated instructional sequence from concrete to abstract, teaching for understanding, using peer mediated instruction, and the use of videos for problem solving. Students not identified with a specific learning disability but struggle with learning math content could also benefit from the use of the research based instructional strategies included in the literature review by [12] who added credibility to the idea for using various research-based techniques to accelerate instruction for low achieving math students.

2.9 Standards based instruction.

Thompson [13] researched the current trend of utilizing Standards Based Instruction (SBI) to increase achievement in science and math. SBI is a reform strategy where the teacher provides engaging student-centered opportunities for learning, rather than lecture-based instruction. In these classrooms teachers take the role of facilitator by allowing students to self-assess their work, complete projects in groups, perform inquiry based tasks and utilize technology including computers and calculators. The research included teacher assessment and observation forms. Student math and science achievement was measured using results from the Iowa Test of Basic Skills (ITBS). Participants in the study included 408 teachers and 10,000 students from grades 6 to 9 in a large urban public school district.

Findings in the study showed significant increases for academic math achievement with the use of manipulatives, group projects, self-assessment, and computer technology. In addition, none of the non-SBI strategies were found to increase math or science achievement. Future research could examine factors related to uncover reasons why non-SBI teacher directed strategies such as lecture, individual drill and practice worksheets, and quizzes do not increase math or science achievement. These results may only be generalized to schools in large urban areas containing students similar in demographics and socioeconomic status to those included in the study. This research supported increasing math achievement by using standards based instruction techniques to accelerate math content.

Little [14] discussed research-based methods of instruction to assist students in the increasing rigor of mathematics content in the US as a result of the No Child Left Behind

(NCLB) legislation. This legislation was enacted because performance indicators showed US students lagging behind students in other developed countries; especially in the area of mathematics. Most of her research findings were designed to benefit all mathematics students and included differentiated instruction, higher order thinking skills, progress monitoring using formative assessments, and the Universal Design for Learning (UDL). Little stated that "a UDL curriculum takes on the burden of adaptation so that the student doesn't have to, minimizing barriers and maximizing access to both information and learning" (p. 10).

The author explained there were eight curriculum enhancements known to be effective in the classroom, including the use of manipulatives, technology, and concept maps. She also discussed the use of accommodations for students with disabilities. Little [14] concluded by saying the greatest gains are recognized through the use of higher order thinking, scaffolded instruction, technology, and accommodations as needed. Little related to the research of Ing [15] by discussing how legislation designed around standardized test data has caused the content of mathematics and analysis of its instruction to change. Differentiated and scaffolded instruction, the use of manipulatives, and progress monitoring through formal and informal formative assessments have been used for many years in elementary education but are just being recognized as successful instructional and remediation tools in secondary education. Little's research findings supported accelerating instruction by providing research proven methods for introducing the new concepts to accelerate students' understanding in their math courses.

Ing [15] took a different approach to examining mathematics instructional strategies by examining whether standardized test scores were a true measure of the quality of instruction received by the student, since many states are using results of these annual exams to determine student, teacher, and school performance levels. The researcher's purpose was to examine the soundness of deductions made relating to instruction received based on two assessments of mathematics achievement. Ing stated, "among students with similar ability levels, if students with one set of instructional opportunities perform better on an item than students with a different set of instructional opportunities, the item is considered to be sensitive to the effects of instruction" (p. 25). Participants in the study included 24 third-grade teachers instructing 486 students from eight schools in a large urban district over the course of one school year. Student attainment was measured by assessments performed at the end of the school year and were compared to standardized scores from previous years.

The highest correlation was seen between prior student achievement and the distal items ($r = .61$, $p < .01$). A moderate positive correlation existed between teacher awareness of students' strategies and performance on proximal items ($r = .59$, $p < .01$). Ing [15] concluded there was little evidence to support performance on items assessing the same content was influenced by instructional opportunities compared to items on standardized assessments. She goes on to say that further research is needed in this area, but that this study raises opportunities for researchers to expand the definition of instructional opportunities. Ing's study was limited to third-grade students in an urban setting, and may not be generalized to dissimilar groups. Similar to the work of [16] and [13], this study analyzed achievement from the perspective of instruction. However, this study was different in that it examines whether using standardized assessment was a good indicator of the value of instruction received. The research not only reinforced the use of standardized test scores as a useful measure for academic achievement but also provided evidence that standardized tests may not be a good measure of quality instruction.

2.10 Black student achievement.

Recognizing the gap in achievement of minority students compared to White students, Strayhorn [17] chose to use data from the National Education Longitudinal Study (NELS) to determine the effect environmental factors, teacher opinions, and family have on 10th-grade Black students. The study analyzed quantitative survey data using linear regression models to determine if links to academic achievement can be identified between the three factors listed. During the base year of the study, 24, 599 students participated, of which 7% were Black. Out of the 7%, ($N = 1,766$) weighted analysis determined a sample size of 450 Black students. The researcher assessed students' opinions toward math and the quality of instruction using a single item for each area. The data were analyzed in three steps including descriptive statistics, correlation analyses, and sequential linear regression.

