THE ACCURACY OF THE ADVANCED MATHEMATICS PLACEMENT CRITERIA IN IDENTIFYING STUDENTS FOR MATHEMATICS COURSE ACCELERATION

A Doctoral Capstone Project

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Abstract

The purpose of this mixed methods study is to provide data points that address the accuracy of the screening process for students to be accelerated in mathematics courses prior to entering middle school in the South Fayette Township School District. This screening process is a decision that happens prior to sixth grade but has long-lasting implications related to the courses students can take in high school and their trajectory for college and career goals. Prior to this study, the district had never conducted a review of the process that was internally developed. The three research questions that drove this study led to an evaluation of student data related to the five most recent cohorts of students that had been accelerated (150 students), as well as a review of participant feedback from a mathematics teacher perspective survey in which 17 teachers completed. The outcome of this study indicated that the screening process has shown to be successful for over 90% of the students that had been identified through the screening process. However, there was a recommendation that resulted from both the student data and teacher feedback for the district to consider changing one of the criteria in order to enhance the screening process.

CHAPTER I

Introduction

Background

South Fayette Township School District has had an accelerated mathematics pathway that begins in sixth grade in place for over twenty years. However, eight years ago, coupled with the implementation of the new Pennsylvania Core Standards for Mathematics, the district established a new set of criteria for determining whether or not students would qualify for placement in this accelerated pathway. The district chose to maintain utilization of the criteria during the timeframe when students are exiting fifth grade and prior to them entering sixth grade. The criteria include three components: cumulative grade average for fifth grade mathematics, the raw cumulative score from two subtests from the Third Edition of the Test of Mathematical Ability (T.O.M.A. 3), and the percentage correct on a comprehensive summative assessment based on the general sixth grade mathematics course’s standards. Since these three criteria are from different sources and use different scales and metrics, the performance on each is converted to points ranging from 0 to 5, and students earn a point total out of 15 points (Appendix H). For the first two years of the new screening process, the Second Edition of the Test of Mathematical Ability (T.O.M.A. 2) was used, and the raw point totals were distributed slightly differently on the scoring rubric (Appendix I).

As the coordinator of the screening process, principal of South Fayette Middle School, and former middle school mathematics teacher in the district, I have been involved in all aspects of the criteria process, from the development of the criteria to the implementation of their use. Since these criteria have been in place, approximately 10% of a grade level's student population each year has qualified for the accelerated mathematics course in sixth grade, ranging from 26 to 32 students. The accelerated mathematics course in sixth grade is Pre-Algebra. If students remain on this pathway, they have the ability to take Advanced Placement (AP) Calculus BC in their senior year. This is not the case for students who do not qualify; they can only reach AP Calculus BC by forgoing an elective in high school in order to double-up on taking mathematics courses.

Purpose of Study

The mathematics course trajectory that is set into motion by the outcomes of the students' performances according to the criteria can allow or prevent students from enrolling in the highest level of mathematics coursework by graduation. The intention of this criteria is to appropriately identify students for acceleration, yet there has been no research conducted thus far to support the accuracy of this criteria.

Since the qualification process is an exclusionary academic decision that occurs once as students enter sixth grade, this research will be informative as to whether or not the criteria are accurately identifying the mathematics placement of students. Additionally, as a former mathematics educator, I am interested in analyzing the data from multiple cohorts of students who have already been accelerated in mathematics to identify if the use of the current criteria is accurate in their placement determination and to determine if a certain criterion is a stronger indication of successful placement than the other two. The mathematics teachers' perspectives, voiced through survey responses, will also be valuable as they will provide a set of observations related to the appropriateness of student placement in their accelerated mathematics courses.

Potential Outcomes

One potential outcome of the research would be the confirmation that the established criteria have a strong alignment with identifying the correct students and that those students are achieving success in the accelerated mathematics sequence. If the data and research support this, then there would be no impact to the existing system. However, if the data and research indicate that one or more of the criteria does not correlate to accurate placement of students and subsequent success, then the qualification process may need to be altered by the district.

Financial Implications

Due to the importance of identifying the most accurate criteria for determining the proper students for acceleration, the selection of and investment in the right tools must be achieved. The cost to conduct the current screening process for students to qualify for the accelerated mathematics sequence is very minimal. Of the existing three criteria, two are data pieces that are generated at no or minimal cost. One criterion, the students' cumulative grade averages in fifth grade math, comes from a query in the district's online grading system. The second criterion, the comprehensive, summative assessment tool of the general sixth grade mathematics course, has already been designed by district mathematics educators. This assessment tool only needs to be copied each year for the students to take. An expense that the district has to incur related to the criteria is the purchasing of the Third Edition of the Test of Mathematical Ability (T.O.M.A. 3). Copies of these exams are budgeted for annually. Additionally, six teachers are paid an hourly rate each year to score the two assessments. Three fifth grade teachers score the T.O.M.A. 3 tests, and three sixth grade teachers score the comprehensive sixth grade assessments. These teachers are paid an hourly rate and are not permitted to exceed 5 hours of grading. The hourly rate as of the 2020-2021 school year is $40.75.

Should the data and research from this Capstone Project indicate that the criteria are not accurately identifying students for the accelerated mathematics sequence, there could be a financial impact on the district of selecting an alternate (or multiple alternate) screening tool(s). The funds allotted to pay the six teachers may also be impacted if new tools would require less or more time for scoring.

Research Questions

To guide the research, the following questions have been identified:

1) Is the screening process for advanced mathematics coursework accurately identifying students for acceleration based on the criteria?
2) Do teachers perceive that students are accurately placed in advanced mathematics courses based on the qualification process that occurs prior to the start of sixth grade?

3) Of the three criteria used in the screening process, does a pattern exist as to a certain criterion indicating a greater likelihood of success in mathematics advancement?

Presumptive Outcomes

Based on these research questions, my professional involvement in the qualification process, and the analysis of the quantitative and qualitative data, I anticipate that the accuracy of the placement criteria for accelerated mathematics will align with this current set of criteria. I expect that nearly all students who have been accelerated in sixth grade will continue on this advanced pathway in subsequent years. If I were to anticipate one of the criteria that would be most indicative of success in the accelerated mathematics pathway, I would identify that as the T.O.M.A. 3. However, due to a potential lack of awareness of this assessment tool by most mathematics teachers, I believe that the teachers' observations and feedback will emphasize the use of a different criterion, particularly the comprehensive sixth grade summative assessment.

CHAPTER II

Literature Review

Historical Progression of Mathematics in Public Schools

Research has found that when students take advanced level mathematics courses in high school the result correlates to positive outcomes. Students taking such courses yield higher assessment scores, a higher likelihood of enrolling in college and completing a bachelor's degree, greater returns in the labor market, and increased career satisfaction (Altonji et al., 2012; Bozick & Lauff, 2007; Chen, 2009; Nord et al., 2011; Pellegrino & Hilton, 2012). Completing Algebra I in eighth grade sets students on a trajectory in high school to surpass the completion of Geometry and Algebra II, leading to enrollment in courses that are deemed advanced level. Due to this trajectory, there has been a recent nationwide effort to increase student engagement in advanced level courses and, most notably, in having students take Algebra I by eighth grade (Bernhardt, 2014; Reed, 2008; Domina, 2014, Simzar & Domina, 2014). Furthermore, Finkelstein et al. (2012) noted in their research that "success in high-level mathematics in high school is predictive of post-secondary success and careers in STEM fields" along with finding that a close relationship exists between a student's level of success in middle school mathematics and his/her level of performance in high school courses (p. 1). However, historically, mathematics courses such as Algebra I and Geometry were not always courses deemed important for all students.

Klein (2001/2003) claims that educational leader William Heard Kilpatrick had the greatest influence on elementary and secondary mathematics instruction in the early 1900s. Kilpatrick believed that mathematics instruction should only be relevant to practical value and that the traditional high school mathematics curriculum should only be available as an indulgence to a select few (Klein, 2001/2003; Loveless, 1998). Kilpatrick's approach to mathematics instruction reigned in the public-school system, although not unchallenged, through to the 1950s. This practical approach to mathematics instruction was strongly reinforced by the Life Adjustment Movement in education in the 1940s.

It became apparent during World War II that there was a lack of basic skills needed for bookkeeping and gunnery by army recruits (Klein, 2001/2003). As a result, the Life Adjustment Movement had mathematics programs in schools focus on real-life skills such as "consumer buying, insurance, taxation, and home budgeting, but not on algebra, geometry, or trigonometry" (Klein, 2001/2003, pp. 178-179). In a separate account of the progression of education and the Life Adjustment Movement, Ravitch (1983) found that at the height of this approach to education, the curriculum across the country lacked so much rigor and intellect that a high school principal described the approximate 30% of his students enrolled in academic courses as wasting their time. These practical approaches to mathematics instruction during the early 20th century shifted later in the late 1950s to what is described as the New Math period (Klein, 2001/2003).

Klein (2001/2003) posits that, in response to national embarrassment of the U.S.S.R.'s launching of the first satellite into space, the United States wanted to improve the quality of mathematics instruction in public schools. The New Math movement yielded new curricula for elementary, junior, and senior high schools, as well as the introduction of calculus as a high school course (Klein, 2001/2003; Loveless, 1998). The New Math period waned by the early 1970s when the nation shifted to return to basic skills instruction in mathematics. This period of mathematics education is labeled as the Open Education Movement and was a reappearance of the fundamentals presented by Kilpatrick in the beginning of the 20th century (Klein, 2001/2003). Lasting less than a decade, the Open Education Movement received great criticism due to national recognition of the poor quality of mathematics education it delivered in public schools.

In 1983 a commission under the leadership of the U.S. Secretary of Education produced a report on the status of public education. The report, *A Nation at Risk: The Imperative for Educational Reform*, highlighted numerous issues in education, specifically stating the inadequacies in mathematics education (Klein, 2001/2003). *A Nation at Risk* reported that only 31% of the nation's graduates were completing intermediate algebra by the time of graduation (United States, 1983; Klein, 2001/2003). Notably, in 1989 the National Council of Teachers of Mathematics (NCTM), with support from the National Science Foundation (NSF), produced the *Curriculum and Evaluation Standards for School Mathematics*, which was "comprised of sections devoted to general standards for the bands of grades: K-4, 5-8, and 9-12" (Klein, 2001/2003, p. 185). The NCTM Standards placed an emphasis on the use of technology and manipulatives in mathematics instruction, particularly calculators, as well as the concept of constructivism, which promoted student-centered learning and mathematical principles being taught through real world problems and discovery (Klein, 2001/2003). Although the NCTM Standards were widely utilized and implemented in the 1990s, the development of mathematics curricula informed by these standards did not uniformly occur nationwide, nor were all states and districts following the guidance constructed by NCTM.

By the turn of the 21st century, states and local school districts were still the authorities governing mathematics standards and curriculum. However, when the *No Child Left Behind* (NCLB) Act was passed in 2001, all public schools became accountable for their students incrementally reaching certain achievement levels in the areas of reading and mathematics through standardized testing in grades 3 through 8, as well as once in high school (Klein, 2015). The goal of this act was for all students to reach the proficiency level on their state assessments by the year 2013-2014. According to Klein (2015), many critics feel that the scope of the mathematics curriculum during this period became too narrow and heavily focused on preparing students for the standardized test due to the NCLB Act.

The current state of mathematics instruction comes as a result of the development of the Common Core State Standards for Mathematics (CCSSM) in 2010. Again, these standards were not a national curriculum, but another attempt to provide standards nationwide that, according to Akkus (2016), "were shaped to guarantee that all students graduate from school with the necessary skills and knowledge to achieve in school, profession, and life, regardless of where they live" (p. 1). Pennsylvania was one of the states to adopt the CCSSM; however, the standards were not officially adopted until 2014, after undergoing modifications to fit the needs and desires of the state's education department. These standards were also renamed as the Pennsylvania Core (PA Core) Standards (Pennsylvania School Boards Association, 2015). The modifications were made in order to withhold control of educational standards at the state level, as well as to include certain standards that the state's department of education believed to be crucial (Pennsylvania Department of Education, 2013). Districts, including South Fayette Township School District, had to make a quick transition to adopt and phase in the new PA Core Standards in one year, causing rapid and simultaneous curricular and instructional changes within Pennsylvania's public school. Pennsylvania joined over 40 other states who currently use the CCSSM standards (or a modified version), as well as the accompanying mathematical practices to guide their schools' K-12 mathematical curricular framework (Akkus, 2016; Polikoff, 2017). In a collective statement by leading mathematical educational organizations, the National Council of Teachers of Mathematics (NCTM), the National Council of Supervisors of Mathematics (NCSM), the Association of State Supervisors of Mathematics (ASSM), and the Association of Mathematics Teacher Educators (AMTE) describe the Core's curricular framework as "the foundation for the development of more focused and coherent instructional materials and assessments that measure students' understanding of mathematical concepts and acquisition of fundamental reasoning habits, in addition to their fluency with skills" (National Council of Teachers of Mathematics et al., 2010).

Over the course of history, mathematics instruction has vacillated between the need to prepare students for their practical futures and the desire to develop students who are globally competitive. After the tribulations of trying to achieve one or the other by way of different instructional eras, many practitioners and scholars believe that the CCSSM accomplishes both the need and the desire- the practical and the competitive.

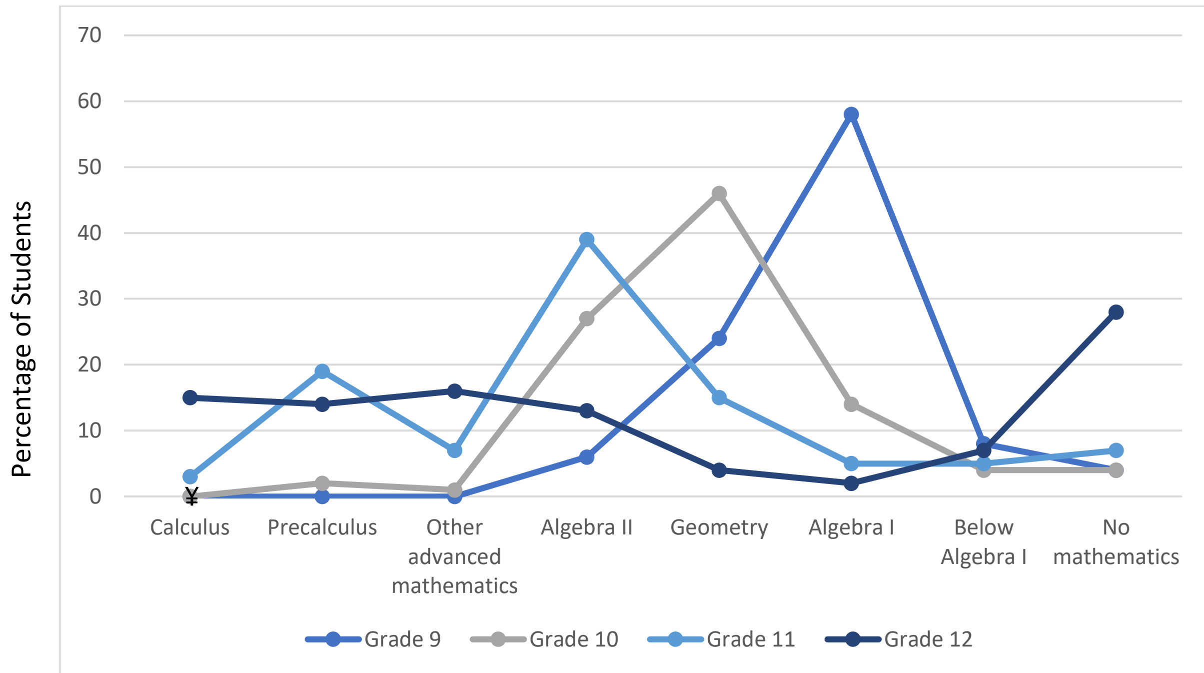
Course Sequencing of Mathematics Curricula

Because the United States still does not have a national curriculum, even with the CCSSM in place in over 80% of the states, the sequencing of mathematics courses at the secondary level can vary by district and state. The Common Core Curriculum does recommend a sequencing of mathematics courses after fifth grade, and this sequence is absent of tracking or ability group placement (Summer, 2011). The sequencing takes all students, heterogeneously grouped, through one course to the next, by grade level not ability, and integrates mathematics coursework (e.g. Algebra I, Geometry, Pre-Calculus, etc.) at the appropriate levels. The sequencing outlined by the Common Core Curriculum after fifth grade is Math 6, Math 7, Math 8, Secondary Math I, Secondary Math II, Secondary Math III, and Secondary Math IV. California is an example of a state that provided this sequential coursework, as well as course nomenclature, for its schools to adopt. California does not mandate this sequencing in high school, and in 2015 a review by EdSource of the state's 30 largest school districts found that only about half of those large districts moved away from a traditional sequence to the integrated design of the Common Core (Harlow, 2015). California is not alone in not having schools fully adopt the Common Core's integrated approach. For example, in Pennsylvania, some schools did realign their courses to the Core's recommended sequence, at least through eighth grade, but nearly all schools maintained their traditional approach of single-topic courses in high school such as Geometry, Algebra II, and Pre-Calculus. This pattern of traditional sequencing tends to be common practice across the country, especially due to the familiar, tiered nature of mathematical concepts.

At the middle school level, an analysis of school tracking programs conducted by Schmidt (2009), reveals that 27% of U.S. eighth grade students attend a non-tracked school in which only one mathematics course is available to all students. The remaining 73% of eighth grade students attend a tracked school that offers two or more different mathematics courses or tracks. At the high school level, the National Center for Education Statistics, under the United States Department of Education, conducted the High School Transcript Study (HSTS) in 2009, gathering data about course pathways in mathematics from a sample of 37,700 high school graduates from approximately three million public and private schools from across the nation (National Assessment of Educational Progress, 2009/2018). From this study, it was determined that the most common pattern of course sequencing in mathematics for high school students was Algebra I in ninth grade, Geometry in 10th grade, Algebra II in 11th grade, and higher-level courses (Trigonometry, Precalculus, or Calculus) in twelfth grade (National Assessment of Educational Progress, 2009/2018). However, course selection and achievement levels in middle school, along with available mathematics courses in high school, local and state requirements for graduation credits, and students' interests and levels of motivation also impacted the course sequencing for students at the high school level (Lee et al., 1998; Newton, 2010). As a result of these factors, the common course sequencing pattern previously described may not be prescriptive for all high school students. Based on the data collection from the HSTS, Figure 1 displays the distribution of percentages of students enrolled in various mathematics courses in each of the four high school years.