From school influences found that praise from teachers and doing homework increased math achievement in Black students. However, Black students in areas with a high percent of families at or below the poverty level tended to score lower on math achievement tests. The research findings are only reported through 2000, limiting their usefulness since teaching methods have changed in many schools over the past 10 years. Although this research provides strong quantitative evidence, further research could reveal additional information by including qualitative research on the cultural aspect of Black families. This research reported findings similar to [4] and included areas such as family involvement and teacher influences identified as crucial for success of the EXCITE program studied by [6]. Using information from this study supports the need for classroom practices that make students successful on the first attempt. Praise should be included with the focus of accelerating instruction to create a positive classroom environment to improve academic achievement and mathematics perception.

Woolley et al. [16] believed in order for students to experience mathematical success in secondary courses, it was crucial for students to develop problem-solving skills in middle school. The authors of this study agreed with other current research that student motivation is linked to teacher expectations. Woolley et al.[16] used survey data from 933 Black middle school students in sixth through eighth grade from the TEAM-Math project in the 2004–2005 school year. Questions on the mathematics survey included personal motivation, perceptions of their teacher, and their presumed mathematics performance. The questions for motivation included confidence, interest, and anxiety towards math. The students were also asked about teacher expectations, standards and instructional practices used.

The data supported many of the hypotheses such as confidence and interest increased with positive teacher expectations. Student confidence was linked to their perceived math performance and increased SAT-10 scores. Students performed better in both subjective and objective mathematics measures as their confidence in math increased and math anxiety decreased. One finding had conflicting results in that students who responded that their teachers hold high expectations showed an increase in confidence towards mathematics but at the same time reported higher levels of math anxiety than students of teachers that do not hold high expectations. This research was relevant to studying the effects of mathematics acceleration versus remediation on achievement, perception, and behavior of students in math classes. In order to provide effective acceleration, you must expect students can benefit from the instruction. Meaning, the teacher must have high expectations of these usually low-performing math students. However, this study is limited to Black middle school students and therefore the findings may not be generalized to secondary mathematics students.

3. Conclusion

Finnan and Kombe [4] supported the idea of using acceleration as a specific differentiation technique to introduce new content for low achieving math students first. This technique should increase achievement and build confidence in students' perceived math abilities. Mathematics intervention studies reported using differentiation strategies to increase achievement and therefore begin to close the achievement gap for minority students. Incremental progress in achievement can be measured by using formal and informal formative assessment methods. Also, comparative analysis between the acceleration and remediation groups pretest and posttest scores provided evidence for the effectiveness of the intervention. In order to identify all possible causes for the difference in achievement between the acceleration and remediation groups, qualitative surveys were given to assess the students' learning styles and attitudes towards math content and instruction.

4. Purpose

The purpose of this study was to examine the effectiveness of academic acceleration on mathematics achievement in a middle Georgia high school. The study also measured the student's perception to mathematics before and after the intervention to see if there was a positive change in their attitude towards math after the intervention. One last area the study included was the area of time on task. Student's on-task and off-task behavior was measured to identify whether the acceleration group had a higher rate of engagement.

5. Research Questions

Research question 1:

Do students who receive acceleration in mathematics support have higher gains on the mathematics achievement posttest than students who receive remediation in mathematics support?

Research question 2:

Do students who receive acceleration in mathematics support rate their perception of mathematics more positively than students who receive remediation in mathematics support?

Research question 3:

Do students who receive acceleration in mathematics support have a higher percent of time on task in their core mathematics class than students who receive remediation in mathematics support?

6. Definitions of Variables

Acceleration: Acceleration was defined as introducing new content from the core math course in the elective math class to participants in the study before it was taught in the core math class. Acceleration was used as an intervention technique for low achieving mathematics students taking Mathematics I Support as an elective credit. The effects of acceleration on the treatment group were triangulated using cognitive, affective, and behavioral measures.

Achievement: Mathematics achievement was defined as the number of items students in the study answered correctly on the multiple choice assessments. Achievement was measured by comparing gains in scores from a pretest and posttest STAR Math assessment for the acceleration and remediation group containing identical strands of mathematical concepts.

Perception of mathematics: Mathematics perception was defined as the students' attitude towards mathematics content and its instruction. Student perception was measured by comparing responses from a student mathematics perception questionnaire for the acceleration and remediation group containing identical items. The questionnaire was administered before and after the treatment to determine whether mathematics perceptions improved after the intervention for the treatment group.

Mathematics support: Mathematics support was defined as an elective class taken concurrently with a student's core mathematics course so the support teacher could provide instruction that complements the content of the core mathematics course to provide additional help for low-achieving students.

Remediation: Remediation was defined as reviewing content from the core math course in the elective math class to participants in the study after it was taught in the core math class. Remediation was used as a control technique for low achieving mathematics students taking Mathematics I Support as an elective credit. The effects of remediation on the control group were triangulated using cognitive, affective, and behavioral measures.

Behavior: Appropriate mathematics behavior was defined as the amount of time a student is on task during the work session in their core mathematics class. Mathematics behavior was measured using a checklist to record time on task for the acceleration and the remediation group in their core mathematics course.

7. METHODS

7.1 Setting and Participants

According to the U.S. Census Bureau [18], the population for the county of the research site is 12,010 with an average of 48.5 persons per square mile, showing a growth of 25.3% since the last census in 2000. The ethnic makeup of the community is 63.9% White, 31.8% Black, 3.9% Hispanic or Latino, and 0.9% Asian, with other ethnicities making up less than 1%. The median household income is $35,180 with 23.2% of persons living below the poverty level and a median value of owner occupied housing units at $72,100 (U.S. Census Bureau, [18], Quick Facts).

According to the 2009–2010 Report Card [19] (Governor's Office on Student Achievement, 2010) of the 1,482 students enrolled in the system, 65% were eligible for free/reduced lunch. Within the system, 52% of the students were White, 39% were Black, 5% were Hispanic, and 1% was Asian. Information from the 2009–2010 Adequate Yearly Progress (AYP) report (Governor's Office of Student Achievement [2] reflected an enrollment of 448 students with an 80.6% graduation rate meeting AYP. The 2009–2010 Personnel Report [23] (Governor's Office of Student Achievement, 2010) reported 28 full-time teachers.

The research site became one of 10 schools added to the School Improvement Grant (SIG) allocations for a total of 26 schools that qualified for grant funding over the next three school terms as awarded by the Georgia State Board of Education according to the Georgia Department of Education (GaDOE) [1]. One of the most critical areas of need identified in the grant was student achievement in ninth grade. In the SIG application, the Ninth-Grade Data table showed the number of ninth-grade students off-track for graduation rising steadily from 10 (8%) in 2007–2008 to 23 (18%) in 2009–2010. Also, the total number of overage ninth-grade students had risen from 37 in 2007–2008 to 50 in 2009–2010. Another area of need for ninth-grade students at the research site was in the area of behavior. According to the School-wide Information System (SWIS) reports, implemented in the 2010–2011 school term with funds provided by the SIG, the ninth-grade class represented the highest number of office referrals making up 36% (517) out of the 1,435 total referrals during the 2010–2011 school term.

The students involved in the study were 16 students enrolled in Mathematics I as their core class and Mathematics I Support as an elective class. Participants were divided into a control group of eight participants and intervention group of eight participants. Demographic information about subgroups of students is provided in Table 1. The two groups were equated by assigning individuals to groups and equally distributing the participants for the control and intervention groups using scores from the Criterion Referenced Competency Test (CRCT) for Eighth-Grade Mathematics, the most current term reporting grade for their core mathematics class, gender, ethnicity, and current grade level.

The control group received the current method of remediation for mathematics support instruction. The intervention group received acceleration of content in mathematics support before it was presented in their core mathematics class. The research site math coach, as the teacher-researcher, and the mathematics teacher of record for the chosen support and core classes in the 2011–2012 school term participated in the administration of the study for the duration of the 6-week intervention period.

Table 1
Demographic Data of Participants

Groups	Ethnicity		Gender		Current Grade Level	
	White	Black	Male	Female	Ninth	Tenth
Remediation	4	4	5	3	7	1
Acceleration	4	4	5	3	7	1

8. Intervention

8.1 Extraneous variables.

The extraneous factors were identified and controlled by the teacher-researcher. The process of matching was conducted to identify personal characteristics that were divided equally between the remediation and acceleration groups. Attributes included the participants' scores from the Criterion-Referenced Competency Test (CRCT) for Eighth-Grade Mathematics, the most current term reporting grade for their core mathematics class, gender, ethnicity, and current grade level. The pretest, posttest, progress monitoring, attitude and behavioral instruments used during the study were administered to the groups equally. The teacher-researcher administered all assessment instruments and monitored the completion of the math exercises. The Math I Support collaborating teacher followed the directions on the SBOF to record on-task and off-task behavior of students in the acceleration and remediation groups during the work session at 5-min intervals 2 days per week throughout the intervention period.

The STAR Math pretest was administered before the treatment was provided, and the STAR Math posttest was administered after the 6-week treatment period ended. The acceleration and remediation groups also received the same Triumph Learning (2009) Coach exercises given at times appropriate for each group considering whether the group's content was being accelerated or remediated. The class had the same whole group opening and closing instruction each day, conducted by their Math I Support teacher. The acceleration and remediation groups each received separate small group instruction from the teacher-researcher at a 15-min station during the work session 3 days per week for 6 weeks based on the group's focus. Exercises were completed by the participants during the work session 3 days per week after receiving instruction from the teacher-researcher. Using the Triumph Learning Coach exercises, a diagnostic test was administered by the teacher-researcher during the work session at the end of each week during the 6-week intervention period to monitor progress of the content for both groups.

8.2 Treatment variables.

The independent variable that was provided to the intervention group was that of accelerating or previewing mathematics content from the core Math I class for students in Math I Support. The remediation group reviewed the content in Math I Support after it was introduced first in the core Math I class. The content, topics, and skills matched the GPS of the unit being taught in the core Math I class for both the acceleration and remediation groups. A group comparison was completed to measure the means and variance in mathematics achievement both within and between the acceleration and remediation groups.

9. Data Collection

Data collection for this study provided information to compare the group receiving acceleration with the group receiving the usual remediation method of instruction in math support. All participants received a pre and posttest achievement instrument, STAR Math, and Math Perception Survey (MPS; Appendix A). Student's on-task and off-task behavior in both the acceleration and remediation group was monitored using the Student Behavior Observation Form (SBOF; Appendix B) created by the teacher-researcher. Observations were made and on/off task behavior was tallied for both groups at 5-min intervals during two work periods each week throughout the 6-week intervention period.

A computerized mathematics achievement test, STAR Math, was administered to both groups before the 6-week intervention to determine pretest standard scores for each student. At the conclusion of the intervention period the STAR Math test was administered to all students again to analyze the effects acceleration had on achievement versus the standard practice of remediation. Gains from the pretest and posttest standard scores were computed and used to calculate whether the increase was statistically significant.