Figure 1

Percentage of High School Graduates with Earned Credits in Mathematics Courses

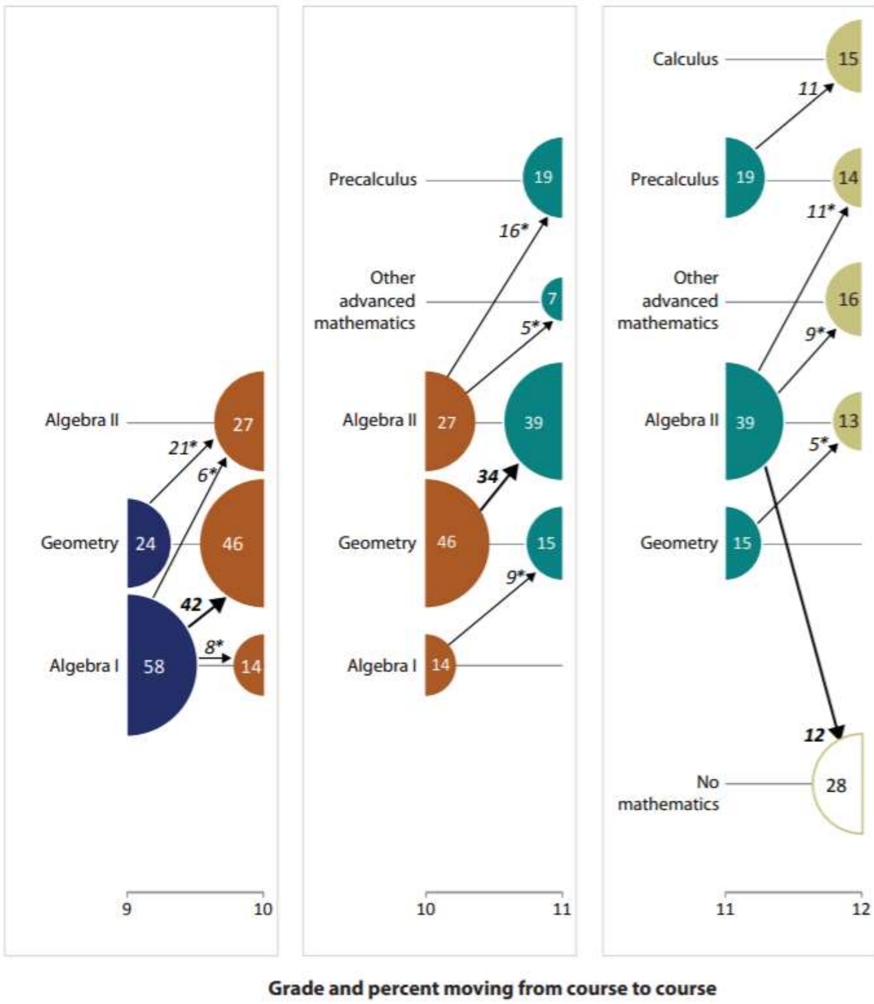


Note. ¥ Reporting standards not met. Adapted from "Paths Through Mathematics and Science: Patterns and Relationships in High School Coursetaking" by J. Brown, B. Dalton, J. Laird, and N. Ifill, 2018, National Center for Education Statistics, p. 10. Copyright 2009 by the National Center for Education Statistics.

Figures 2 and 3, also from the HSTS, display the variety of actual course sequences that represent the students in the study. In Figure 2, each semi-circle, by its size, represents the percentage of students in a given course at a particular grade level. Then, following the arrows from each semi-circle, the percentage of students taking various subsequent mathematics courses is revealed. Figure 3 is a chart displaying common high school mathematics course sequences and the percentage of students from the HSTS that followed each of these pathways.

Figure 2

Percentage of High School Graduates Progressing Through Mathematics Courses



Note. Reprinted from "Paths Through Mathematics and Science: Patterns and Relationships in High School Coursetaking" by J. Brown, B. Dalton, J. Laird, and N. Ifill, 2018, National Center for Education Statistics, p. 10. Copyright 2009 by the National Center for Education Statistics.

Figure 3

Percentages of High School Graduates and Their Different High School Mathematics Course Sequences

Most frequently taken mathematics pathways	Percentage
Algebra I – Geometry – Algebra II – No math	10.1
Algebra I – Geometry – Algebra II – Precalculus	9.7
Algebra I – Geometry – Algebra II – Other advanced mathematics	7.4
Algebra I – Geometry – Algebra II – Algebra II	3.2
Geometry – Algebra II – Precalculus – Calculus	7.8
All other mathematics pathways (1,015 Total)	61.8

Note. Course names may include other labels. For example, Algebra II includes courses such as Linear Algebra and Secondary Math 3. Adapted from "Paths Through Mathematics and Science: Patterns and Relationships in High School Coursetaking" by J. Brown, B. Dalton, J. Laird, and N. Ifill, 2018, National Center for Education Statistics, p. 10. Copyright 2009 by the National Center for Education Statistics.

Course Sequencing at a Local District

South Fayette Township School District is a suburban school district in southwestern Pennsylvania with over 3400 students. The district has consistently had high achievement scores on the state standardized assessment since the PA Core Standards were adopted in 2014. Based on the South Fayette Middle School's Program of

Studies, two tracks of mathematics course sequences are offered, similar to the majority of middle schools found in Schmidt's (2009) study. South Fayette High School's sequencing is similar in progression to that described in the HSTS; however, there is a more extensive set of course offerings. The mathematics curriculum and sequencing, beginning in sixth grade, is shown in Figure 4. The middle school pathway consists of two fixed sequences, including the accelerated pathway and the on-level pathway. As shown in Figure 4, the options for students expand in the high school, resulting in multiple, flexible pathways.

Figure 4

Secondary Mathematics Course Sequencing, South Fayette Township School District

	On-level Pathway	**Accelerated Pathway**	
6th Grade	Mathematical Functions (General Course)	Pre-Algebra	
7th Grade	Pre-Algebra	Algebra I	
8th Grade	Algebra I	Geometry	
Transition to High School Pathways	**On-level Pathway**	**Accelerated Pathway (On-level during Middle School)**	**Advanced Placement Pathway (continuation of Accelerated Pathway from Middle School)**
9th Grade	Geometry	Honors Geometry	Honors Algebra II
10th Grade	Algebra II	Honors Algebra II	Honors Precalculus
11th Grade	Algebra III/Trigonometry	Honors Precalculus	AP Calculus I
12th Grade	Precalculus or Honors Precalculus	Honors or AP Calculus I	AP Calculus II or Honors Linear Algebra

Regardless of the structure of the course offerings that vary from school to school, sequencing of mathematics courses in middle and high schools rely on the use of prerequisite courses, like in the case that Algebra I is typically a prerequisite for Algebra 2 (Finkelstein et al., 2012). Finkelstein et al. (2012) recognize that not all students have seamless course-taking patterns through their secondary careers. For example, a district may require students to repeat a course, like Algebra I, if they do not reach a certain grade expectation and, therefore, do not continue in the traditional pattern. Likewise, students may accelerate beyond the typical course-taking pattern as early as middle school, which has been shown to closely relate to continued achievement in accelerated or advanced high school mathematics (Finkelstein et al., 2012; Stevenson et al., 1994; Wang & Goldschmidt, 2003). Also, as Summers (2011) summarized, “students who are placed in accelerated or advanced mathematics courses following elementary school are better prepared for the postsecondary education of their choice” (p. 7).

Acceleration, Ability Grouping, and Tracking

In education there are several terms, at times used interchangeably, that describe the learning experiences in which students in the same grade level are enrolled in different levels of courses. Some of these terms include acceleration, ability grouping, and tracking. Acceleration is defined by Pressey (1949) as “progress through an educational program at rates faster or at ages younger than conventional” (p. 2). This framing of acceleration has been reiterated by several researchers over time (Carafella, 2016; Colangelo et al., 2004; Ma, 2002; Smith, 1996). Expanding on Pressey’s definition, researchers Southern et al. (1993) actually categorized 17 different types of acceleration. Of those numerous types, single subject-matter acceleration is noted due to it being the most commonly used practice for mathematics acceleration in schools. Specifically, single subject matter acceleration is when a student receives higher grade level instruction by attending class in an advanced grade or by being in a class of similarly-aged peers in which the higher-grade-level content is instructed (Southern & Jones, 2015). In regards to ability grouping, Tieso framed the outcomes of Kulik's research on this practice by defining it as a method "that places students into classrooms or small groups based on an initial assessment of their levels of readiness or ability (Tieso, 2005, pp. 61-62). Tracking selectively places students into a different sequence of courses based on ability (Chiu et al., 2008; Domina, 2014; Klapproth, 2015; Loveless, 1998; Mulkey et al., 2005). As a result of Loveless's (1998) research with tracking, he identified three common tracks in the American public schooling system: a high-track, with advanced level or honors courses that prepare students for colleges and universities, a general track that serves the greatest population of students and provides them with enough exposure for whatever their post-secondary plans may be, and a low track, with low-level or vocational classes that prepare students for consumerism and basic adult functioning. For the purposes of this study and further synthesis of research, these terms may be interchangeably used.

The process of separating students into higher level courses through acceleration has been in practice in the United States school system since the mid-1800s due to the expanding school system as well as a result of industrialization, urbanization, and diverse immigration populations (Chiu et al., 2008; Kozol, 1991; Loveless, 1998; Tyack & Hansot, 1982). Notably, as early as 1862, the St. Louis public schools implemented a flexible promotion program in which students advanced to higher grades or courses based on their individual level of readiness and achievement (Kulik, 2004). However, the passing of Title IV, part of the Civil Rights Act in 1964, impacted accelerative practices because the act prohibited these practices from being discriminatory in any way against a student's race, color, or origin (Chiu et al., 2008; Loveless, 1998). For the last century and through the evolution of tracking practices, these practices have existed with the intent to accomplish three common goals: to increase the achievement level of students who performed beyond the mixed, general ability level, to help students improve their self-esteem, and to assist teachers in being more effective at meeting different levels of learners (George, 1988). Additionally, according to Oakes (1990), ability grouping occurs more expansively in the United States than any other country as revealed by the Second International Math Study (SIMS), which studied mathematical practices in schools across the globe.

It is argued that mathematics is the subject area in which accelerative practices are most frequently applied because proper grouping is most beneficial in these classes and has the most significant implications on career attainment (Mulkey et al., 2005; VanderHart, 2006). Additionally, according to Renzulli and Reis (2003), as well as Passow (1996), accelerative practices are best applied to sequential content areas, particularly mathematics. As shown in Figure 5, Loveless's (2013) synthesis of NAEP 8th grade data between 1990 and 2011, mathematics maintained the practice of tracking longer and more consistently than any other content area. It can also be gleaned from these statistics that tracking in the subject of mathematics has a significantly higher prevalence than the other areas, maintaining that about three-quarters of schools use some form of tracking.

Figure 5

Percentage of Schools with Tracked Courses by Content Area in Grade Eight

Year	*Mathematics*	*English Language Arts*	*Science*	*History*
2011	*76*	*	-	-
2009	*77*	*	-	-
2007	*75*	*	-	-
2005	*73*	*	-	-
2003	*73*	*43*	-	-
2000	*73*	*	*26*	-
1998	¥	*32*	¥	*15*
1996	*71*	*35*	*21*	¥
1994	*72*	*37*	*19*	*17*
1992	*73*	*50*	¥	¥
1990	*75*	*60*	*29*	*29*

Note. *Tracking question was not asked. ¥ No data available– Tracking was not reported. The statistics shown are percentages of schools that were included in the dataset that indicated the presence of ability grouping or tracking practices based on responses from school principals. Adapted from "How Well Are American Students Learning" by T. Loveless, 2003, Brown Center Report of Education, *3*(2), p. 17. Copyright 2013 by The Brookings Institution.

Approaches to Mathematics Acceleration

Although mathematics is the subject area in which acceleration happens most frequently, there is not a uniform grade level or method for which acceleration occurs. At the elementary level, since classes are mostly self-contained, acceleration typically happens in the form of within-class ability grouping (Loveless, 1998, 2013; Mulkey et al., 2005; Oakes, 1990; Slavin, 1987, 1988). Within-class ability grouping is when students are placed into smaller groups for instruction and can be configured as heterogeneous or homogeneous groups. The group's composition is typically determined by the teacher and based on the purpose for grouping, as well as the students' abilities, skills, and/or interests (Gentry & MacDougall, 2009). Unlike what typically occurs at the secondary level, within-class ability grouping at the elementary level is intended to be flexible where the teacher frequently assesses the students and reassigns them to different groups based on the results of those assessments (Tieso, 2003). According to Loveless (2013), over the last 20 years the occurrence of within-class ability grouping in mathematics has increased from 40% to 61% at the upper elementary level. Loveless (2013) believes that the increase in this grouping method is a pedagogical response by teachers due to accountability being linked to standardized testing.

The stratification of acceleration for single-subject advancement, in which students are placed into homogeneous groups and, for the duration of these school years, into inflexible sequences of courses, most commonly begins to occur at the middle school or junior high level (Loveless, 1998, 2013; Lucas, 1999; Mulkey et al., 2005). Although the stratification of ability grouping continues to occur at the high school level, the rigidity of course sequencing and selection decreases and opportunities for a variety of accelerative options increase for students at different achievement levels (Loveless, 1998).

Research indicates that acceleration beginning in middle school is largely determined by achievement on standardized tests, teacher subjectivity, and parental influence (Bitter & O'Day, 2010; Hallinan, 2003; Kelly, 2007; Loveless, 1998; Meehl, 1954; Oakes, 1985; Useem, 1992). For example, the Wake County Public School System, which is the largest school system in North Carolina and the 15th largest in the nation, utilizes the following criteria for acceleration in mathematics: nomination by a parent or educator and a score of 80% or higher on a standards-based mathematics assessment (Hemelt & Lenard, 2018). Similarly, in the state of California, data sources including students' scores on placement assessments, achievement in previous mathematics courses, and the receipt of teacher recommendations determine students' accelerative placements (Huang et al., 2014; California Department of Education, 2015). In an urban school district in Utah, the determination for acceleration after fifth grade occurs as a result of students' achievement levels on the Iowa Test of Basic Skills (ITBS) (Summers, 2011). Students' results on the ITBS are compared to the achievement levels of students across the United States, and, if a particular student's results are high enough, he/she is accelerated into Pre-Algebra in sixth grade instead of the general course (Summers, 2011).

The South Fayette Township School District's criteria for acceleration does not fully align with all aspects of the aforementioned research. When students are considered for acceleration upon entering sixth grade, the criteria include two placement assessments, as well as the cumulative grade average from fifth grade mathematics. Neither teacher nor parental recommendations play a role in the screening process for acceleration. Additionally, the placement assessments that are utilized do not include Pennsylvania's state standardized assessment in mathematics. One of the assessments is a curriculum-based assessment designed by the middle school math department in 2014. This tool comprehensively assesses the proficiency level of students' mathematical knowledge with the on-level sixth grade curricular skills as determined by PA Core Curriculum Framework. If students are accelerated in sixth grade, they would be placed beyond the on-level sixth grade course and enrolled into Pre-Algebra, which would be a single-subject advancement. The other assessment is the *Test of Mathematical Ability-Third Edition* (TOMA-3). Although the district only uses the raw data from two subtests, the TOMA-3 contains four core subtests: *Mathematical Symbols and Concepts, Computation, Mathematics in Everyday Life, and Word Problems*. It is a "tool used to identify, describe, and quantify mathematical deficits in school age children" (TOMA-3: Test of Mathematical Ability, 2012, para. 1). The third element used for the determination of acceleration in sixth grade mathematics is the cumulative average of a student's grade performance in fifth grade mathematics from each of the grading quarters.

Regardless of grade level for entry or criteria used to determine entry, there are disparities in the composition of students who are enrolled in accelerated courses, even after the passing of the Civils Right Act in 1964. As Webel and Dwiggins (2019) describe it, "a student's placement in a track is likely not determined solely by mathematical ability but also influenced by societal and economic factors" (p. 6). Utilizing data from the National Assessment of Education Progress (NAEP), it was determined that nearly 50% of White, non-Hispanic eighth graders, along with 67% of Asian eighth graders, are enrolled in advanced mathematics courses in comparison to 16% of Black eighth graders and 38% of Hispanic eighth graders (Braddock, 1989; Domina, 2014; Gutiérrez, 2008; Lubienski & Gutiérrez, 2008). Similarly, another study conducted by Kelly (2004) revealed that there is a Black-White course-taking gap in which data shows that the likelihood of White students being enrolled in advanced mathematics courses is double that of Black students. However, Kelly (2009) in continued research, found that this course-taking gap for Black students being enrolled in advanced mathematics courses is significantly less in predominantly all Black schools in comparison to non-Black or integrated schools. Race also seems to be a factor in the presence of tracking opportunities in schools. Based on the data from the National Assessment of Educational Progress (NAEP) 8^{th} Grade Mathematics Assessment, which was a national collection of data, a correlation between the existence of tracking in schools and the school's racial composition, particularly the percentage of White students was evident. The NAEP data revealed that tracking is most common when about half of the student population in a school is made up of White students (VanderHart, 2006). When White students make up either the majority or the minority of a school's population, leveled coursework or tracking by ability happens less frequently (VanderHart, 2006). Figure 6 displays the likelihood of tracking or not based on the percentage of White students.

Figure 6

Percentage of White Students and the Prevalence of Tracking

Percentage of White Student Population	Tracked	Not Tracked
Less than 20%	**0.294**	**0.706**
20% to 40%	**0.589**	**0.411**
40% to 60%	**0.761**	**0.239**
60% to 80%	**0.613**	**0.387**
80% to 90%	**0.582**	**0.418**
More than 90%	**0.267**	**0.733**
Total	**0.545**	**0.455**

Note. Adapted from "Why Do Some Schools Group by Ability?: Some Evidence from the NAEP," by P. VanderHart, 2006, *American Journal of Economics and Sociology*, 65(2), p. 450. Copyright 2006 by American Journal of Economics and Sociology, Inc.

Similar to determining that tracking has racial implications, Walston and McCarroll (2010) found that students from higher economic status are twice as likely to take an advanced mathematics course in eighth grade in comparison to a peer from a low economic status. Loveless (1998) claims that socio-economic status is even more significant in fostering the segregation of students in different tracks than race. Data from Loveless (1998) states that when students' prior achievement is equally considered, there is no evidence of race disparities between high and low track students; however, even with identical achievement scores as their wealthier counterparts, students from poor families are more frequently placed in low tracks due to potential reasons such as status discrimination or lower levels of parental influence. Oakes (1985), a fervent opponent of tracking, believes that tracking intensifies social inequalities. Oakes (1985) illuminates racial and socio-economic disparities by making the claim that there are disproportionately higher numbers of poor and underrepresented students in low track courses compared to the number of affluent, White students in high tracks. As shown with race from the NAEP data, there was also a correlation between the existence of tracked courses in a school relative to the school's population of students from low socio-economic backgrounds (VanderHart, 2006). Figure 7 shows the propensity for tracking in schools when the percentage of students receiving a subsidized lunch due to low socio-economic status is a low percentage.

Figure 7

Percentage of Low-Income Students Receiving Free or Reduced Lunch and the Prevalence of Tracking

Percentage of Low-Income Student Population	Tracked	Not Tracked
None	**0.542**	**0.458**
1% to 10%	**0.625**	**0.375**
10% to 25%	**0.529**	**0.471**
25% to 50%	**0.435**	**0.565**
50% to 75%	**0.413**	**0.587**
More than 75%	**0.221**	**0.779**
Total	**0.508**	**0.492**

Note. Adapted from "Why Do Some Schools Group by Ability: Some Evidence from the NAEP," by P. VanderHart, 2006, *American Journal of Economics and Sociology*, 65(2), p. 450. Copyright 2006 by American Journal of Economics and Sociology, Inc.

Accelerative practices in mathematics are not without consequence. Although the process of determining students for acceleration may not be uniformly defined, enrollment in advanced level classes by students of color and of low socio-economic status has been found to generally be less in comparison to these students' White and wealthier counterparts.

Outcomes of Mathematics Acceleration

There is an abundance of research that has been conducted regarding the impact, or lack thereof, on students as a result of accelerative practices including students' achievement levels, self-beliefs, social comparisons, racial and socio-economic disparities, secondary and post-secondary success, and job acquisition. Of these areas, the one outcome of acceleration with the greatest abundance of research is if a correlation exists between mathematics acceleration and academic achievement. However, not all of the research is in consensus regarding the presence and type of correlation between acceleration and achievement. A conclusion from a study conducted by Fuligni and Stevenson (1995) found that accelerating medium and high ability students positively correlated with these students' achievement at the 10th grade level. Hallinan and Kubistchek (1999) similarly concluded that students in advanced mathematics classes at the end of middle school made significantly more achievement gains by their second year in high school as opposed to their peers in on-level courses. In contradiction, not all studies support positive achievement gains for higher level students. For example, in a meta-analysis conducted by Kulik and Kulik (1992), they concluded, after having conducted fifty-one studies, that acceleration has negative effects on higher level students' achievement. Furthermore, Slavin (1993) conducted a meta-analysis of 27 studies and found that accelerative (tracking) practices had no effect on student achievement. Although there has been evidence established on both sides of the achievement argument, several studies conducted at the secondary level have come to the conclusion that any increased achievement impacts due to acceleration have occurred explicitly because students take different courses and, thus, are exposed to more specific mathematical content (Gamoran, 1987; Gamoran et al., 1997; Ma, 2000; Rock & Pollack, 1995; Schneider et al., 1998; Stevenson et al., 1994; Schmidt, 2009).

While disparities exist in the potential influence acceleration has on positive achievement gains, there is less dispute over the inequities that exist in the demographics of the population of students who are accelerated. Studies reveal that students from low socio-economic status families and underrepresented ethnic backgrounds are underrepresented in acceleration programs (Wyner et al., 2007). Moreover, Baker and Stevenson (1986) posits that there is a research-based link between high socio-economic status and a child's placement in advanced coursework. The researchers believe that this is the case because higher socio-economic status of parents leads to these parents being more well-educated adults who then are influential managers of the trajectories of their children's school career (Baker & Stevenson, 1986; Useem, 1992). Upper-class, White mothers have been shown to utilize their personal educational experiences, along with their involvement in their children's school, as well as social networks, in order to gain advantageous knowledge so that they can best prepare and influence the track of mathematics courses for their children (Lareau & Shumar, 1996; McGrath & Kuriloff, 1998; Useem, 1992). Agreeing with the powerful role of parents, Kifer (1986) identifies the transition from sixth to seventh grade as a pivotal point in which tracking impacts most students, and, since the students are too far away from cementing their future career plans, their parents impact the likelihood of and decisions related to accelerated placement.

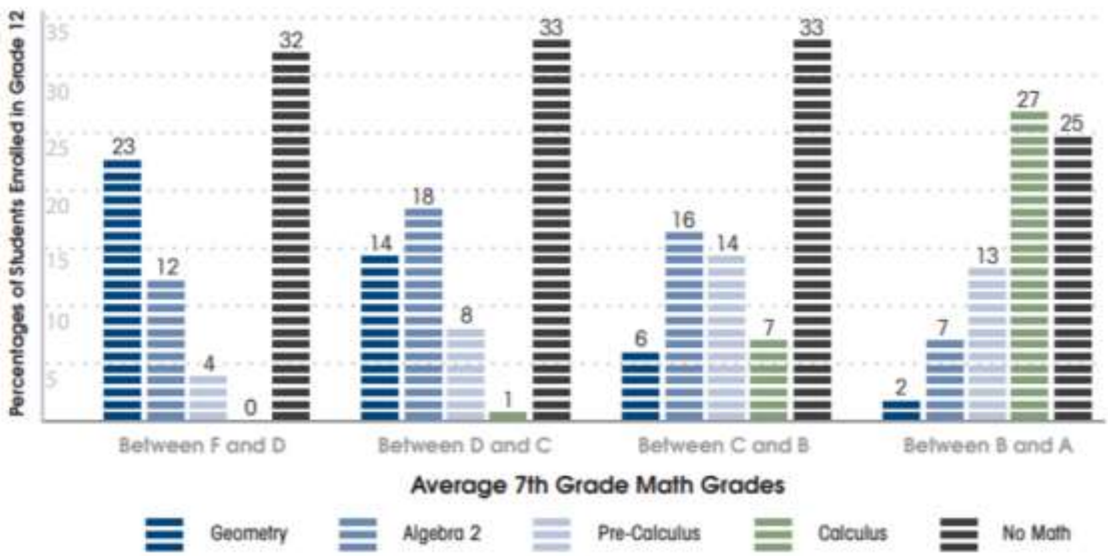
Numerous studies have also been conducted relating a student's self-concept to acceleration in coursework. The results have considerably different findings, spanning from students that are accelerated having higher self-esteem (DeLacy 2000; Gross, 1992; Olszewski-Kubilius, 1995, 1998; Rogers, 1991; Sayler, 1992) to acceleration having no positive impact on students' self-esteem (Gross, 1994; Swiatek, 1994) to students who are accelerated having a decline in their self-esteem over time due to social comparisons (Lupkowski, 1992). Oakes (1985, 1990) arrived at the same positive relationship on students' self-concept when they were advanced into the high track. Oakes's (1985, 1990) research found that low-track and high-track students displayed and maintained opposite self-esteem levels and self-images, relative to their tracking placements. Kulik (1992), much like Lupkowski (1992), found impacts to students' self-concept that contradicted those of Oakes's findings. These researchers, along with others, found that tracking actually lowers the self-concepts of students in high tracks, while it increases self-concepts of students in low tracks (Hallam & Ireson, 2008; Kulik, 1992; Lupkowski, 1992; Wigfield et al., 1998; Zeleke, 2004). The support to these claims is that when students are homogeneously grouped in tracked classes, they are more realistically able to assess their ability in comparison to their peers, and, those in higher tracks have their own self-concepts challenged more by their peers of similar high abilities (Goldberg et al., 1966; Lupkowski, 1992; Nicholson, 1998). Challenging these results, Ma (2002) conducted a study examining the self-esteem levels of accelerated and non-accelerated students in three distinct categories: gifted students, honors students, and regular students. Ma's (2002) raw data concluded that in all three populations accelerated students had only slightly higher self-esteem than their non-accelerated counterparts at the high school level. The difference was the least significant in the gifted population and the most significant in the regular population (Ma, 2002).

Tracking not only has lasting impacts on individuals' self-concepts, but also on their high school and post-secondary success. The synthesis of numerous studies has indicated that successful completion of Algebra I by eighth grade will lead to a greater likelihood of high school completion, as well as an employable future (Finkelstein et al., 2012). For students who matriculated to a college or university, Hoyt and Sorensen (1999, 2001) found through an analysis of students' transcripts at Utah Valley State College that students who took higher levels of mathematics in high school were less likely to need remedial courses in college. Another set of studies found that when students successfully complete advanced mathematics courses in high school beyond Geometry, they will be more likely to attain a college degree (Trusty & Niles, 2003). Reviewing several studies that interviewed accelerated and non-accelerated students in regards to post-secondary plans, Kulik (2004) concluded that accelerative practices increase students' educational ambition and positively impact their long-term educational plans. Furthermore, Adelman's (1999) analysis of the *High School and Beyond* data illuminated that the strongest correlation to college degree completion could be drawn directly back to the highest level of mathematics completed by a student in high school.

As a result, it could also be concluded that since middle school mathematics coursework and sequencing influence the opportunities for course selection in high school, accelerating students in middle school has a significant impact on students' futures. This impact is quantifiably described in two different national studies. Rose and Betts (2004), utilizing the High School and Beyond data, discovered that students who took advanced level mathematics courses in high school earned higher salaries in their respective careers, ten years after graduation, regardless of their demographics, family, school characteristics, or even their highest degree earned, college major, or occupation. Using the same data, as well as the National Longitudinal Survey of Youth, Levine and Zimmerman (1995) found that not only are the salaries higher for individuals based on their enrollment in advanced high school mathematics courses, but when females are accelerated, their wages increased in comparison to other non-accelerated females. Conducting a separate study to corroborate these findings relative to how middle school mathematics coursework is an indicator for future success in high school and beyond, Finkelstein et al. (2012) gathered a dataset that spanned six school years and included over 24,000 students from school districts in California. With a strong correlation to the previously conducted research, Finkelstein et al. (2012) concluded that “course performance as early as grade seven is a strong predictor of future high-school course enrollment” (Finkelstein et al., 2012, p. 9). Figure 8 displays the percentage of students enrolled in each type of mathematics course in grade 12 based on their cumulative letter grade performance from their mathematics course in grade seven, according to Finkelstein et al.’s (2012) study. The greatest percentages of enrollment in advanced level courses correlates more significantly to students with higher grade averages in grade seven based on the data in this display.

Figure 8

Distribution of Grade 12 Mathematics Course Taking Based on Grade Seven Mathematics Grade Averages



Note. Reprinted from "College Bound in Middle School and High School: How Math Course Sequences Matter," by N. Finkelstein, A. Fong, J. Tiffany-Morales, P. Shields, and M. Huang, 2012, The Center for the Future of Teaching and Learning, p.13. Copyright 2012 by WestEd.

Similar to the results of Finkelstein et al.'s study, the dataset of the HSTS in 2009 also found a strong association between a student's placement in ninth grade mathematics and the highest level of mathematics completed by graduation (National Assessment of Educational Progress, 2009/2018). The percentage of students taking the highest level of mathematics, Calculus, was greatest in the population of students who were enrolled in an accelerated course of Geometry or higher in ninth grade (National Assessment of

Educational Progress, 2009/2018). This percentage was over quadruple in comparison to students who were enrolled in the general, on-level course of Algebra I in ninth grade (National Assessment of Educational Progress, 2009/2018). However, the HSTS did show that successfully completing Algebra I in ninth grade still provided high school students with the opportunity to complete advanced level mathematics courses above Algebra II (National Assessment of Educational Progress, 2009/2018).

In summary, both the studies by Finkelstein et al. (2012) and the data from the HSTS of 2009 conclude that a successful completion of Algebra I, whether by eighth or ninth grade, is a significant determination of students' future mathematics coursework. Recognizing the importance of Algebra I, Finkelstein et al. (2012) argue that acceleration is a critical decision and that students should not be enrolled into Algebra I unless they have developed the necessary foundation for learning algebraic concepts and skills. Regardless of the grade level or if students are accelerated or advanced by natural sequencing to Algebra I, data shows that without readiness for the concepts and skills, there are negative consequences for the students' placements and performances in higher level high school mathematics courses, as well as post-secondary mathematics courses (Finkelstein et al., 2012).

Mathematics Teachers' Perceptions of Acceleration

Although the outcomes based on the utilization of accelerative practices vary, there are common beliefs as to the reasons that teachers support the existence of tracking in mathematics. One of these beliefs is that the curriculum and/or pace offered to each level in a tracking system is more appropriate and suitable for the students' ability levels within each track (Levine, 1983; Reed, 2008; Reuman, 1989; Richer, 1976; Schmidt, 2009). Another shared belief is that mathematics, unlike other subjects, is hierarchical in nature (Ruthven, 1987) and, as a result, students who have different sets of mastered concepts cannot optimally work in the same environment on the same task (Zevenbergen, 2003). Although teachers profess that their philosophy is to prefer a diverse group of learners in their classrooms, researchers have ultimately found that they believe homogeneous groups established through tracking are simply easier to teach (Loveless, 2013; Spear, 1994; Webel & Dwiggins, 2019).

Expanding on these beliefs, Robert C. Spear conducted a qualitative study with 31 seventh grade teachers regarding their perceptions on the advantages and disadvantages of ability grouping. The general responses to advantages of ability grouping were that separate groups increase student learning, and ability groups are easier to prepare for and to teach (Spear, 1994). Furthermore, this group of teachers believed that ability groups provide the students with the type of instruction and learning tasks that they need intellectually (Spear, 1994). Through the study, Spear also found that those who favored ability grouping or tracking communicated about their instruction in ways that were more content-centered, whereas the dialogue of those who preferred the advantages of heterogeneous, mixed-ability groups was more student-centered.

While research data provides its own disadvantages to accelerative practices, the teachers who participated in Spear's study claimed another disadvantage as the power that parental influence has relative to the decisions made about ability grouping (Spear, 1994). This group of educators did not believe that the placement of students actually represented their ability levels but rather that of the involvement that their parents had in their education (Spear, 1994). Through empirical research, Boaler (1997) supported an additional negative perception of tracking by teachers. Although teachers believed that placing students in different tracks was a successful method to increase achievement levels, they actually found that this practice brought greater levels of stress to the students in the low track and demotivated the students who were just shy of qualifying for the high track (Boaler, 1997; Boaler et al., 2000).

Oakes (1985) also suggests that teachers have distinct perceptions related to their classroom environments and relationships with the students in different tracks. Teachers describe more positive relationships with students in high-track classrooms and more peer conflicts and behavioral concerns in low-track classrooms (Oakes, 1985). Pedagogical choices and instructional methods of teachers in tracked schools have also yielded different results for students enrolled by ability group. Although most teachers believe that ability grouping or tracking is beneficial to each student, research has found that the level of expectation by the teacher within tracked groups varies. Teachers have demonstrated to expect more from students in high track classes and have provided them with more responsibilities, as well as more challenging work (Hallam & Ireson, 2005; Oakes, 1992). In these high tracks, the teachers have also instructed at a faster pace and required the students to complete a greater workload (Boaler et al., 2000). Oakes (1985) noted that teachers of high track courses display more enthusiasm, are more organized, have a greater set of instructional strategies, and elicit more student engagement. Conversely, it has been found that teachers lower their expectations for students in the low track, often seeking behavioral compliance and completion of remedial tasks (Oakes, 1985, 1992; Reed, 2008). Finley (1984) claims that when teachers are assigned to instruct low track classes for a period of time, both their instructional skills and efficacy decrease. The students' awareness of these different behaviors has also not gone undocumented. Boaler et al. (2000), after interviewing numerous secondary students about their experiences in tracked classes, summarized the students' perceptions:

> When students were divided into ability groups, students in high sets (tracks) came to be regarded as "mini-mathematicians" who could work through high-level work at a sustained fast pace, whereas students in low sets (tracks) came to be regarded as failures who could cope only with low-level work- or worse- copying off the board. This suggests that students are constructed as successes or failures by the set in which they are placed… (p. 643)

Comprehensively, the collective research suggests that the presence of tracking influences teachers' perceptions about the abilities, behaviors, and needs of their students; Reed (2008) describes this as a practice of teachers creating a prototype of a profile for students in each track before even working with individual students.

Conclusion

The approach to mathematics instruction in public schools has evolved from one that reserved the taking of advanced level mathematics courses for a privileged few to one that strives to provide most students with the opportunity to take advanced level mathematics courses by the end of high school. Over the last 30 years, different organizations have attempted to create a national mathematics curricular framework in order to improve mathematics instruction. Although a uniform, national curriculum still does not exist, there are significant similarities in the mathematics course sequencing that exist across the country. This common course sequencing, moving from rigid and tracked in middle school, to more flexible and extensive in high school, has been found to play a pivotal role in the likelihood of post-secondary success for students. Besides traditional course promotion through the natural sequence, students have also been able to reach advanced level mathematics courses in high school due to acceleration. However, accelerative practices and the impact of such practices on students have been a debated topic for much of the last 125 years, with researchers rarely arriving at a consensus. Loveless (1998) summarizes years of studying tracking and the inability to truly quantify its impact on education by stating that “research on tracking and ability grouping is frequently summarized in one word: inconclusive” (p. 14).

The purest objective of accelerating students would be to provide each student with the opportunity to enroll in the level of curriculum that is needed based on previously mastered skills, regardless of age or grade level. Furthermore, advocates of acceleration would offer that it allows students to reap more beneficial outcomes, especially due to the multiple studies linking advanced level course taking with collegiate and career success. However, critics of such practices would assert that the practices are discriminatory, damaging to certain demographics, and lacking strong, positive benefits.

Teachers’ perspectives on acceleration and tracking are also often found to be contradictory. Although teachers’ narratives often describe an intent to teach mathematics through differentiation in heterogeneously-grouped classes, their actions often demonstrate a preference towards the ease of homogeneously, tracked groups.

Evidence has been established that there are positive achievement gains for students who are accelerated, and contradictory evidence has also indicated that there is not a significant impact for this population of students. Collections of studies have indicated less beneficial outcomes, when particular factors of tracking for students of underrepresented races, as well as low socio-economic statuses are considered. Debate has also ensued about how accelerative practices impact students' self-concepts. However, the greatest culminating take-away, supported by data from multiple recent studies, is the impact that acceleration in middle school has on positioning students for high school and post-secondary course taking options. Following those advanced trajectories, it has been shown that students who are accelerated and then subsequently and successfully complete the advanced coursework will have a greater likelihood of career attainment and success (Adelman, 1999).