9.1 STAR math.

The Renaissance Learning Incorporated [21] STAR Math Assessment was administered as a pretest and posttest to students in both the acceleration and remediation groups as a measure of academic mathematics achievement. The STAR Math test contained 24 multiple-choice items that were automatically selected based on the student's response to the current item. The test results provided information of a student's current mathematics level reported through a standard score, grade equivalent, and other norm referenced statistical data. The program automatically generated reports based on how many and what level of mathematics questions the student answered correct. STAR Math was determined as a valid and reliable progress monitoring tool by the US Department of Education [22]. Diagnostic STAR reports were run for individual students from the pretest to identify a student's baseline standard score and grade equivalent. The posttest growth report was used to compare the standard score (SS) and grade equivalent (GE) to the pretest to measure improvements in these areas after the intervention period. Pre and posttest scores were analyzed using a one-tailed *t*-tests (*t*, *p*) comparing gains from each treatment. The data were analyzed and patterns for subgroups and themes identified are noted in the results.

9.2 Coach Math

The Triumph Learning Coach series lessons were used to provide students in both the remediation and acceleration groups with equal daily practice exercises during the work session and weekly academic progress monitoring reports through diagnostic testing [20]. The Georgia Department of Education [1] gave their approval for the reliability and validity of Triumph Learning's Coach materials when they purchased and issued a class set to all public schools throughout the state in 2009. The objectives for the Coach exercises and weekly diagnostic tests were determined based on each group's focus of instruction. The remediation group received six exercises on day 1 of the intervention, during the work session, reviewing the previously taught math content, and the acceleration group received six exercises on day 1 of the intervention, during the work session for the new math content. During day 2 of the weekly intervention, the remediation group received the new content practice problems assigned to the acceleration group on intervention day 1 and the acceleration group received the remediation group's intervention day 1 review problems. Intervention day 3 both groups worked problems containing the new content. The weekly diagnostic tests contained five items for each objective from exercises practiced during the week and was administered to all students equally at the end of each week during the intervention period by the teacher-researcher. Correctly working at least five out of six problems on an exercise identifies a student as ready to test on the objective. Correctly answering four out of five problems on a diagnostic test objective identifies mastery for the student. Diagnostic test scores were analyzed using a one-tailed *t*-test comparing gains from each treatment.

9.3 Math Perception Survey.

The Math Perception Survey (MPS) was developed by the researcher to measure the student's attitudes toward mathematics and its instruction. Content validity was established by peer review with three teacher researchers and reliability was established by piloting the survey with five students. The MPS contained 15 items of which 13 were multiple-choice and two were open-ended response. Two of the multiple choice items contained an "other" response where students could fill in an alternative to the listed choices, and four items were rated using an interval scale with assigned numerical values for data analysis. The MPS asked questions from the student's perception of math to their preferred method of math instruction. The MPS was administered to all students in the study before and after the treatment period. There were no correct or incorrect answers, only patterns in the answers chosen by students for specific questions. Data results were analyzed using descriptive statistics (*M*, *SD*) of students' answers to specific survey questions. Patterns from the answers emerged within the subgroups and are discussed in the results.

9.4 Student Behavior Observation Form.

The Student Behavior Observation Form (SBOF) was developed by the researcher and content validity was established by peer review with three teacher-researchers. The SBOF defined both on-task and off-task behavior for reliability of the observed results. Participants in both treatment groups were observed during the intervention period to identify the number of student's on-task at six different 5-min intervals, during the work session, 2 days each week, using the SBOF. The percent of students on-task in each group during the work session was compared to student gains for both the acceleration and remediation groups.

10. Results

This study evaluated acceleration used as a differentiation technique and its effects on achievement, perception and time on-task compared with the current method of remediation in low achieving mathematics students in a support classroom setting. More specifically, the study focused on the following three research questions.

1. Do students who receive acceleration in mathematics support have higher gains on the mathematics achievement posttest than students who receive remediation in mathematics support?
2. Do students who receive acceleration in mathematics support rate their perception of mathematics more positively than students who receive remediation in mathematics support?
3. Do students who receive acceleration in mathematics support have a higher percent of time on task in their core mathematics class than students who receive remediation in mathematics support?

The means and standard deviations for the acceleration and control groups are given in Table 2. The mean gains for the acceleration group (*M* = 32.00, *SD* = 74.52) did differ significantly from the mean gains for the remediation group (*M* = -28.75, *SD* = 47.78).

Table 2

Comparison of Gains in Pretest (STAR Math) and Posttest (STAR Math) Standard Scores for the Acceleration and Remediation Groups

STAR Math	N	M	SD	t-value	p
Acceleration Group	8	32	74.52	1.89	.04*
Remediation Group	8	-28.75	47.78		

$p < .05$

The results show that students in the acceleration group gained an average of 32.00 points on their standard scores from pre to posttest, while the remediation group showed an average loss of 28.75 points in their standard scores from pre to posttest. Posttest STAR Math scores for each group were statistically significant (*p* = .04) over their pretest scores. This means that only four out of 100 students would be expected to show this level of increase in their scores from pretest to posttest due to chance. Students in the acceleration group would be expected to have greater gains in standard scores over the students in the remediation group approximately 96% of the time. The effect size using Cohen's *d* was then calculated resulting in a large effect (*d* = 1.04). The average student receiving acceleration as a teaching method in support math class would be expected to have about 85% higher gains on the STAR Math posttest standard score over their pretest score than a student receiving the current method of remediation.