CHAPTER III

Methodology

The researcher has played a significant role in the placement process for mathematics acceleration since the inception of the process, and, in seeking evidenced research for this study, the researcher also conducted a review of many literature sources. As a result of these actions, the researcher was better able to construct a comprehensive methodology for research. This methodology takes into account the validity of the screening process that is currently used for identifying students for mathematics acceleration, the teachers' perception of the placement of students in advanced mathematics courses, and the possibility of a certain criterion having a greater likelihood of predicting success for students in advanced mathematics courses over time. This chapter's purpose is to provide a detailed account of the actions taken in order to complete this action research project.

The objective of this section is to fulfill the need for research to be conducted relative to the screening process for placement of students in South Fayette Township School District's advanced mathematics coursework pathway. Guiding the purpose of this section and action research project are three research questions which will be listed and further explained in detail. Additionally, an explanation of the methodology and how it was utilized for this action research project will be outlined in order to provide an understanding of the outcomes.

As previously explained, this research was prompted as a result of the academic implications that the screening process for advanced mathematics has on a student at early grade levels. This exclusionary process, which is completed prior to a student entering middle school, has never undergone an audit or been thoroughly researched regarding its accuracy in identifying the proper mathematics placement of students. With research indicating that mathematics is the subject area in which accelerative practices are used most frequently, it is necessary for a district to know the lasting impacts the screening process has on its students (Mulkey et al., 2005). To assist the reader in having a better understanding of the value of this study, it is critical that additional district demographics and details are provided, as well as the justification for the use of the targeted compilation of student data and teacher perspectives. For the use of student data and teacher perspectives, the approved process and use of proper consent will be further described.

Purpose

The purpose of this research is to validate or recommend revisions to the district’s screening process for placement of students in the advanced mathematics coursework pathway at South Fayette Township School District. Additionally, this research will validate recommended revisions related to the accuracy of screening through the use of collected data and evidence. Since the screening process occurs before students enter middle school and because students who are placed in advanced math classes in sixth grade are able to reach higher levels of mathematics over the course of grades six through twelve,, it is critically necessary to determine if this process displays accuracy over multiple cohorts of students. Sharing the evolution of the district's advanced mathematics screening process from its original design and impact to its current form and impact will help the reader gain a better understanding of the value of this research.

Prior to the transition to the PA Core Standards and redesigning the screening process for advanced mathematics in 2014, South Fayette Township School District had utilized two criteria in order to determine students' placement in their mathematics coursework pathway prior to sixth grade. Those two criteria were teacher recommendation and a cumulative fifth grade math average of greater than 90%. Teachers reviewed the students who reached the minimum grade average and then identified the students who they believed were best qualified for advanced coursework. This subjective process led to noticeable outcomes which, along with the need to align the mathematics curriculum with the PA Core Standards, drove the overhauling of the screening process criteria into its current form. These outcomes included the placement of over 50% of the entire student population in advanced mathematics as a result of inflated fifth grade cumulative mathematics averages, parental influence on teachers' decision making, and a large number of students struggling in advanced mathematics coursework at the high school level. Regarding the parental influence in the process, the district agreed with Spear's research that accelerated placement was being unfairly affected by parents, particularly of our predominantly upper and middle class White families (1994). The fifth grade cumulative mathematics averages for three years were also reviewed at this time, and it was determined that, on average, over 86% of fifth grade students had a cumulative yearly mathematics average greater than 90%. As a result of these outcomes and the timing of the adoption of the PA Core Standards at the state level, the screening process was redesigned by a team of mathematics educators from the district, representing grades six through eight. The objectives of the new process were to remove subjectivity and parental influence, base the qualification on evidence of students' preparedness and mathematical ability, and assess the prerequisite skills needed by a student who would be entering an advanced mathematics course in sixth grade. Knowing that whatever screening process would be developed and utilized would make academic determinations for students that could impact them beyond high school, including their trajectory for career and college success, the mathematics educators wanted to identify criteria that would accurately place students both in the short-term and long-term.

As a former sixth grade mathematics educator and a member of the educational team that redesigned the screening process for advanced mathematics placement, the researcher had firsthand involvement with the district-level decisions that led to the selection of the three criteria in 2014. Due to a change in professional roles, the researcher then had the perspective of reviewing the results of the screening process and scheduling students for their sixth grade mathematics courses. Throughout this time and in both roles, the researcher has wondered if the district's process leads students to the most appropriate placement, not only for middle school, but as the literature supports, for success in students' future college and career-related decisions and outcomes.

In order to validate the accuracy of the criteria for the screening process, three questions were constructed. The data and feedback collected through the guidance of these research questions will impact the mathematics course trajectory of future students attending South Fayette Township School District. These three questions are:

- Is the screening process for advanced mathematics coursework accurately identifying students for acceleration based on the criteria?
- Do teachers perceive that students are accurately placed in advanced mathematics courses based on the qualification process that occurs prior to the start of sixth grade?
- Of the three criteria used in the screening process, does a pattern exist as to a certain criterion indicating a greater likelihood of success in mathematics advancement?

Not only have these questions been developed to guide the research, but they were also paramount in identifying the targeted principles for the literature review and the construction of the questions utilized in the mathematics teacher questionnaire.

As illuminated in the literature review from Chapter Two, there are positive outcomes for students related to taking advanced level mathematics courses in high school which include higher assessment scores, a higher likelihood of securing a bachelor's degree, higher salaries in the labor market, and increased levels of career satisfaction (Altonji et al, 2012; Bozick & Lauff, 2007; Chen, 2009; Nord et al., 2011; Pellegrino & Hilton, 2012). With the weight of those potential outcomes for students and the decision for acceleration in mathematics being made at the end of fifth grade in the South Fayette Township School District, the study, which is being guided by the three research questions, is intended to determine if the district's process is valid.

Although there are secondary outcomes that the researcher hopes to glean from this research, the primary outcome is to determine if the criteria used in the process for accelerating students in mathematics in sixth grade is accurately fulfilling their intention. From this outcome, the district will know whether or not a change in the process is necessary in order to better identify students for acceleration. Additional outcomes include determining how teacher perspectives align with the student placement data, as well as with the research found in the literature review, and whether one of the criteria is a stronger indicator at predicting long term success in advanced level mathematics courses than the others. Regardless of what all of the outcomes indicate, the criteria used for the screening process impacts the educational pathway for each student who comes through the district for several years, and the outcomes will provide the district with information needed to make informed decisions. Therefore, it is critical that the process is comprehensively reviewed and the district is provided with thorough research in order to be informed about such an impactful set of criteria.

Setting

The setting for this study is the South Fayette Township School District. The South Fayette Township School District is a fast-growing suburban, public school that is located in Allegheny County in southwestern Pennsylvania. The district educates the residents of eight different communities within the township, and both the township municipality and district share the same borders within its 21-square mile region. The population of nearly 16,000 has rapidly increased by approximately 11% since 2010 and 48% since 1980, with the quality of education provided by the school district and available new housing as the top attractions. Consistently, the township has had at least 100 new homes built each year for the last 10 years. Conveniently located equidistantly from the city of Pittsburgh as well as the Pittsburgh International Airport, South Fayette Township School District is a bedroom community with a median household income of over $86,000 and a median household property value of approximately $154,000. Primarily residential, the district contains over 7,000 households and relies heavily on local taxes. About half of the township is still underdeveloped and only recently has there been an increase in commercial development.

Community Demographics

The most recent census data revealed that the per capita income is $45,733, and the median income for a household in the township is $86,858. Individuals had a median income of $47,378, with males having a median income of $48,750 and females earning a median income of $33,534. The unemployment rate is 1.5%, and the poverty rate is 4.2%. Within the township, 88.4% of the residents are White, 9.5% are Asian, 1.4% are Hispanic or Latino, 1.0% are African American, 0.6% are two or more races, and 0.3% are American Indian and Alaskan Native. Between 2015-2019, the percentage of township residents that identify as a “foreign born person” was 7.4%. which is slightly higher than the state average of 6.8%. This is important to note because there has been an increase in the Asian population in the township, particularly from South Eastern Asia, within the last ten years. This is also reflected in the statistic that 9.7% of the households in the township speak a language other than English in the home.

Of the approximately 7,000 households in the township, the most significant household type is families with children at 65%. The average household size consists of 2.50 persons, and the average family size was about 3.20 persons. About 32% of the households have children under 18 years of age residing in the house. Approximately 56% of the households had married couples living together; whereas, 8.1% of the households contained a female householder with no spouse present, and 4% of the households contained a male householder with no spouse present. The make-up of households that had someone residing alone who was 65 years or older was 10.7%.

The following distribution breaks down the residential population by age: 26.8% of the population is under 20 years old, 8.3% of the population is between 20-29, 13% of the population is between 30-39, 16.5% of the population is between 40-49, 13.7% of the population is between 50-59, 8.9% of the population is between 60-69, and 12.9% of the population is 70 or older. The median age of males is 40.9 and the median age of females is 40.8. About 47.3% of the township's population is male, and 52.7% of the population is female.

School District History and Demographics

South Fayette Township School District was formed in 1928 with the opening of the LaFayette High School. Fast forward to the next century, and the district is still considered by many residents to be the "jewel of the community," uniquely defined by existing on a single campus environment. There are four schools: an elementary school, grades K-2; an intermediate school, grades 3-5; a middle school, grades 6-8; and a high school, grades 9-12. Additionally, on the campus, there are separate administrative and student services offices. Adjacent to the campus, the district houses its transportation office and fleet of buses. Considering the district from a fiscal perspective, the annual budget is approximately $64 million with 73% coming from local revenue sources, 23.7% coming from state revenue sources, and 3.3% coming from federal revenue sources. South Fayette Township School District is a district within the services of the Allegheny Intermediate Unit.

The district prides itself on its rich tradition of school colors, mascot, and motto. The colors are Kelly green and white, the mascot is the lion, and the motto is "Tradition, Pride, and Excellence." The district's mission statement is, "The mission of the South Fayette Township School District, in partnership with the community, is to cultivate academic, artistic, and athletic excellence of the whole child by fostering the skills to be confident, ethical, empathetic, and responsible global citizens." The district employs 239 teaching professionals, 188 part-time and full-time staff members, and 26 administrators or supervisors.

Currently, there are 3,438 students enrolled in the district with the racial composition of the student population being 72.8% White, 18.9% Asian, 4.3% Two or More Races, 1.9% Black, 1.9% Hispanic, 0.1% Native American, and 0% Hawaiian/Pacific Islander. The gender make-up is 48.6% female students and 51.4% male students. Among the over 3,400 students, 10.7% are economically disadvantaged, 8.7% are in special education, 0.007% are identified as gifted, 1.4% are English Language Learners, 0.1% are in foster care, 0.5% are deemed homeless, and 0.8% are military connected. It is important to note that the percentage of students who are identified as gifted is considerably low in the district due to its approach of providing a spectrum of enrichment services that meet the needs of all learners. By meeting the needs of the learners, fewer students are identified as in need of gifted services. The district has 43 students attending charter schools, 30 enrolled in approved therapeutic schools, and 81 attending Parkway West Career and Technical Center in grades nine through twelve. Upon graduation from South Fayette Township High School, 92% of the student population attends a college or university, 4% enrolls in a trade/technical school, 3% enters the workforce directly, and 1% enlists in the armed forces.

In 2001, the footprint of the campus consisted of two school buildings on the campus: the elementary school, housing kindergarten through sixth grades, and the junior-senior high school, housing seventh through twelfth grades as well as the administrative offices. Due to rapid enrollment increases, the campus has grown by two buildings in the last twenty years with three additional renovation projects. The South Fayette Township High School was built in 2002 but required a $30 million expansion project in 2017. During the same time as the high school building construction, the middle school underwent a multimillion-dollar renovation project in order to house grades five through eight. In 2013-2014, a brand new intermediate school opened for students in third through fifth grades. This was a $24.5 million development. Again in the summer of 2020, the middle school had a minor renovation project in order to accommodate increased enrollment. The addition of seven new classrooms occurred by reconfiguring existing interior spaces for the cost of just under $1 million. The district has plans to add an additional primary center in the future and to redistribute the grade levels across the buildings in order to absorb the projected enrollment numbers.

The current enrollment at South Fayette Township High School is 1,071 students. The racial demographics are 77.7% White, 15.1% Asian, 2.8% Two or More Races, 2.5% Black, 1.8% Hispanic, 0.2% American Indian/Native Alaskan, and 0.0% Hawaiian/Pacific Islander. 53.3% of the student population is male and 46.7% of the population is female. Of the approximately 1,000 high school students, 10.2% are economically disadvantaged, 9.0% receive special education services, 0.1% are English Language Learners, 0.2% are in foster care, 1.0% are deemed homeless, and 1.2% are military connected. South Fayette Township High School was ranked 1,253 among high schools in the nation, 45 among high schools in the state of Pennsylvania, and 12 among high schools in the greater Pittsburgh area.

South Fayette Middle School, which now consists of grades six through eight, has an enrollment of 835 students. The racial composition of the student body is 72.9% White, 18.7% Asian, 4.6% Two or More Races, 2.3% Hispanic, 1.3% Black, 0.3% American Indian/Native Alaskan, and 0.0% Hawaiian/Pacific Islander. 50.3% of the student population is male and 49.7% of the population is female. With similar statistics in student groups compared to the high school, the middle school has 11.7% of the population identified as economically disadvantaged, 9.1% receiving special education services, 1.3% English Language Learners, 0.2% in foster care, 0.3% deemed as homeless, and 1.3% with military connections. South Fayette Middle School was ranked as the number one middle school in Allegheny County for four consecutive years, from 2014-2018, based on state assessment achievement levels.

South Fayette Intermediate School, grades three through five, houses 801 students comprising the following racial groupings: 71.2% White, 21.2% Asian, 4.8% Two or More Races, 1.8% Black, 1.0% Hispanic, 0.0% American Indian/Native Alaskan, and 0.0% Hawaiian/Pacific Islander. The gender make-up is 49.2% males and 50.8% females. Student groups have the following compositions: 10.1% economically disadvantaged, 9.4% special education, 3.0% English Language Learners, 0.0% foster care, 0.4% homeless, and 0.4% military connected. The Intermediate School also had the top-ranking position in Allegheny County for three years, from 2014-2017, based on the school's academic achievement on state assessments.

South Fayette Township Elementary School, the only building not to have any recent renovations or expansions, currently has 731 students enrolled in kindergarten, first, and second grades. Within those 731 students, 68.1% are White, 21.7% are Asian, 5.4% are Two or More Races, 2.5% are Hispanic, 2.0% are Black, 0.1% are Hawaiian/Pacific Islander, and 0.0% are American Indian/Native Alaskan. 52.2% of the students are male and 48.8% of the students are female. Students who are identified as economically disadvantaged are 10.9% of the population, 6.8% of the students receive special education services, 1.9% are English Language Learners, 0.3% are in foster care, 0.1% are deemed homeless; and 0.4% are connected to the military. South

Fayette Elementary School has been recognized on the national level as a Blue Ribbon School for its levels of achievement and academic programming. The elementary school is the building that is projected to be the next construction project. It is proposed to include third grade in the future.

Participants

The teacher participants in this research project were identified due to their teaching of a mathematics course in grades six through twelve. This group of 23 educators was asked to complete a questionnaire through the means of a Google Form. Of the 23 educators who were invited, 17 completed the questionnaire and provided consent by submitting the form anonymously. In order to gain their consent, the participants were informed in a written disclaimer prior to submitting the questionnaire. They were made aware that they could exit the questionnaire at any time before submitting and elect not to participate. Appendix A provides a view of the survey that includes the written disclaimer. Participants were also informed in the written disclaimer, prior to starting the survey, that minimal risk of identification existed through triangulation based on identifying data including gender, years of experience, and response to teaching accelerated/advanced courses.

The completion rate of the questionnaire by the teacher participants was 73.9%. This majority level of completion could be due to the minimal amount of time that was required on each participant's behalf to complete the questions. Additionally, since the questionnaire was electronic, the participants could complete it at their convenience, both in terms of time and location. One possible participant communicated with the researcher directly that he/she would not be completing the questionnaire because his/her teaching assignment never includes advanced level students, although this was not a requisite to participate. The researcher was satisfied with the level of completion and could only make conjectures related to the five remaining participants who did not complete the questionnaire. Some of those considerations include distrust in the process, lack of interest in the action research project, or lack of prioritization of time to complete the questionnaire.

The data collection in this mixed methods research project also included student data. In order to utilize the student data and fulfill the requirements of the Institutional Review Board, no actual students nor any identifying information related to students were utilized in the data collection. Additionally, the researcher had a district-level administrator codify every student who would have data used in this study so that, prior to the researcher using any of the students' data, the compilation would be independent of any identifying information. Based on not having nor using identifying information related to the student data, neither parental consent nor student assent was necessary; therefore, the use of student data was approved by the Institutional Review Board.

Researcher

The researcher has worked in education for twenty years and has been exclusively employed by the South Fayette Township School District. In those twenty years, the researcher has held the roles of sixth grade science teacher, sixth grade mathematics teacher, assistant principal of the middle school, principal of the middle school, and assistant to the superintendent for secondary education. The researcher holds a Bachelor of Science degree in Elementary Education and a Master of Education degree in Educational Leadership. The researcher has gained knowledge and experience related to school operations, curriculum and instruction, data analysis, and district-level financial planning based on the multiple roles held over two decades. As previously mentioned, it is the researcher's intent to provide the district, particularly in the role of assistant to the superintendent for secondary education who is responsible for overseeing secondary level curriculum, with the outcomes from this action research in order to validate or revise the screening process for advanced mathematics placement.

Research Plan

Before any literature, participant, or data research began, a timeline outlining the process was developed. This timeline helped to structure the scope of the entire project into manageable, incremental, and logical steps. The literature review, which occurred prior to completion of the data collection and participant submissions, was vital in assisting the researcher in honing the focus of the action research, as well as connecting it to or juxtaposing it against other research studies. This review provided a detailed evolution of mathematics education in the nation's public school system, identified different approaches to how schools and districts sequence their mathematics courses, and provided multiple explanations of the ways that schools commonly choose to accelerate students. Additionally, the literature review presented the impact that acceleration can have on the future of all students, on different subgroups of students throughout schooling, and teachers' instructional perspectives.

After the conclusion of the review of literature, the researcher shared a questionnaire with secondary level mathematics teachers in the South Fayette Township School District to gain their perspectives on the accuracy of the screening process used to determine placement of students in advanced mathematics courses. Occurring parallel to both the review of literature and participant questionnaire, the researcher gathered anonymously coded data about the five cohorts of students who qualified for the advanced mathematics course pathway based on the current screening process.