Students participating in the survey were given a Math Perception Survey prior to the intervention to obtain base line data concerning their opinions toward mathematics and its instruction. The MPS was administered to all participants again after the 6-week intervention period to determine what if any, affect the method of instruction, acceleration or remediation, had on their opinions toward mathematics. Results are displayed in Table 3 for the acceleration group and Table 4 for the remediation group.

Data for the acceleration group before and after the intervention are listed in Table 3. Following the intervention period, students in the acceleration group that were *comfortable* with math increased from 0.0% to 25.0% but the percent *uncomfortable* with mathematics also increased from 0.0% to 25.0%. Post intervention survey results reflect an increase in student' preference to work in *small groups*, with a *partner*, or *individually*.

Table 3

Acceleration Group Math Perception Survey Results Prior to and Following the Intervention

Survey Item/Scale	Response A	Response B	Response C	Response D	Response E
1. Your opinion of Math?	Comfortable	Somewhat Comfortable	Somewhat Uncomfortable	Uncomfortable	
	0.0%/25.0%	62.5%/12.5%	50.0%/50.0%	0.0%/25.0%	
2. What has caused your mathematics attitude?	Free Response				
3. Preference for assignments?	Whole Class	Small Group	Partner	Individual	
	12.5%/12.5%	0.0%/25.0%	75.0%/87.5%	25.0%/37.5%	

Table 3 (Continued)

Survey Item/Scale	Response A	Response B	Response C	Response D	Response E
4. Best way to teach?	Lecture	Worksheets	Visual Aids or Manipulatives	Projects	Other
	12.5%/12.5%	37.5%/37.5%	12.5%/12.5%	37.5%/62.5%	0.0%/0.0%
5. Materials that would help?	Vocabulary	Outline	Numbered Steps	Graphic Organizer	Examples of Work
				25.0%/12.5%	37.5%/25.0%
	0.0%/50%	50.0%/37.5%	75.0%/87.5%		
6. Most assignments are completed?				Individual	
	Whole Class	Small Group	Partner		
	25.0%/25.0%	0.0%/12.5%	37.5%/0.0%	62.5%/62.5%	
7. Main way I have taught?	Lecture	Worksheets	Visual Aids or Manipulatives	Projects	Other
	62.5%/37.5%	50.0%/75.0%	0.0%/0.0%	25.0%/0.0%	0.0%/0.0%
8. Teacher explains learning goals?	Always	Usually	Sometimes	Never	
	25.0%/12.5%	25.0%/50.0%	37.5%/25.0%	12.5%/12.5%	
9. Do you take notes?	Yes	No			
	75.0%/50.0%	25.0%/50.0%			
10. Teacher review answers and comment on mistakes?					
	Never	Seldom	1-2 times per day	3-4 times per day	Several times
	0.0%/0.0%	50.0%/50.0%	12.5%/12.5%	0.0%/12.5%	37.5%/25.0%
11. Teacher answers questions?	Always	Usually	Sometimes	Never	
	75.0%/37.5%	0.0%/12.5%	25.0%/50.0%	0.0%/0.0%	
12. Do you understand expectations?	Always	Usually	Sometimes	Never	
	37.5%/25.0%	12.5%/25.0%	50.0%/25.0%	0.0%/12.5%	
13. One thing to make math easier to understand?	Free Response				

Note: Several items reflect totals greater than 100% because students were told to answer all responses that apply.

Item 2 asked students to list what they believed was the reason for their attitude towards mathematics, and in both the pre-intervention and post-intervention survey results for the accelerated group 37.5% of students left this question blank. Common responses included comments regarding the difficulty of the math and their inability to understand. The largest increase (25.0%) in the preferred method of instruction (Item 4) from pre to post-intervention survey was the preference to complete projects (62.5%). On item 5, one-half of the students in the acceleration group believed vocabulary would help them learn in the post-intervention survey, but none of them marked this item in the pre-intervention survey.

Results varied but were inconclusive for the way the teacher has taught (Item 7), explained learning goals (Item 8), reviewed answers (Item 10), and answered questions (Item 11). Students' decreased their *yes* responses about taking notes in class from the pre-intervention survey (75.0%) to the post-intervention (50.0%) survey. Item 13 was a free response item that requested students to list one thing they would like to change about math class. Five students responded in the pre-intervention survey, but only four commented on the post-intervention survey in the acceleration group. Suggestions to change one thing to make math easier to understand included topics such as changing the classroom rules, more discipline, no homework, working one-on-one with students, allowing students to work with a partner, or working in groups. These results indicate that at least half of the students in the acceleration group believe the math is too difficult, and prefer to work with someone else whether it be a peer or teacher through project based instruction.

Results for the remediation group before and following the intervention are listed in Table 4. Following the intervention period, students in the remediation group that were *comfortable* with math decreased from 50.0% to 12.5% but the percent *somewhat uncomfortable* with mathematics also decreased from 50.0% to 37.5%. Post intervention survey results reflect an increase in students' preference to work with a *partner* by 37.5%.