The first research question, "Is the screening process for advanced mathematics coursework accurately identifying students for acceleration based on the criteria?" will be answered through a quantitative analysis of the academic achievement data related to the multiple cohorts of students who have been identified to be placed on the accelerated mathematics course pathway. Not only will these students' results on each of the three criteria be critically reviewed for patterns and trends, but so will the students' grade achievements in each advanced mathematics course from sixth through eleventh grades. Successful completion of these courses is determined by the district as a cumulative average of 80% or greater. The students who have reached that minimum average are permitted to ascend to the next advanced level course. However, a cumulative average lower than 80% will remove students from the advanced level pathway and require them to take the course again or take a lower level of the subsequent course. Eleventh grade is selected as the final year for examination in the research because the district's graduation requirement is a minimum of three years of mathematics, and some students may elect not to take a mathematics course in their senior year. In seeking answers to this particular research question, a spreadsheet was created that contained thirteen columns of data related to each individual displaying statistics ranging from the results on each of the criteria to the cumulative averages in each of the advanced mathematics courses. The literature related to an ideal screening process for determining the placement of students in accelerated courses is not conclusive; however, the literature does concur that placement in middle school mathematics, specifically Algebra I, should not be rushed for students because it is paramount to their success in high school mathematics and post-secondary courses.

The second question, "Do teachers perceive that students are accurately placed in advanced mathematics courses based on the qualification process that occurs prior to the start of sixth grade?" utilizes a qualitative approach to discern the teachers' beliefs related to the accuracy of the advanced mathematics placement screening process. The survey not only asks the teachers about their perceptions of the characteristics of the students who were placed in advanced courses and the process's accuracy, but also asks about the consideration of students who were not accelerated and the appropriateness of their placement in general level courses.

The final question, "Of the three criteria used in the screening process, does a pattern exist as to a certain criterion indicating a greater likelihood of success in mathematics advancement?" returns to the examination of the data collected from the multiple student cohorts. Since the collection of data includes the achievement levels of each student in the advanced mathematics courses from sixth to eleventh grade, there is a possibility that there will be a drop off point in which the greatest number of students identified for acceleration exit the advanced course pathway. Connecting that potential drop-off point back to the performance levels on each criterion, a certain criterion may emerge as an indicator of long term success for students. Determining if there is a pattern relative to a certain criterion would be beneficial for the district being able to accurately identify students for acceleration since each criterion is currently considered to be equally important. If a pattern emerges from the data, that individual criterion could be considered with a greater weight or significance during the screening process.

As previously stated, the literature review, accompanied by these guiding questions, provides the researcher with the ability to assess the current criteria used in the screening process for placement in the advanced mathematics course pathway. Although the student data is significant to the research from the perspective of their achievement outcomes in the accelerated courses, the questionnaire was just as important because it considered the teachers' perspectives. The teachers, experts in their content, are a critical piece to the success of students in advanced courses, as also revealed in the literature review. Therefore, their perspective about and familiarity with the district's current process, provides insights into how they value the criteria and view the placement of students. Ultimately, with the synthesis of the literature and the data, the district will have evidence to determine if the process that is being utilized to determine the mathematics course trajectory for students at the secondary level is accurately placing students. Although the financial implications related to the outcomes of this research are minimal, the impact on students and their futures is not. The placement of students in advanced or general level courses prior to sixth grade is one that can permit or prevent a student from achieving at the highest level in mathematics. This is an educational decision made exceptionally early yet one that yields significant, long term ramifications.

Fiscal Implications

The cost to conduct the screening process to determine students who qualify for the accelerated mathematics sequence is very minimal. Of the existing three criteria, two are data pieces that are generated at no cost. One, the students' cumulative grade averages in fifth grade math, comes from a query in our online grading system. The second criteria, the comprehensive, summative assessment tool of the general sixth grade mathematics course has already been designed by our math educators. It only needs to be copied each year for the students to take. An expense to the district related to the criteria is the purchasing of the Test of Mathematical Ability (T.O.M.A.) 3. Copies of these exams are budgeted for annually by the assistant to the superintendent for secondary education. Additionally, six teachers are paid an hourly rate each year to score the two assessments. Three fifth grade teachers score the T.O.M.A. 3 tests, and three sixth grade teachers score the comprehensive sixth grade assessments. These teachers are paid an hourly rate and are not permitted to exceed five hours of grading.

The hourly rate is $40.25 and is budgeted for within the district's general budget for extra professional responsibilities.

Should the data and research from this Capstone Project indicate that the criteria are not accurately identifying students for the accelerated mathematics sequence, there could be a financial impact on the district of selecting an alternate (or multiple alternate) screening tool/s. The funds allotted to pay the six teachers may also be impacted if new tools would require less or more time for scoring.

Research Design

A mixed-methods approach was selected as the research method due to the utilization of both quantitative and qualitative data collections. The quantitative part, relative to the first and third research questions, includes the collection of thirteen data points for each student included in the five cohorts. As shown in Appendix B, these data points include each student's performance on the three criteria from the screening process and the cumulative grade average for each accelerated mathematics course taken from grades six through eleven. If a student ever exited the accelerated pathway or moved from the district, data would not be available. The teacher questionnaire also included certain quantitative aspects, as shown in Appendix A. These questions were designed as a result of the thorough research conducted in the literature review process. The quantitative questions included whether or not teachers could identify and name the three criteria used to screen students for advanced mathematics placement and how well they could describe this process from "very well" to "not at all." Additionally, the teacher participants rated, on a five-point Likert scale, how important they believed knowing the criteria was to them as a mathematics educator. The 1 on the scale represented, “I do not need to be made aware or be familiar with the criteria,” while the 5 represented, “I should be fully aware and extremely familiar with the criteria.” Another quantitative aspect of the teacher questionnaire asked the participants to identify the most important indicator from the three criteria used in the screening process. This question was followed by an open-ended response opportunity for which qualitative data could be collected. The participants were provided the opportunity to express their beliefs in the screening process and provide a rationale for a different tool or assessment to use in place of one of the already-existing criteria. Similar to this pair of mixed method questions, the next four questions were designed to yield quantitative and qualitative data. The participants were asked, based on their perspectives from teaching advanced level mathematics courses, how accurate the placement of students in the accelerated courses was. The responses were assigned a rating of one (“Not accurate”) to five (“Extremely accurate) on a Likert scale. Then, the teachers were asked to respond, in their own words, about the characteristics of students who were in accelerated courses but seemed to be inaccurately placed. The next question asked participants to rate how often they felt that students in general mathematics courses belonged in an advanced level course. This rating occurred from “Never” (1) to “Always” (5) on the scale. Participants subsequently had the opportunity to describe the characteristics of the students who they perceived should have been in accelerated courses but were not. The final question was open-ended and allowed all participants to describe any additional recommendations relative to the screening process that they believed may help to improve the accuracy of student placement and long-term success. Overall, this mixed-methods approach will provide the researcher and, ultimately, the district, with a comprehensive data set, both from the students' outcomes and teachers' perspectives, so that an informed decision can be made regarding the accuracy of the screening process for accelerating students in mathematics.

Data Collection

After making the necessary revisions required to receive approval by the Institutional Review Board (IRB) to conduct the research, the researcher initiated the process as it was outlined in the timeline provided for IRB approval. The first step of the collection was to request the data related to the multiple student cohorts. In order to be in compliance with the approved process, an independent, district level administrator was needed in order to code the students in such a way that no student could be identified by the researcher. Since the student data included multiple cohorts and thirteen pieces of data for each student, requesting this data in September provided enough time for it to be exported and compiled into a detailed spreadsheet. The questionnaire that was utilized in the research was electronically shared with the 23 mathematics educators in January, and the participants were provided with two weeks to submit their responses. Seventeen of the 23 educators participated.

The questionnaire was shared electronically since it was designed as a Google Form. Participants' names and email addressed were not collected through the submission of the form. Therefore, participation was anonymous and voluntary. On the

Google Form, however, the participants were made aware of a minimal possibility of data triangulation due to identifying data including gender, years of experience, and response to teaching accelerated/advanced courses. Also included in the Google Form was the pertinent information regarding informed consent. Respondents were also given the opportunity to contact the researcher with any questions.

After the window closed for the teachers to participate in the research by submitting the questionnaire, the responses were exported into a Google Sheet. Both the Google Form and Sheet were chosen as the collection tools due to their ease of use and access, by both the respondents and researcher, respectively. Within the Google Sheet, the researcher had the ability to aggregate similar data, as well as disaggregate individual data, based on the goal of a particular analysis or question within the questionnaire. The Google Sheet also allowed for the search of repeated key terms or phrases used in the participants' open-ended responses.

The spreadsheet that was constructed with all of the students' data was able to be manipulated in multiple ways. The spreadsheet could be sorted by an individual column (criterion or course) in ascending or descending patterns. Graphs could be easily generated from data in order to determine the magnitudes of different selected data points. The data could be analyzed for trends and patterns, both within the spreadsheet, as well as through other exported graphical displays. Collectively, the analysis of both data sets provided evidence related to the problem statement, as well as in response to the three research questions, such that the researcher was to construct recommendations for the district.

Ethical Concerns and the Institutional Review Board

In order to conduct this mixed-methods research study, approval from the IRB was necessary. Prior to submitting a proposal to the IRB, a research plan was submitted to the researcher's Doctoral Capstone Committee on August 2, 2020. Additionally, the superintendent of the South Fayette Township School District provided written endorsement and permission for the study to take place within the district, utilizing student data and teacher feedback. This letter is provided as Appendix C. With the approval of the researcher's committee and district, a proposal with the necessary IRB forms, which can be viewed in Appendix D, was submitted to the Institutional Review Board for approval on August 14, 2020. The plan did not receive initial approval, as stated in a letter from September 2, 2020; the Chair of the Institutional Review Board requested that a statement about the possible triangulation of identifying information be included in a written disclaimer for the questionnaire. Additionally, there was questioning regarding the use of student data for individuals under 18 and the need for parental consent. The notification of these requests can be found in Appendix E. On September 4, 20202, the researcher responded to these requests by amending the questionnaire to include the statement regarding possible risk through triangulation, as well as an explanation that the student data would be coded by a district level administrator and that no identifying information would be known to the researcher. This response can be seen in Appendix F. The researcher received formal approval (Appendix G) of the research plan on September 11, 2020.

Validity of Research Plan

The researcher took multiple steps in order to increase the validity of the research. The first step taken was a request to have the student data coded by a district level administrator. The data codification removed any possibility that the researcher would be able to identify a student or have subjectivity during the research based on current or previous roles held in the district. Additionally, the questionnaire that was used was first reviewed by the researcher's Doctoral Capstone Committee in order to make sure that the questions were not leading and did not contain bias. The survey was also created so that the respondents were anonymous with a minimal risk of identification through triangulation of certain data. The questions that were developed in the questionnaire came as a result of the literature review and the guiding questions in order to include the teachers' perspectives into the research of the accuracy of the criteria used for placement of students in advanced level mathematics courses.

The researcher utilized spreadsheets as the tools to gather and analyze the data. The student data was inputted by an independent administrator, and the teacher data was exported to the Google Sheet directly from the Google Forms. Therefore, the data was unaltered by the researcher. Although the researcher has held roles that have been close to the screening process, by having the anonymity of the students being preserved through codification, potential subjectivity is removed. Additionally, the researcher holds no further bias towards the study or its findings. The goal is to be able to share data-based evidence with the district related to the accuracy of a critical screening process.

Summary

This chapter described the methodology process for how the researcher would gather data in order to answer the three guiding questions while connecting the study and its outcomes to the review of literature. This chapter revealed important aspects that contributed to the methodology of the study. The details related to the setting and participants, the research plan, the methods for collecting data, the fiscal implications, and validity of the research were thoroughly explained. In order to arrive at meaningful recommendations that may result from this research, it is important to have a comprehensive understanding of how data was gathered and analyzed. Chapter 4 will provide the results of this study as evidenced in the data in order to answer the guiding questions and to provide the district with feedback regarding the criteria used in determining the acceleration of students in mathematics courses.

CHAPTER IV

Data Analysis and Results

In the following chapter, the analysis of the data related to the three research questions that were previously described will be presented. The results include both quantitative and qualitative datasets that were collected and synthesized from five cohorts of students who qualified for acceleration in their mathematics course pathway, as well as responses from middle school and high school mathematics teachers. The quantitative data collected came from the results of a total of 150 students who were a part of the five most recent cohorts of students. Additionally, these students were identified for mathematics acceleration prior to entering sixth grade. Each student was anonymously coded to maintain objectivity within the analysis, adhering to the requirement from the Institutional Review Board. Results from the three pieces of criteria used in the screening process, as well as cumulative grade averages from each student’s accelerated mathematics courses from sixth grade to the most recently completed course were utilized in the data analysis. Additionally, responses from six of the questions from the teacher questionnaire yielded quantitative data. The qualitative data that was collected resulted from the teacher questionnaire and included responses to five open-ended questions.

Data from both the spreadsheet of the student results, as well as responses to the teacher questionnaire, were utilized to determine if the screening process accurately identifies students for mathematics acceleration. This concept was framed in the first research question. The data related to the student cohorts was organized so that it could be determined if students were successfully promoted each year in order to remain on the accelerated mathematics pathway. Also, a comparison was conducted for each cohort based on the number of students in each cohort who began in the accelerated sixth grade mathematics and how many of those students remained in the last mathematics course that each respective cohort had completed. The teachers' feedback from the questionnaire relative to the criteria used in the screening process was also thoroughly analyzed. The second research question was informed by teachers' responses to open-ended questions related to their perceptions of the accuracy of student placement in accelerated mathematics courses based on the screening process. The final question was also conducted as a mixed methods analysis. The spreadsheet that contained the students' results was sorted in multiple ways and analyzed for patterns of whether or not a certain criterion of the screening process indicated a greater likelihood of success for students in the accelerated mathematics course pathway. Additionally, the teachers' responses to the items in the questionnaire that addressed their perception of the three criteria were reviewed.

Data Analysis

A correlational analysis of the students' results during the screening process compared to their long-term achievement in the accelerated mathematics coursework was conducted to address the first research question, "Is the screening process for advanced mathematics coursework accurately identifying students for acceleration based on the criteria?" Separately, a comparison of the retention rates for each cohort in the accelerated mathematics courses from sixth to eleventh grade was constructed.

Additionally, the results from teachers' ratings on two Likert scales from the questionnaire were utilized in order to address this first question.

The student data, comprised of the five most recent cohorts of students who qualified for the accelerated mathematics course pathway, consisted of 150 individual students. These students were codified in a spreadsheet by being assigned an alpha-numeric code. The first student of the first cohort was identified as "aa001." As cohorts changed, the second letter changed; however, the numeric assignment continued in cardinal order throughout all cohorts. The last student in the fifth cohort was identified as "ae150." Each student had up to 13 pieces of data assigned, based on the last mathematics course completed. Every student had the following data: raw cumulative score on the two T.O.M.A. subtests, percentage earned on the curriculum-based assessment, cumulative grade average from fifth grade mathematics, points earned from the screening process rubric for the T.O.M.A. results, points earned from the screening process rubric from the curriculum-based assessment results, points earned from the screening process rubric from the cumulative grade average results, total points earned from the three criteria, cumulative grade average from the sixth grade accelerated Pre-Algebra course, and cumulative grade average from the seventh grade accelerated Algebra I course. Then, depending on the last mathematics course that a specific cohort finished, each student may have had the following data: cumulative grade average from the eighth grade accelerated Geometry course, cumulative grade average from the ninth grade accelerated Honors Algebra II course, cumulative grade average from the tenth grade Honors Pre-Calculus course, and cumulative grade average from the eleventh grade accelerated Advanced Placement Calculus AB course.

A series of correlational analyses were conducted in which the students' total points earned from the screening process were compared to their cumulative grade averages in each of the accelerated mathematics courses in order to explore whether or not students who qualified for advanced placement were continually finding success in subsequent accelerated mathematics courses after their initial placement. Students must earn a minimum cumulative grade average of an 80% in order to be promoted to the next accelerated course.

Addressing the second question, "Do teachers perceive that students are accurately placed in advanced mathematics courses based on the qualification process that occurs prior to the start of sixth grade?" both quantitative and qualitative data was analyzed. The participants in the questionnaire not only rated their perceptions of the accuracy of student placement in advanced mathematics courses on Likert scales, they also responded to three open-ended questions. The ratings on the Likert scales were examined for volume and consistency of responses by participants. The responses to the open-ended questions were reviewed to identify if there were commonalities and alignment with the other data related to the accuracy of placement of students in advanced mathematics courses.

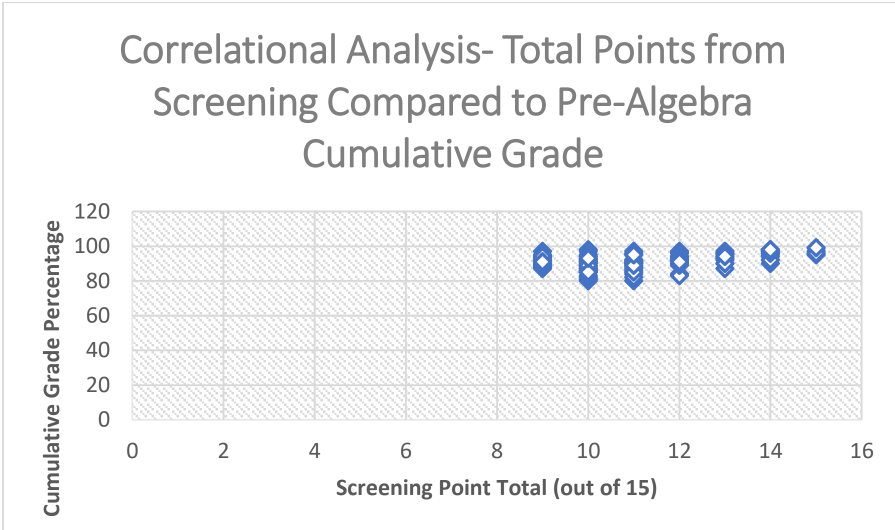
The analysis of the final research question, "Of the three criteria used in the screening process, does a pattern exist as to a certain criterion indicating a greater likelihood of success in mathematics advancement?" utilized both quantitative and qualitative data. Using the comprehensive spreadsheet of the scores that the students in each of the cohorts received during the screening process, the data was sorted and critically examined for the existence of a pattern. In addition to that, two items from the questionnaire were examined for how the teacher participants perceived the accuracy of the existing criteria or other potential screening tools.