Table 4

Remediation Group Math Perception Survey Results Prior to and Following the Intervention

	Survey Item/Scale	Response A	Response B	Response C	Response D	Response E
1.	Your opinion of Math?	Comfortable	Somewhat Comfortable	Somewhat Uncomfortable	Uncomfortable	
2.	What has caused your mathematics attitude?	50.0%/12.5%	37.5%/75.0%	50.0%/37.5%	0.0%/0.0%	
		Free Response				
3.	Preference for assignments?	Whole Class	Small Group	Partner	Individual	
		25.0%/0.0%	12.5%/12.5%	37.5%/75.0%	37.5%/12.5%	
4.	Best way to teach?	Lecture	Worksheets	Visual Aids or Manipulatives	Projects	Other
		25.0%/12.5%	50.0%/25.0%	12.5%/50.0%	37.5%/25.0%	0.0%/0.0%
5.	Materials that would help?	Vocabulary	Outline	Numbered Steps	Graphic Organizer	Examples of Work
		37.5%/50.0%	12.5%/25.0%	62.5%/37.5%	25.0%/25.0%	12.5%/50.0%
6.	Most assignments are completed?	Whole Class	Small Group	Partner	Individual	
		25.0%/25.0%	0.0%/25%	25.0%/12.5%	50.0%/37.5%	
7.	Main way I have taught?	Lecture	Worksheets	Visual Aids or Manipulatives	Projects	Other
		62.5%/62.5%	50.0%/50.0%	0.0%/0.0%	0.0%/12.5%	12.5%/0.0%
8.	Teacher explains learning goals?	Always	Usually	Sometimes	Never	
		37.5%/25.0%	25.0%/50.0%	25.0%/12.5%	12.5%/12.5%	
9.	Do you take notes?	Yes	No			
		75.0%/37.5%	25.0%/62.5%			
10.	Teacher review answers and comment on mistakes?	Never	Seldom	1-2 times per day	3-4 times per day	Several times during class
		12.5%/0.0%	25.0%/75.0%	37.5%/12.5%	0.0%/0.0%	25.0%/12.5%
11.	Teacher answers questions?	Always	Usually	Sometimes	Never	
		50.0%/50.0%	25.0%/50.0%	25.0%/0.0%	0.0%/0.0%	
12.	Do you understand expectations?	Always	Usually	Sometimes	Never	
		50.0%/37.5%	12.5%/25.0%	37.5%/37.5%	0.0%/0.0%	
13.	One thing to make math easier to understand?	Free Response				

Note. Several items reflect totals greater than 100% because students were told to answer all responses that apply.

Item 2 asked students to list what they believed was the reason for their attitude toward mathematics, and in both the pre and post-intervention survey all students in the remediation group answered this question. Common responses included comments regarding the difficulty of the math and their inability to understand. The largest increase (37.5%) in the preferred method of instruction (Item 4) from pre to post-intervention survey was the preference to use visual aids or manipulatives (50.0%). On item 5, one-half of the students in the remediation group believed vocabulary and examples of work would help them learn in the post-intervention survey, which was an increase in both responses over the pre-intervention survey.

Results varied but were inconclusive for the way the teacher taught (Item 7), explained learning goals (Item 8), reviewed answers (Item 10), and answered questions (Item 11). Students' decreased their *yes* responses about taking notes in class from the pre-intervention survey (75.0%) to the post-intervention (37.5%) survey. Item 13 was a free response item, and requested students to list one thing they would like to change about math class. All students in the remediation group responded in the pre-intervention survey and all but one commented on the post-intervention survey. Most students' comments regarding item 13 included responses such as making the math easier, working on projects, and allowing students to work with a partner or individually with the instructor. The results reflect at least half of the students in the remediation group have similar opinions to the acceleration group. They believe the math is too difficult, and prefer to learn through project based instruction with someone else whether it is a peer or teacher.

A Student Behavior Observation Form was completed two times each week during the 6-week intervention period to calculate whether students in the acceleration group spent more time on-task than students in the remediation group. Tally marks were used to identify the number of students on and off-task within each group. Results from these bi-weekly work session observations showed students in the acceleration group were on-task 66.14% of the time, and students in the remediation group were on-task 65.27% of the time. These results reflect only a negligible difference in the time on-task among the two groups.

The intervention method of accelerating content in math support to increase achievement in low-performing mathematics students produced significant increases in mathematics achievement. However in most areas surveyed, the students in the acceleration group did not change their attitudes towards mathematics and its instruction more than the students in the remediation group. In addition, students in both groups had almost equal time on-task.

11. Discussion and Conclusions

The purpose of this study was to determine if acceleration or remediation produced higher mathematics achievement, mathematics perception, and on-task behavior during the work session. The data reflect the acceleration groups mean gains (M = 32.00, SD = 74.52) differed significantly (p = .04) over the remediation group gains (M = -28.75, SD = 47.78) producing a large effect (d = 1.04) on mathematics achievement. Survey data between the two groups showed mixed results from the pre-intervention MPS to the post-intervention survey results. The comfort level of the acceleration group went down, but the comfort level of the remediation group increased. Students' preference in both groups to work with a partner increased from the pre-intervention MPS to the post-survey, but the acceleration group increase their preference to teach using projects while the remediation group's preference for projects decreased after the intervention period. The results of the SBOF tabulating on and off-task behavior between the two groups produced relatively equal results.