Results

Comparing the total points earned by the students as a result of the three criteria used in the screening process to each of their cumulative grade averages in the accelerated math courses yielded a general trend. As shown in each of the six scatterplots, Figures 9 to 14, students who earned a total of 10 or 11 points during the screening process consistently had the lowest cumulative averages, even lower than students who had earned a total of nine points. The group of scatterplots also revealed that earning a higher total of points during the screening process did not increase a student's chance of getting the highest cumulative grade averages in each course. Students who qualified with any of the point totals, 9-15 points, were able to achieve the highest cumulative grade average.

As shown in Figure 9, all 150 students in the five cohorts successfully completed the accelerated sixth grade Pre-Algebra course and were promoted to the accelerated Algebra I course in seventh grade. The highest cumulative average earned by any student was 99%, and the lowest average was 81%. The first average below a 90% (A range) occurred for a student who earned a total of 13 points.

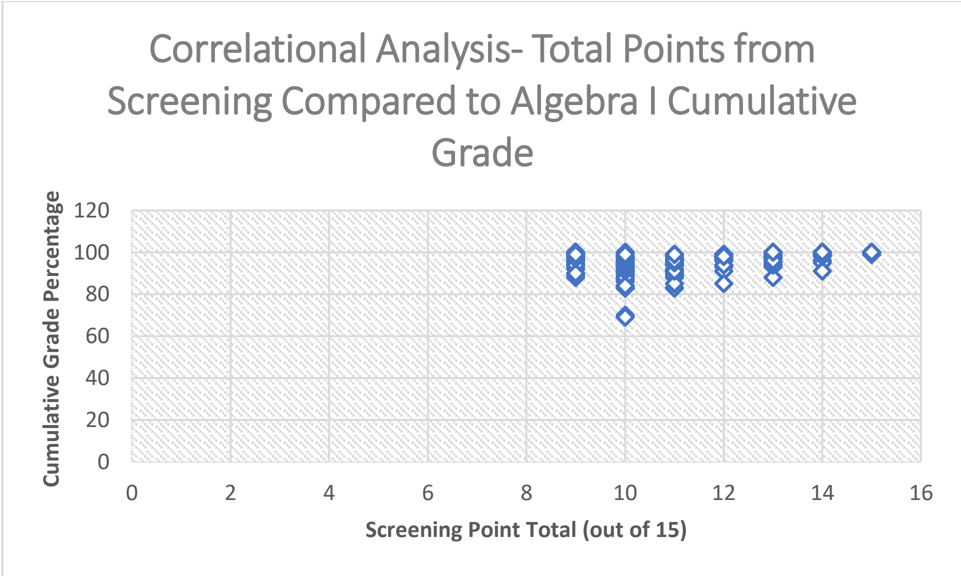
Figure 9



Note. The comparison of the total number of points students earned during the screening process to their cumulative grade average in Pre-Algebra 6

A similar shape and trend with the data occurred with these five cohorts of students as they advanced to the accelerated seventh grade course of Algebra I (Figure 10). However, there were two students, both earning ten points during the screening process, who fell below the passing average. One had earned a cumulative average of 69%, and the other had earned a cumulative average of 70%. These two students were exited from the accelerated program following their enrollment in Algebra I. The range of cumulative grade averages was 100% to 69%. In this course, it was also the same student with a screening point total of 13 who earned the first cumulative average below 90% (A range).

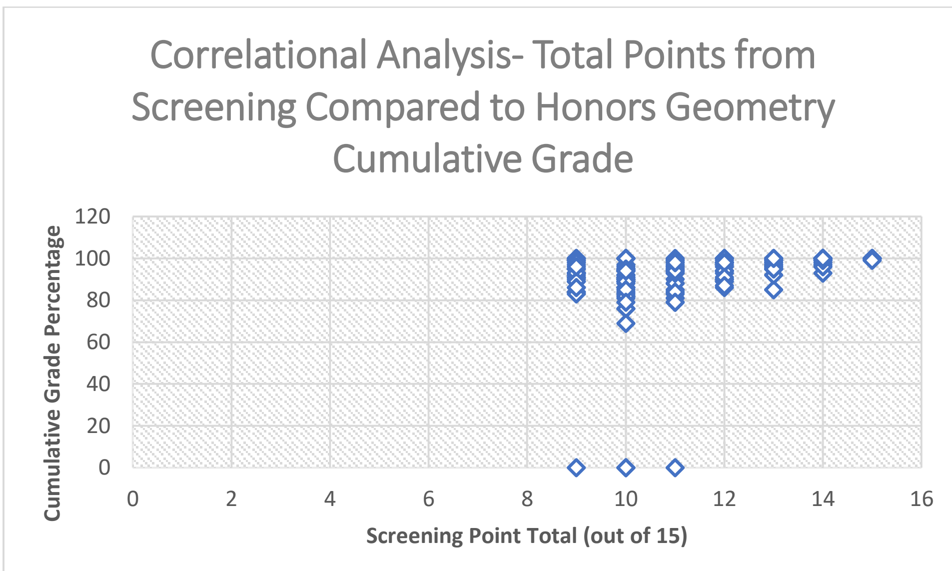
Figure 10



Note. The comparison of the total number of points students earned during the screening process to their cumulative grade average in Algebra I

In Figure 11, the data began to show that more students who had earned a 10 or 11 during the screening process were not meeting the minimum passing average of 80%. Two students with a screening point total of 11 were not successful and each had cumulative grade averages of 79%. One student with this same screening process had a point total of 11, although this individual had also met the grade minimum to be enrolled in Honors Geometry, but had elected not to take the course and exited the accelerated pathway. That student is indicated as a circle at the bottom of the graph above the number 11. There were three students who had a screening point total of 10 who did not reach the minimum. They had cumulative grade averages of 79%, 76%, and 69%. Similar to the formerly mentioned student, one student with this point total also opted not to continue on the accelerated pathway even though the previous grade average permitted this student to do so. The two students who did not meet the grade average minimum exiting Algebra I are also represented as circles at the bottom of Figure 11. The range of cumulative grade averages were 100% to 69%. Yet again, the first cumulative grade average earned that was less than 90% (A range) was the same previously mentioned student with a screening point total of 13.

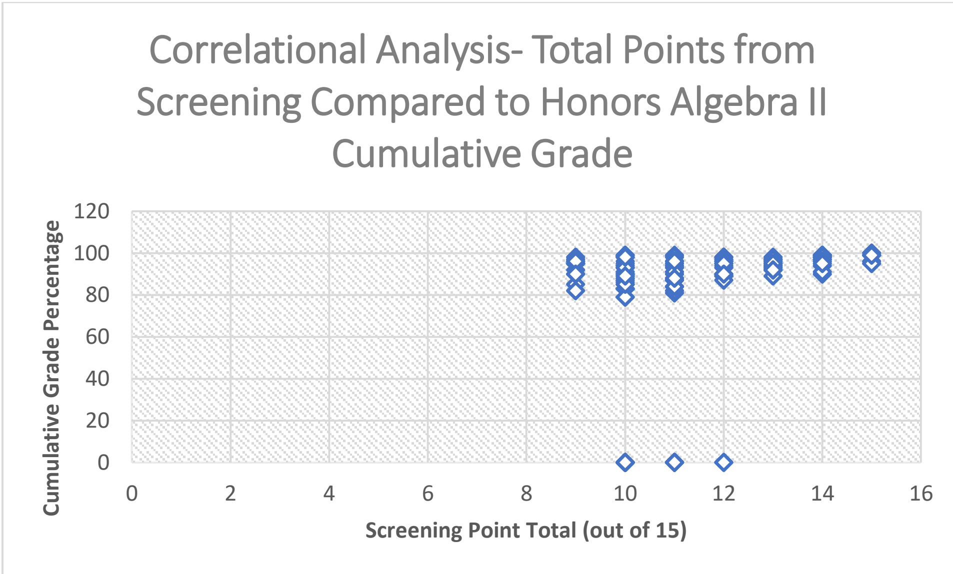
Figure 11



Note. The comparison of the total number of points students earned during the screening process to their cumulative grade averages in Honors Geometry

Figure 12 displays the first occurrence in which a student who had earned above an 11-point total during the screening process did not choose to enroll in the Honors Algebra II course. This particular student had earned the requisite grade average in Honors Geometry but had elected to exit the accelerated pathways. Additionally, a student who was on track to be enrolled in this accelerated course and had a screening point total of 12 withdrew as a student in the district. All students who did not meet the minimum cumulative grade average at the end of this course had 10 points as their screening point total. There are other circles at the bottom of this graph representing additional students who made the minimum cumulative grade average in the previous course but who chose not to continue in the accelerated mathematics pathway. This group consisted of four students with 11 points as their screening total and eight students with 10 points as their screening total. In addition, three other students who had an 11-point screening total and met the cumulative grade average to maintain status in the accelerated pathway withdrew from the district. The range in cumulative grade averages was 100% to 79%. Also, the trend continues with the first cumulative average under 90% being associated with the aforementioned student who had a screening point total of 13.

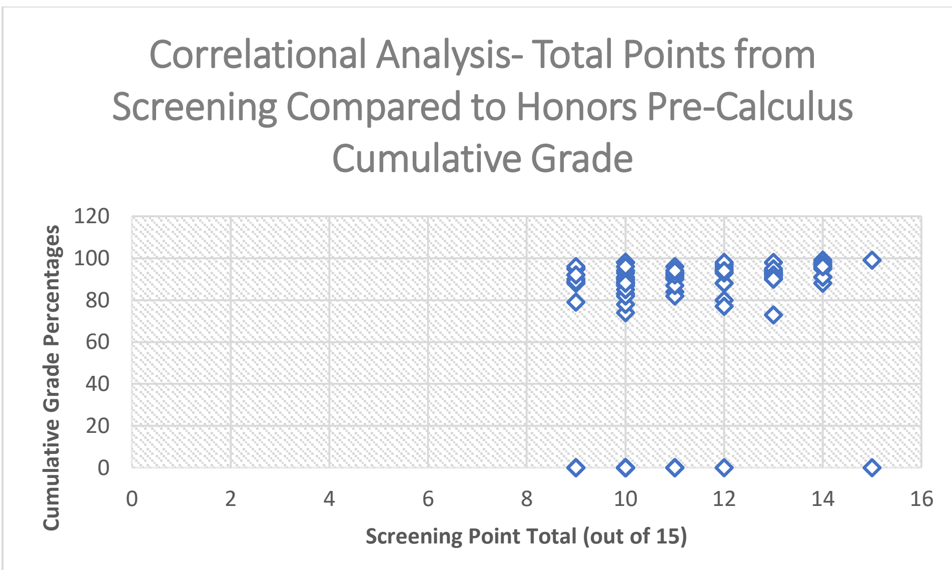
Figure 12



Note. The comparison of the total number of points students earned during the screening process to their cumulative grade average in Honors Algebra II

The data indicates that sizes of the cohorts continue to decrease at the close of Honors Pre-Calculus based on more students earning a cumulative grade average below the minimum of 80%. Additionally, there are more students, represented by circles at the bottom of Figure 13, that chose not to enroll in this course. One student who had earned a 15-point screening total and met the grade requirement for enrolling in this course elected not to continue on the accelerated pathway. This student has been previously mentioned as the first student to score below a 90% in each of the previous courses. This student had a cumulative grade average of a 73% in Honors Pre-Calculus and, thus, exited the accelerated pathway. There was one student with a screening point total of 12 who did not qualify to enroll in this course and one student with a 12-point total who fell below the minimum cumulative grade average of 80%. Of the students with a 10-point screening total, there were five who did not qualify to enroll in this course, one who was eligible to enroll but withdrew as a student in the district, and one who earned a 79% cumulative grade average in this course, which would subsequently remove the student from the accelerated pathway. The range in cumulative grade averages was 99% to 73%, and the first average below a 90% (A range) occurred with a student who had a screening point total of 14.

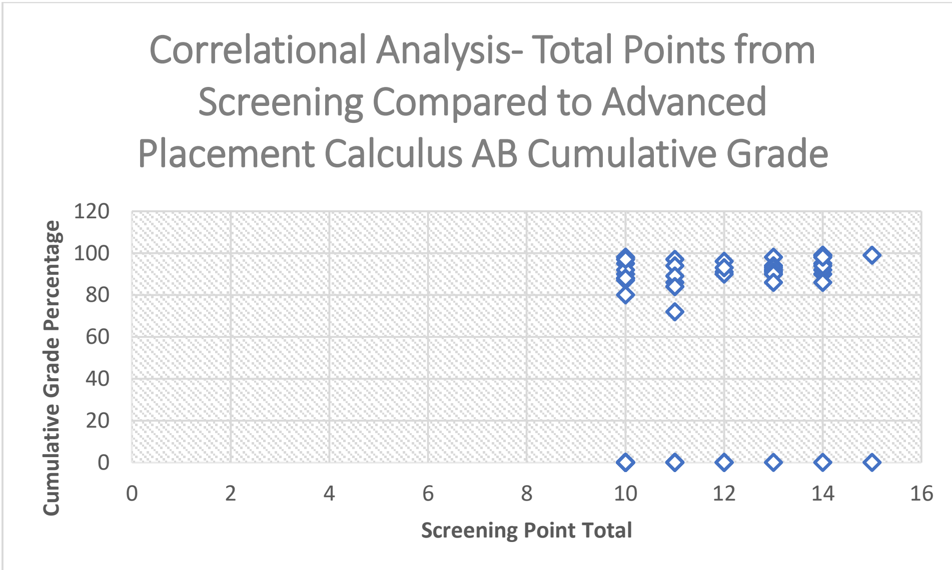
Figure 13



Note. The comparison of the total number of points students earned during the screening process to their cumulative grade average in Honors Pre-Calculus

In Figure 14, no data is displayed for a screening point total of 9. This occurred because only the first two cohorts had reached this level in the course sequence, and their screening criteria had a minimum cut-off score of ten points. Their cohorts completed the former version of the Test of Mathematical Abilities, the T.O.M.A. 2. Therefore, the scatterplot is fully representing the cohort of students who have begun and continued through the entire series of accelerated mathematics courses through eleventh grade. In addition to the students who had previously exited the accelerated pathway due to choice, grade average, or withdrawal, there were additional students impacted in Advanced Placement Calculus AB. One additional student within the 11-point screening total group failed to meet the minimum grade average of 80% at the end of this course. This student earned a 72% and subsequently exited the accelerated pathway. Nine additional students, ranging in screening point totals from 13 to 10 points, elected not to take this course, even though they had met the minimum cumulative grade average requirement. Separately, one student who had a 14-point screening total withdrew as a student in the district. In Advanced Placement Calculus AB, the range in cumulative grade averages was between 99% and 72%. The first cumulative average that was below 90% occurred for a student with a 14-point screening total.

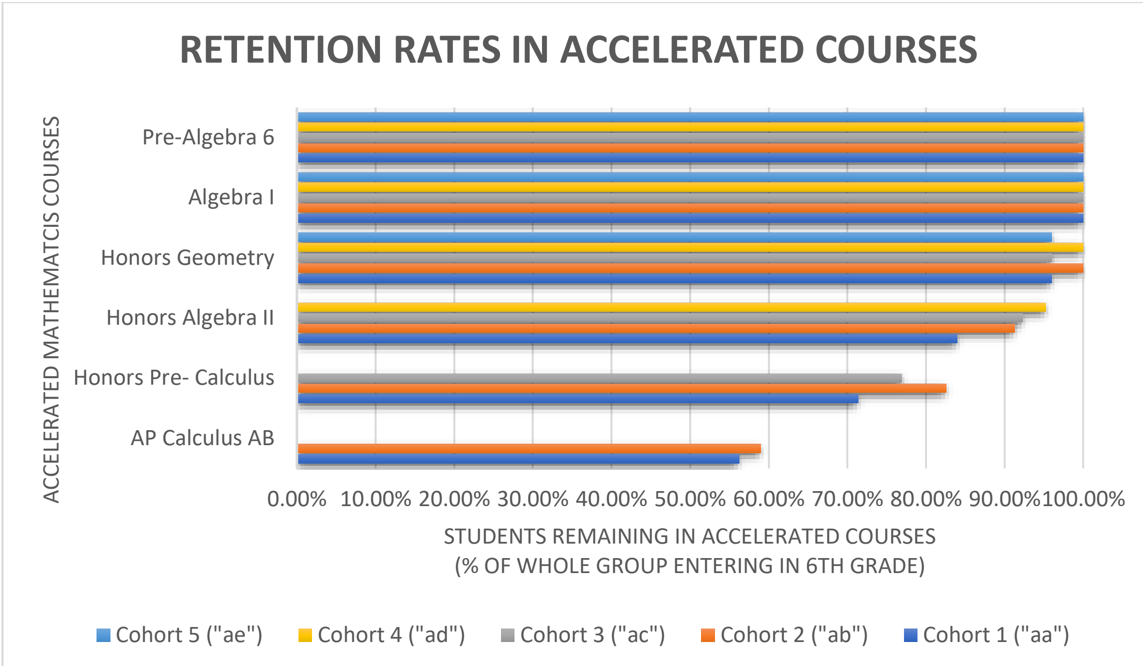
Figure 14



Note. The comparison of the total number of points students earned during the screening process to their cumulative grade average in Advanced Placement Calculus AB

The previous scatterplots showed the cumulative grade performances by the students in the five cohorts, and they also showed trends of when students began to exit the accelerated pathway. The following chart, Figure 15, is another representation of such student data in which each cohort's retention rate of students remaining in the accelerated mathematics pathway is displayed. The graphical display indicates that, for the three courses of accelerated mathematics in the middle school, students are highly successful and nearly all of the students are able to qualify for promotion to the next accelerated course. Two cohorts, Cohort 1 and Cohort 5, each had a 96% enrollment rate compared to the original group. Cohort 1 had two students, whereas Cohort 5 had one student, who did not meet the minimum grade requirement upon exiting Algebra I. The greatest decrease in students remaining in the accelerated course pathway occurred after Honors Algebra II. For the three cohorts that had already advanced to enroll in Honors Pre-Calculus, there was a noticeable decline in the amount of students compared to the total amount who began on the accelerated pathway in sixth grade. Cohort 1 saw a decrease of 12% after Honors Algebra II, Cohort 2 saw an 8% decrease after Honors Algebra II, and Cohort 3 saw a decrease of 16% after Honors Algebra II. Another significant decrease in student enrollment occurred after Honors Pre-Calculus. Both Cohorts 1 and 2 had their greatest decreases, 16% and 24%, respectively. If you consider the entire group of 150 students, 40 exited the program in total, with 14 of those students exiting due to not meeting the cumulative grade requirement. From start to finish with these cohorts, 90.7% of the students who qualified for advanced placement through the screening process were able to maintain their accelerated status through to the most recent course that they had finished.