Does the use of acceleration as a differentiation technique produce greater gains in mathematics achievement in low-achieving students than the current method of remediation? In accordance with results by Finnan and Kombe [4], the use of acceleration produced significant gains (M = 32.00, p < .05) in mathematics achievement over the method of remediation (M = -28.75). A comparison of the gains in the acceleration group over the loss in achievement of the remediation group resulted in a 60.75 total difference in their mean standard scores. This large effect (d = 1.04) on mathematics achievement is also supported by findings recognized by Olszewski-Kubilius [6] in a similar program that identified underserved students and provided acceleration to increase student achievement.

Does acceleration improve student's perception towards mathematics and its instruction? In contrast to results by Finnan and Kombe [4] and Woolley et al.[16], the MPS results of the acceleration group did not show an increase in student's confidence in perceived mathematics abilities. The percent of students *uncomfortable* with mathematics in the accelerated group actually increased from 0% to 25% after the intervention, while the remediation group maintained 0% on both the pre and post-survey results in the response of *uncomfortable*. Also, the remedial group saw a decrease in the response of *somewhat uncomfortable* from 50% pre-intervention to 37.5% post-intervention. However, the students in both the acceleration and remediation groups increased their preference to work with a partner from 75% and 37.5% to 87.5% and 75% respectively. In the post-intervention results 50% of students in both groups preferred to be provided vocabulary. This was an increase for both groups over their pre-intervention results. Research by Beecher and Sweeney [5], Alloway et al. [9], and Thompson [13] supports these preferences aligned with SBI and differentiation saying that they are effective techniques to increase achievement in mathematics.

Does the use of acceleration provide more time on-task than remediation in low-achieving mathematics students? Contrary to the work of Beecher and Sweeney [5], the minimal difference in the acceleration groups mean percent of time on-task (66.14%) and the remediation group (65.27%) does not provide conclusive evidence that the use of acceleration increases students' time attending to their work.

12. Significance/Impact on Student Learning

The goal of utilizing various instructional techniques is to increase student achievement. If one method proves to provide statistically higher gains in student achievement over another, the one resulting in the greatest effect on achievement should be implemented. The current method of remediation at the research site has not proved to be successful in increasing achievement, but a lack of research in the differentiation method of acceleration has not convinced teachers to incorporate its use in elective mathematics support classes. Results of this study show that acceleration used as a differentiation technique in low-achieving mathematics students significantly increased mathematics achievement over the use of remediation. This method resulted in an overall mean standard score that was 60.75 points higher for the acceleration group over the remediation group. This significant difference (p = .04) in achievement cannot be ignored. Since acceleration can produce this large effect (d = 1.04) on achievement in only 6 weeks, consider the long term effects it could have on standardized test scores if implemented for the entire school year. If this method of instruction results in compounded effects on mathematics achievement over the course of a full school year, the following school term, fewer students should be off-track for graduation.

However, qualitative support for the use of acceleration during this short intervention period showed mixed results. Results for many of the MPS items varied from pre and post intervention and from the acceleration to the control group. Several responses even seemed contradictory to increases in achievement in the acceleration group and decreases in achievement among the remediation group. For these reasons, most of these responses to the MPS were determined inconclusive by the teacher-researcher. Students in the acceleration group did not have a clear increase in perceived mathematics ability or greater time on-task than the students in the remediation group.

13. Factors Influencing Implementation

Several factors may have impacted the results of this study. The intervention period was only 6 weeks which provides support for the dramatic increases in achievement for the accelerated group, but this short amount of time may have hindered changes to perception and time on-task. Apparently, achievement is more easily influenced than opinions toward mathematics and its instruction. Several students mentioned they had negative attitudes towards mathematics content for many years. This long term negative emotion towards the content makes it difficult for a short-term intervention to affect.

Another factor that could have influenced results was the students' adjustment period to the new instructional method. Although the method of remediation was currently being used, students in this class were used to whole group instruction. The teacher-researcher noticed students seemed to have a "getting adjusted" period to the class being divided into two distinct groups during the work session. After a couple of weeks the students seemed to be comfortable with the new methods and were settled into the new classroom routine.

Looking at results of the MPS, it seems that the specific questions relating to their teacher or current method of instruction may have been confusing to the students. During the intervention period there were two teachers in the classroom environment. Prior to the intervention there was only one teacher. Some students may have been confused over which teacher the questions referenced.

Also, the teacher-researcher may have positively influenced the results to the answer of MPS item 5 by providing vocabulary over the new content each week to both groups. In addition, the teacher-researcher may have negatively affected students' responses to Item 9 about taking notes in class by providing "notes" for each new element introduced during the intervention period to both groups. More students may have answered *no* after the intervention to this item because during the intervention period students did not physically write notes on notebook paper. Rather, the step by step notes were copied and provided for them by the teacher-researcher. Although, the teacher-researcher encouraged all students to highlight important information, steps, and vocabulary, in addition to prompting students to insert information they believed would help them understand the content to the notes that were provided.

13.1 Implications and Limitations

The significant (p = .04) mean gains in the acceleration group (M = 32.00) producing a large effect (d = 1.04) in increased mathematics achievement cannot be ignored. The teacher-researcher will implement acceleration as a differentiation technique when working with low-achieving mathematics students in the future. After the teacher researcher shares these findings with support teachers at the research site, teachers with similar groups of students should implement acceleration of content over remediation for greater gains in mathematics achievement. This study can also serve as a basis for future research in the use of acceleration as a differentiation technique to increase mathematics success in low-achieving students. As a result, this study could benefit demographically similar schools across the state and nation.