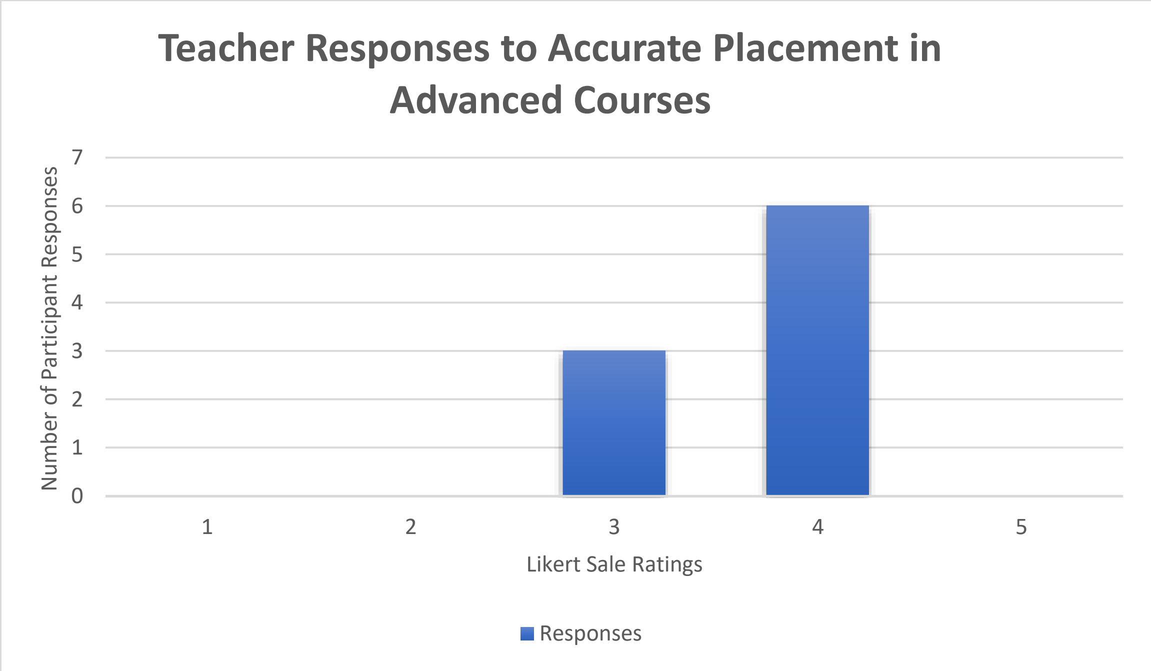
Figure 15



Note. This bar graph displays the percentage of students in each cohort who remained in the accelerated courses from entrance until the completion of the most recently finished course.

Two questions from the teacher questionnaire specifically asked the teachers to rate their perception of how accurate the placement of students was in accelerated courses. Both of these questions asked the participants to respond on a Likert scale from 1 to 5. For the first question, “If you have taught the highest level mathematics course at a respective grade level in last seven years, please describe how accurate the placement of students seems to be, from your perspective, knowing that the nearly all of the students were in that course because they qualified for advanced placement through the screening process at the end of fifth grade,” 5 represented “Extremely accurate; all students seemed to be appropriately placed in advanced level courses" and 1 represented "Not accurate; all students seemed to be inappropriately placed in advanced level courses." Figure 16 shows the results of the nine participants that responded. Although 17 teachers completed the questionnaire, this question may not have applied to all participants if they did not teach an advanced level course within the last seven years. In response to the question, 67% of the participants expressed that the accuracy of student placement in advanced mathematics courses was at a score of 4. No participants felt that the placements were extremely accurate; nor did the participants express that the placement was completely inaccurate.

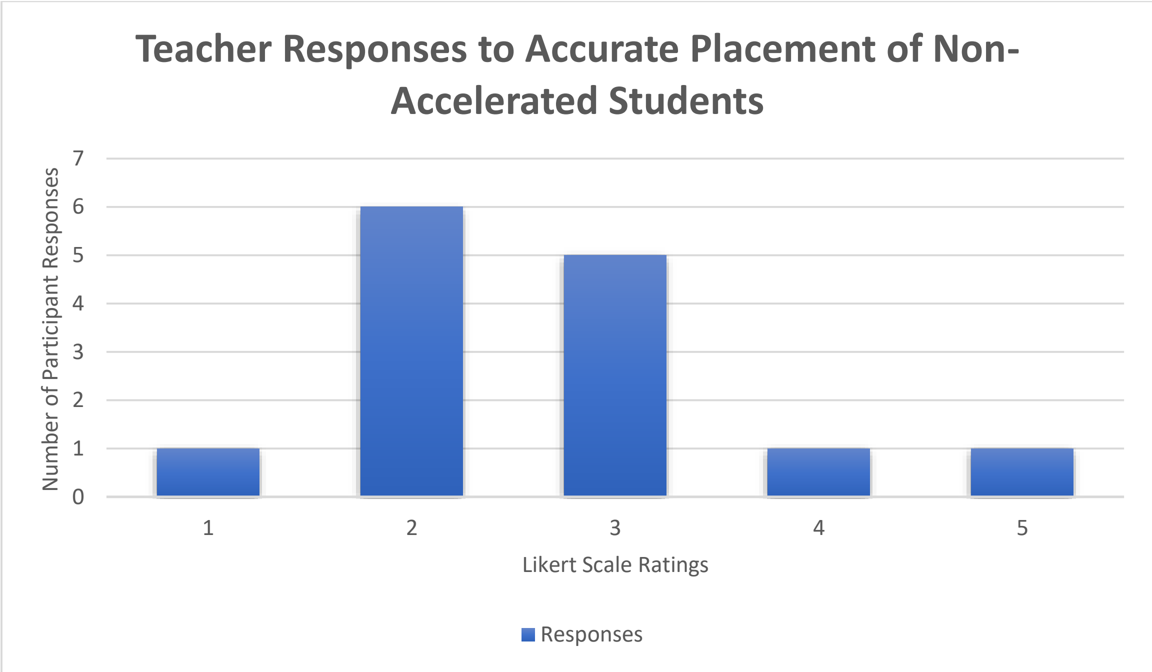
Figure 16



Note. This bar graph displays the total number of responses for each of the ratings on the Likert scale, from Not Accurate (1) to Extremely Accurate (5)

The second question, which was similar in nature, asked the participants to consider the following, "If you have taught mathematics courses that are not at the highest level at each grade level, how often do you find that students in these classes should have been placed in the advanced course sequence?" Again, the participants' responses were rated on a Likert scale of 1 to 5 with 5 being "Always" and 1 being "Never." The results revealed that there was less consistency among the perceptions of the 17 participants who responded to this question (Figure 17). Most teachers, approximately 65%, rated the frequency in which non-accelerated students should have been placed in accelerated courses between a 2 and 3. There were two individuals who had opposite perceptions of how often they believed that non-accelerated students should have been placed in advanced courses. One of these teachers felt that it never occurred; whereas, another teacher felt that it always occurred.

Figure 17



Note. This bar graph displays the total number of responses for each of the ratings on the Likert scale, from Never (1) to Always (5)

Following each Likert scale question, participants were given the opportunity to respond to an open-ended question. The first open-ended question asked the teachers, "If you felt that students had been inaccurately placed in the highest level mathematics course, please describe the characteristics of such students.". Nine participants chose to respond to this question. As shown in Figure 18, there are some common themes of characteristics that participants identified which included deficits in prior knowledge, difficulty with higher level/application-based problems, lack of confidence, immaturity, and lack of self-advocacy skills. The theme that was repeated the most frequently was that of students having deficits in their mathematical knowledge related to previously taught skills.

Figure 18

Teacher Responses to Characteristics of Advanced Students Who May Not Have Been Appropriately Placed

Characteristic	**Teacher Responses**	**Occurrence of Theme**
Deficits in Prior Knowledge	"Deficits in prior knowledge"; "lack of necessary mental math and basic calculation skills"; "Basic skills are weak."; "They do not have the appropriate prerequisite skills"; "Reliant on calculators"; "Basic Algebra skills are weak."	6
Difficulty with higher level/application-based problems	"Difficulty with problems that went beyond basic skills and concepts"; "Weak completing application problems"; "Not able to think beyond a procedure"	3
Lack of Confidence	"Lack of confidence in completing individual tasks or when participating in class."; "Lack of experience of what to do when a concept is not understood"; "Struggled with work ethic/organization/study habits/independence"	3
Immaturity	"It is typically immaturity. These students are very good at school but are not quite ready to take on the rigor and the work load."; "Work ethic is not mature."	2
Lack of Self-Advocacy Skills	"Difficulty or hesitation in formulating questions to ask when struggling with a concept"; "Failure to self-advocate"	2
Other	"Expectation of Extra Credit to achieve a grade"	1

Similar to the open-ended question, participants of the questionnaire were given the opportunity to respond to another question after they rated the frequency with which they found students in non-accelerated courses who they believed should have been placed in the advanced course pathway. The teachers were asked to expand by responding to, “Please describe the characteristics of students that you perceive should have been placed in the advanced course sequence but were not.” With a response rate of 88%, there was minimal repetition in themes. Some overlap did exist with the themes of onset of later maturity, completion of work, level of motivation, level of understanding of mathematics concepts, and performance above peers. The most commonly mentioned characteristic for students who were not in the advanced level mathematics courses but were perceived by their teachers as being capable was the level of understanding of mathematics concepts with four occurrences (Figure 19).

Figure 19

Teacher Responses to Characteristics of Non-Advanced Students Who May Not Have Been Appropriately Placed in General Mathematics Courses

Characteristic	Teacher Responses	Occurrence of Theme
Level of Understanding of Mathematics Concepts	"Exhibit complete or nearly complete understanding of certain topics prior to discussing them in class"; "Lesser challenging problems seem trivial"; "Questions show interest in the 'why' instead of just the 'how'"; "If a student has a deep conceptual understanding on how things work and the 'why' behind how the problem works."	4
Performance Above Peers	"Students that score 98% or above in my class."; "Performs well-above peers on majority of assessments and learning tasks"; "Performance above peers in class performance and mastery of content"	3
Completion of work	"Consistent effort in and out of class"; "Homework completion is consistent and accurate"; "Strives to complete all assignments and extra learning opportunities with motivated work ethic"	3
Level of Motivation	"Driven to succeed at the highest level"; "Seeks out additional opportunities for enrichment/instruction"	2
Onset of Later Maturity	"Students who have matured over the summer."; "Maturity also plays a factor at later level."	2
Other	"Students have a focus on learning and treat grades as a reflection of learning."; "They were too intimated to take the advanced level course."	2

In sorting the comprehensive spreadsheet that contained the results of the students' performances on the three criteria during the screening process, as well as their success in each of the accelerated courses for which they were enrolled, the following information was ascertained. The first way in which the data was sorted was to take each of the columns that contained the points earned from the screening rubric associated with each of the screening criterion and order them from greatest to fewest points earned. Then, how many students successfully remained in the accelerated pathway in each column was determined. Once the first student exited, it was noted. For example, after ranking all 150 students based on their T.O.M.A. scores, the student who was 31st on the list was determined to be the first to exit the accelerated course pathway. Students beyond this student may have been more successful and continued on the accelerated pathway, but, as one measure of each criterion being an indicator of long-term success, that first student to exit was identified (Figure 20).

Figure 20

Each Criterion's Exiting Student Report Based on Scores

	T.O.M.A. Score	**Curriculum-based Assessment**	**Cumulative Fifth Grade Math Average**
Number of students in spreadsheet before a student exited the accelerated course pathway	30 students	42 students	18 students

The next analysis of data occurred to determine if a pattern existed related to a certain criterion indicating a greater likelihood of success in mathematics advancement. The analysis included examining the magnitude of students who exited the accelerated pathway according to the points they earned for each criterion from the screening process (Figure 21). Of note, students that fell in the 4-point range on the rubric based on their T.O.M.A. results constituted the greatest population of students that, at some point on the pathway, did not meet the qualifications to remain in the accelerated series of courses. This population was significantly higher than any other point range associated with the T.O.M.A. results. The variation in the students who were required to exit the accelerated pathway due to not meeting the grade minimum based on their curriculum-based assessment results was not as significant. The greatest amount was nearly 17% of students who had earned 1 point. Three points was the fewest amount of rubric points that could be earned in the screening process based on students' cumulative fifth grade math averages; this point total yielded the largest population of students who did not remain in accelerated coursed due to not meeting the requisite cumulative average. That data also revealed that almost the same amount of students who had earned the maximum rubric score of 5 points, as well as the score of 3 and 2 points, based on their T.O.M.A. results, had elected to exit the accelerated pathway at some point. Even though these students were identified as being appropriately prepared for advanced level work, they made a choice not to continue in the sequence of courses. The greatest portion of students who chose to leave the accelerated pathway based on the points earned from their curriculum-based assessment results were those who earned 1 point. There is also an overall trend with this category that, as the points increase, the percentage of students who chose to leave the accelerated pathway decreases. For this same type of comparison relative to the cumulative fifth grade math average, those students who had earned 3 points comprised the greatest number of students who opted to exit the accelerated pathway.

Figure 21

Amount for Each Type of Exited Student Based on Rubric Scores for Each Criterion

		5 points	4 points	3 points	2 points	1 point	0 points
T.O.M.A.	**Did not qualify to be promoted**	8.3%	31.3%	5.9%	5%	0%	0%
T.O.M.A.	**Elected to exit accelerated pathway**	21.7%	14.3%	23.5%	20%	0%	0%
Curriculum-based Assessment	**Did not qualify to be promoted**	6.7%	2.7%	10.6%	6%	16.7%	N/A
Curriculum-based Assessment	**Elected to exit accelerated pathway**	0%	5.4%	14.9%	27.3%	44.4%	N/A
Cumulative Fifth Grade Math Average	**Did not qualify to be promoted**	3.8%	13.4%	0%	N/A	N/A	N/A
Cumulative Fifth Grade Math Average	**Elected to exit accelerated pathway**	17.5%	20.9%	33.3%	N/A	N/A	N/A

Utilizing only the first two cohorts, since they are the only cohorts who had progressed from the first accelerated course in sixth grade to the final course considered in the study, Advanced Placement Calculus AB, a chart was constructed to analyze how many students in each criterion and rubric point total remained in the accelerated pathway. These students' data revealed the following for each criterion of the screening process. For rubric points earned based on T.O.M.A. results, the greatest number of students who remained in the pathway, as well as who exited, earned the maximum point total of 5. For the curriculum-based assessment, similar to all of the cohorts, the greatest number of students remaining in the accelerated pathway had a 4-point total, and the most significant number of students who exited had a 1-point total. Finally, the trend for the students who completed the full pathway based on their cumulative fifth grade math average followed the point values. The greatest number of students who completed the pathway scored 5 points, whereas, the fewest number scored 2 points. It is notable that both of the students from these two cohorts who qualified for accelerated placement with only 2 points finished the entire sequence (Figure 22).

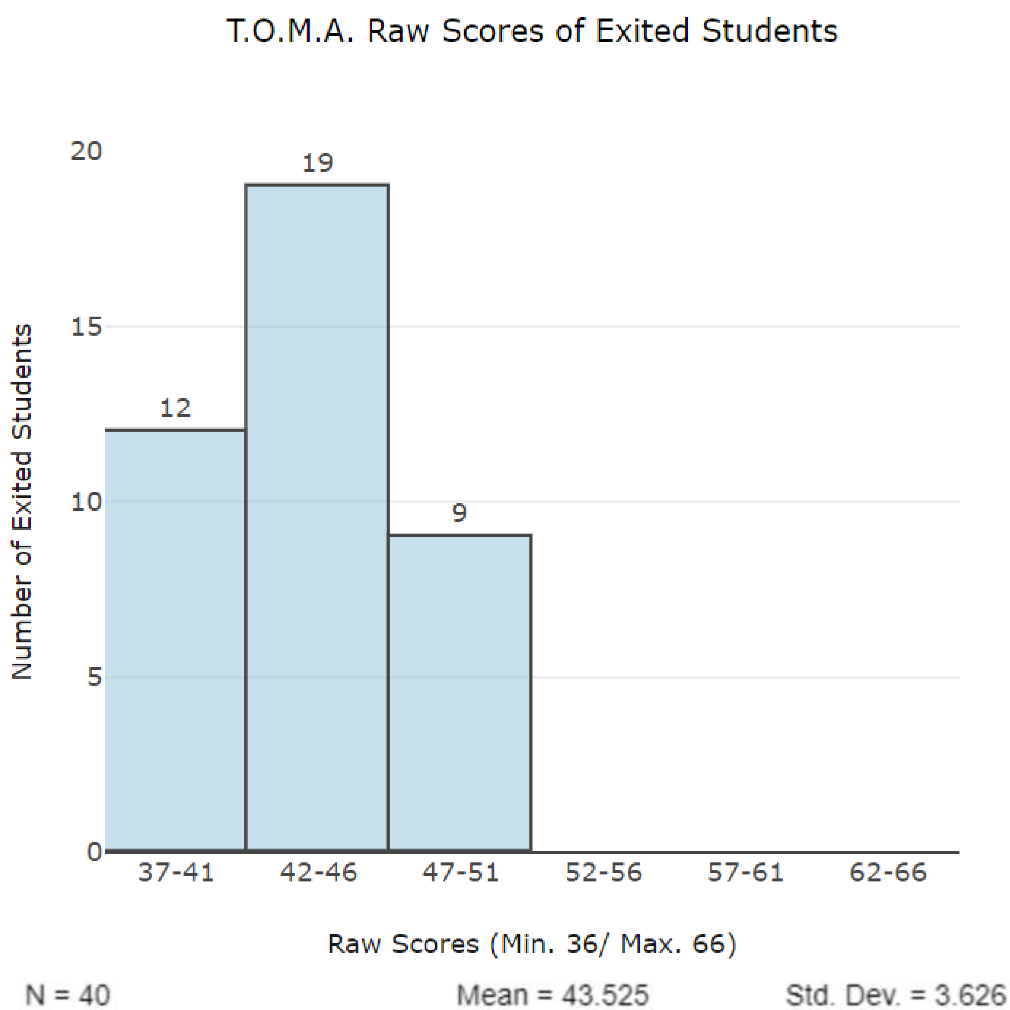
Figure 22

Comparison of Students Who Exited and Did Not Exit Accelerated Pathway Based on Rubric Scores for Each Criterion