This study was limited to two groups of eight students in one mathematics support class. The limited number of participants (N = 16) in the study hinders the ability of this study to be generalized to student populations dissimilar to the researched group. Several students also had strong opinions of their current teacher's methods of instruction, and this may have influenced their responses to the pre and post MPS. The SBOF had two instances beyond the researcher's control where class was interrupted for unannounced school activities. Although this interrupted observation of both groups on and off-task behavior, overall the students were much less attentive during these times. These two classroom interruptions may have had a negative influence on the end results for percent of time on-task.

Another limiting factor was noted is the high standard deviation within the achievement results in both the acceleration (SD = 74.52) and remediation (SD = 47.78) standard scores. This variability could decrease the reliability of the data. Outliers were not excluded from the data due to the small sample sizes (n = 8). The teacher-researcher attempted to eliminate any bias toward the method of acceleration and its effects of mathematics achievement, but positive references to this method of instruction may have inadvertently influenced results.

Although results of this study support the idea of using acceleration as a remediation technique in low-achieving mathematics students, further research needs to be performed in this area. Additional research should include a larger sample size, and longer intervention period. Equating the groups in future studies both demographically and by pretest STAR Math results may also increase the validity of the study.

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Appendix A

Math Perception Survey

Thank you for your participation in this voluntary survey. The purpose of this questionnaire is to assess your perception about math instruction and use those perceptions to improve our current curriculum and methods of instruction. You may stop at any time. Your completion of the survey indicates your consent to participate.

Name: ____ Date: ________________________

1. What is your opinion about Math most of the time? (Mark all that apply.)
    a. Comfortable (It is easy!)
    b. Somewhat Comfortable (I do okay.)
    c. Somewhat Uncomfortable (I do not understand some of the concepts)
    d. Uncomfortable (It is too hard!)
2. What do you believe has caused you to have this attitude towards Math? ___________________________________
   ____
3. How do you prefer to complete assignments in math class?
    a. Whole Class
    b. Small Group
    c. Partner
    d. Individual
4. What do you believe is the BEST way for your math teacher to deliver content?
    a. Lecture
    b. Worksheets or textbook problems (repeated practice of the same kind)
    c. Pictures, graphs, and/or using items you can feel
    d. Working in groups to solve problems or complete projects
    e. Other ________________________________
5. Mark any materials you believe would help in understanding the concepts if the teacher discussed or provided them? (Mark all that apply)
    a. Important vocabulary
    b. Outline of the key concepts
    c. Numbered steps
    d. Graphic Organizer
    e. Examples of poor, good, and strong work
6. How are the majority of your math assignments completed?
    a. Whole Class
    b. Small Group
    c. Partner
    d. Individual
7. What is the main way you were taught the math content?
    a. Lecture
    b. Worksheets or textbook problems (repeated practice of the same kind)
    c. Pictures, graphs, and/or using items you can feel
    d. Working in groups to solve problems or complete projects
    e. Other ________________________________
8. Does your teacher explain what the Georgia Performance Standards, learning target or "I can" statements are for the math content you are learning?

   a. Always
   b. Usually
   c. Sometimes
   d. Never
9. Do you usually take notes in math class when learning new information?
   a. Yes
   b. No

10. How often does your math teacher have you review answers and provide comments about mistakes you made?

   a. Never
   b. Seldom
   c. 1 – 2 times per day
   d. 3 – 4 times per day
   e. Several times throughout each class
11. How often will your math teacher answer your questions if you do not understand?
   a. Always
   b. Usually
   c. Sometimes
   d. Never
12. Do you understand your teacher's expectations for your behavior in math class?
   a. Always
   b. Usually
   c. Sometimes
   d. Never
13. If your teacher could change one thing about math class to make it easier to understand, what should it be? ________
____
____

14. What is your race?
   a. American Indian or Alaska Native
   b. Asian
   c. Black or African American
   d. Hispanic or Latino
   e. Native Hawaiian or Other Pacific Islander
   f. White
15. What is your gender?
   a. Male
   b. Female

Thank you for your time and participation in this student perception survey.

Appendix B

Student Behavior Observation Form

Directions for the Collaborating Teacher/Observer: Place one tally mark representing each student meeting the criteria listed below for on-task or off-task behavior as appropriate in the box corresponding to the correct interval for the recorded time.

Intervention Week _____ - Observation Day 1

Work Session Time Intervals:	5min	10min	15min	20min	25min	30min
Remediation Group:						
On-Task						
Off-Task						
Acceleration Group:						
On-Task						
Off-Task						

Intervention Week _____ - Observation Day 2

Work Session Time Intervals:	5min	10min	15min	20min	25min	30min
Remediation Group:						
On-Task						
Off-Task						
Acceleration Group:						
On-Task						
Off-Task						

On-Task behavior - Looking at teacher during instruction/directions, participating in class discussion, working on assigned work, or working cooperatively on a cooperative project.

Off-Task Behavior - Instead of working on assigned task, the student is out of seat, fidgeting, playing with objects, making gestures, acting silly, calling out, talking to someone about an unrelated topic, making noises, looking around, daydreaming, delaying starting the assigned task, or has head down.