	5 points	4 points	3 points	2 points	1 point	0 points
T.O.M.A.	**29** students completed the pathway	**5** students completed the pathway	**6** students completed the pathway	**N/A**	**N/A**	**N/A**
	18 students exited the pathway at some point	**5** students exited the pathway at some point	**6** students exited the pathway at some point	**N/A**	**N/A**	**N/A**
Curriculum-based Assessment	**3** students completed the pathway	**13** students completed the pathway	**7** students completed the pathway	**13** students completed the pathway	**3** students completed the pathway	**N/A**
	1 students exited the pathway at some point	**1** students exited the pathway at some point	**7** students exited the pathway at some point	**10** students exited the pathway at some point	**11** students exited the pathway at some point	**N/A**
Cumulative Fifth Grade Math Average	**20** students completed the pathway	**17** students completed the pathway	**2** students completed the pathway	**N/A**	**N/A**	**N/A**
	13 students exited the pathway at some point	**17** students exited the pathway at some point	**0** students exited the pathway at some point	**N/A**	**N/A**	**N/A**

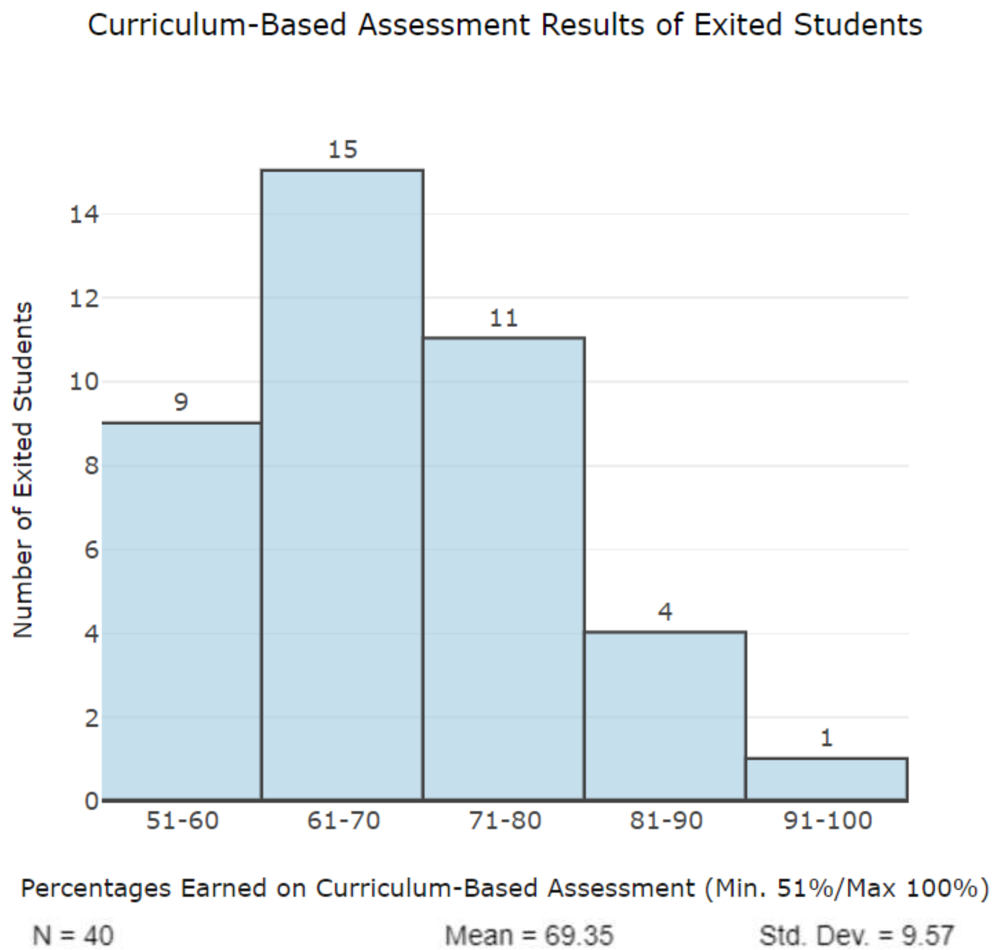
The following three histograms (Figures 23, 24, and 25) display the distribution of students who exited the accelerated pathways based on their performances on each of the three criteria in a different manner. Exited students include students who did not meet the minimum cumulative grade average needed to maintain accelerated status, as well as students who elected to exit the advanced mathematics course pathway at any point on their own. Of the 150 students comprising the five cohorts, 40 students, or 26.7%, exited the program. Fourteen out of the 40 students who exited were placed off of the accelerated pathway due to not earning the required cumulative grade average. Analysis of the T.O.M.A. results showed that all 40 students who exited the program, regardless of reason, earned less than a 52 raw score point total on the assessment (Figure 23). Of the three criteria, this display has the clearest separation of the total scores for students who have or have not exited. The greatest number of these students, nearly half of those who exited, had a raw score between 42 and 46 on the T.O.M.A. In regards to the curriculum-based assessment results, the standard deviation was the greatest of the three graphical displays, meaning that there was a greater range of students who exited the accelerated pathway in comparison to the average percentage earned (Figure 24). Most significantly, though, students who earned an 80% or less on the curriculum-based assessment were more likely to exit the accelerated course pathway. Those who scored 80% or less on the curriculum-based assessment comprised 87.5% of the 40 students who exited the program. When analyzing the criterion of the fifth grade mathematics cumulative grade averages, little deviation was found in the data between the students who exited and did not exit the accelerated course pathway. The greatest frequency of those exiting the pathway occurred with students earning a 98% cumulative fifth grade mathematics average (Figure 25). Notably, with the exception of averages of 100% and 92%, students who exited had every other cumulative average. It is also worthwhile to acknowledge that, according to the screening rubric and process, students earned zero points for any cumulative average below a 90%. Therefore, it would require high scores for the other two criteria for a student to qualify for advanced mathematics placement with a cumulative fifth grade math average of less than a 90%.

Figure 23



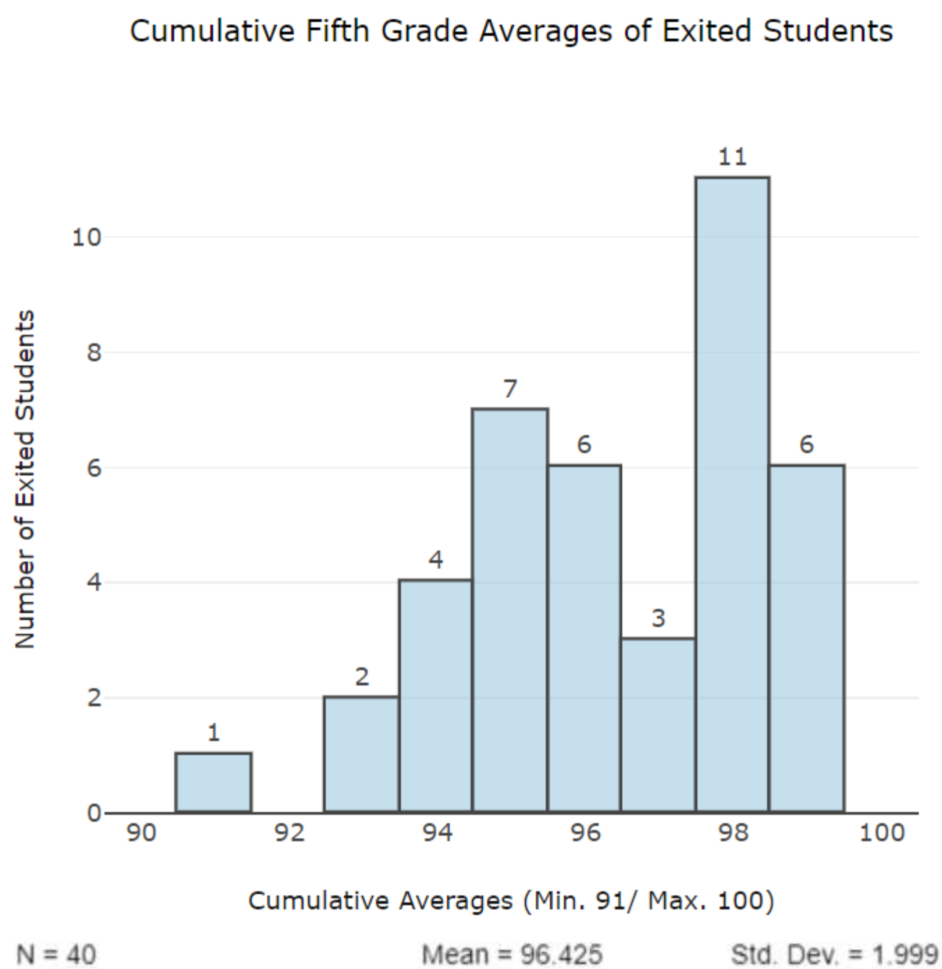
Note. This histogram displays the frequency of students who exited the accelerated course pathway within the stated ranges of raw scores from the T.O.M.A.

Figure 24



Note. The histogram displays the frequency of students who exited the accelerated course pathway within the stated ranges of percentages earned on the curriculum-based assessment.

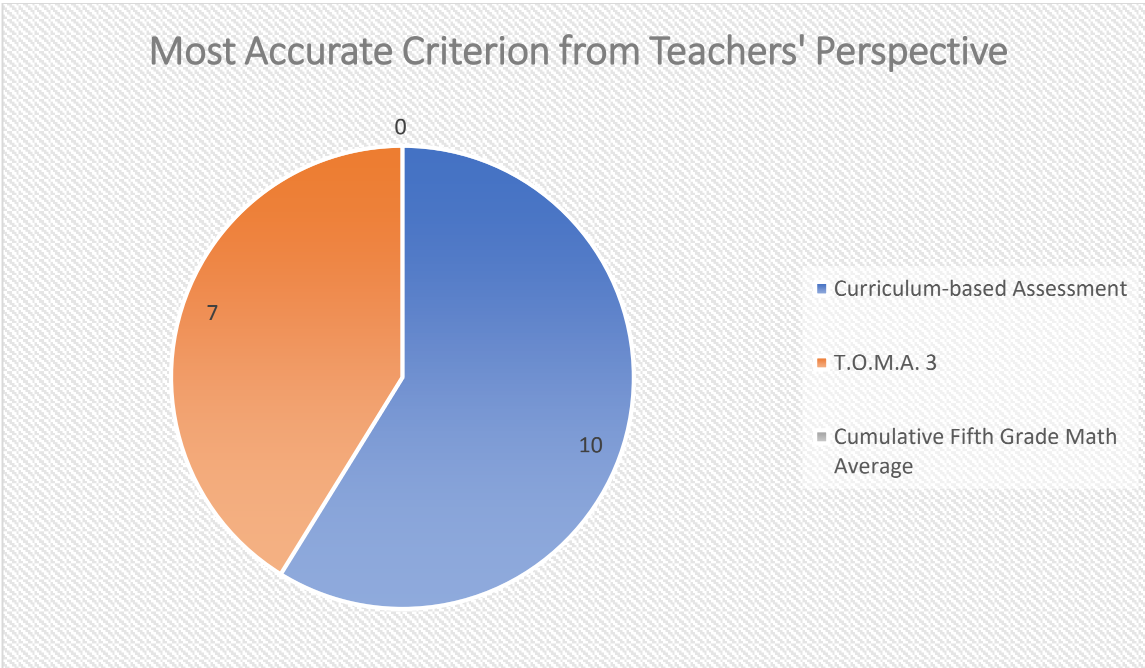
Figure 25



Note. The histogram displays the frequency of students who exited the accelerated course pathway for each of the cumulative fifth grade mathematics averages between 90% and 100%.

On the teacher questionnaire, the participants were asked to identify which of the three existing criteria of the screening process they perceived to be the most useful in accurately placing students in accelerated mathematics coursework. As shown in Figure 26, the majority of the teachers responded with the “comprehensive curriculum-based assessment of sixth-grade content." Over 58% of all of the questionnaire participants identified this assessment as the most accurate criterion in the process.

Figure 26



Note. This circle graph displays the responses by questionnaire participants regarding which of the three criteria they perceived to be the most accurate in placement of students in accelerated coursework.

The teachers who participated in completing the questionnaire were also given an open-ended question in which they could state a different tool or specific assessment that they believed should be used in place of one of the existing criteria. Here are the responses from the seven participants who chose to respond:

- "An interest questionnaire to assess students' interest in participating in accelerated/advanced math courses"
- "I don't have a specific tool; however, I currently have a student that has 100% in both Q1 and Q2 that should be in Pre-Algebra but didn't meet the criteria prior to 6th grade."
- "I believe that students need to be advanced on their PSSA Math 5th grade test before they can even be considered for advanced math placement, but that can't be done because the results are released too late."
- "I believe that students' scores on the 5th Grade PSSAs should also be factored into the placement."
- "Not sure how much the cumulative math average assists"
- "If they were basic, proficient, or advanced in math on the PSSA"
- "Teacher recommendation"

The participants most frequently recommended to include the achievement levels of the fifth grade mathematics Pennsylvania State School Assessment in the screening process for each student.

Triangulation of data occurred in this study because multiple, different points were analyzed regarding students who qualified for advanced placement in mathematics. The student data included results for each of the three criteria used in the screening process, those scores converted to points from the screening process's rubric, and cumulative mathematics averages for each of the accelerated courses that every student has completed. The student data encompasses these data points for the past eight years because that is when the first cohort would have entered its first accelerated mathematics course. Additionally, data was gathered from teachers in regards to their years of teaching experience, certification, perceptions of the screening process, and perceptions of the qualities of both the accelerated and non-accelerated students in mathematics. Information and statistics gathered from the review of literature was examined and considered when looking at the results of the student data and teacher questions.

Discussion

1. Is the screening process for advanced mathematics coursework accurately identifying students for acceleration based on the criteria?

Based on the analysis of the data, the most significant indicator that the current screening process is accurately identifying students for acceleration is that 90.7% of the students who qualified were able to maintain their status in advanced placement based on achievement. This statistic does not include the students who qualified to remain in the accelerated pathway but made the choice to exit. Including those students, the overall rate that would represent the population of students who have maintained their status in the accelerated pathway is 73.3%. Although the reasons for students exiting on their own accord were not identified in this study, their cumulative averages indicated that they were performing at a level that would be considered successful for accelerated courses. Additionally, the data showed that the students who had qualified for accelerated placement prior to entering sixth grade were most successful in the middle school accelerated courses: Pre-Algebra 6, Algebra I, and Honors Geometry. In each of the recorded cohorts, very few students exited the program. These results may also be attributed to the phenomenon described by other researchers who have found through multiple studies that course sequencing in middle school is less flexible than in high school, which causes students to move less from the accelerated pathway during sixth, seventh, and eighth grades (Loveless, 1998, 2013; Lucas, 1999; Mulkey et al., 2005). The most significant loss of students in the accelerated pathway occurs after Honors Algebra II. This loss includes both students who do not qualify to remain in the accelerated pathway, as well as those who self-select to exit. This is not unlike the trend that occurred in the data from the High School Transcript Study (HSTS) of 2009 in which the most noticeable decline in the population of students advancing to the next accelerated course happened after Algebra II and before Pre-Calculus (National Assessment of Educational Progress, 2009/2018). If the intention and measure of success of the screening process is for the entire cohort that began as accelerated students in sixth grade to remain accelerated through Advanced Placement Calculus AB, then that has not been achieved at a rate of 100%. In the two cohorts that have completed the full sequence of courses from sixth to eleventh grade, fewer than 60% of the students from their respective original groups still enrolled in Advanced Placement Calculus AB. However, those statistics again include students who could have qualified to make it to that course but chose to exit at one point on their own.

2. Do teachers perceive that students are accurately placed in advanced mathematics courses based on the qualification process that occurs prior to the start of sixth grade?

The data indicates that the majority of teachers do believe that students are accurately placed in advanced mathematics courses based on the qualification process.

Unlike existing research that indicates the use of standardized tests, teacher subjectivity, and parental influence, the criteria that is currently employed and preferred by the group of teachers who participated in the questionnaire represents two assessments, neither which are standardized (Bitter & O'Day, 2010; Hallinan, 2003; Kelly, 2007; Loveless, 1998; Meehl, 1954; Oakes, 1985; Useem, 1992). Although one teacher in the survey suggested "teacher recommendation" as an added component to the screening process, it was not a tool that the majority of teacher participants expressed. However, and in alignment with the research, three of the teacher participants believed Pennsylvania's annual standardized math assessment should be added as a measure to the screening process.

3. Of the three criteria used in the screening process, does a pattern exist as to a certain criterion indicating a greater likelihood of success in mathematics advancement?

After analyzing the data in multiple ways, there was not a conclusive pattern that existed relative to one criterion indicating a greater likelihood of success in the district's accelerated course sequence. However, there were outcomes from this collection of data that did reveal certain indicators about each criterion. First, the fifth grade cumulative mathematics average revealed no correlation to a student's long-term success in the accelerated course pathway. Students of every grade average, from 90% to 100%, exited the program, with the greatest number having a cumulative average of 98%. In addition to what the quantitative statistics revealed, the teachers also reinforced the notion that this criterion was not perceived as valuable. None of the 17 participants chose this as the most useful tool in accurate placement of students in accelerated mathematics coursework. One teacher went as far to say, “Not sure how the cumulative math average assists” in an open-ended response. In regards to the other two criteria, the T.O.M.A. and the curriculum-based assessment, a variety of analyses pointed to different recommendations based on the results of the five most recent cohorts. First, all 40 students who exited the program earned a 51 or lower raw point total on the T.O.M.A. Although there was not a pattern revealing that the T.O.M.A. was the strongest indicator, there was a clear distinction between the scores of students who exited and did not exit the pathway. There was a similar pattern for the curriculum-based assessment results for which there was a threshold separating those who were more and less successful in advanced courses. Students who earned an 80% or lower on the curriculum-based assessment exited the accelerated pathway at a higher volume than those who scored 81% and higher. Compounding these two patterns and based on the data, the profile of a student who would have a greater likelihood of success in advanced mathematics would consist of results greater than 51 as a raw point total on the T.O.M.A. and greater than 80% on the curriculum-based assessment. Reviewing the data associated with the only two cohorts who had finished the entire sequence of accelerated mathematics courses defined in this study, no pattern was found indicating one criterion as stronger than another for predicting long-term success for students. The only criterion’s data pointing towards a slight pattern for these two cohorts is the curriculum-based assessment. For students who earned 4 or 5 points, only one with each point value exited the accelerated pathway. That number of students was the fewest of any category and point value. Similarly, but on the low end of the point values, the greatest number of students who exited the program had earned 1 point based on results from the curriculum-based assessment.

Summary

The collection of quantitative and qualitative data was used to inform the three research questions. It was important to analyze the multiple data sets in order to be informed about the current screening process that is used to place students in advanced mathematics coursework prior to entering middle school. Since this process, which happens early in a student's career, has far reaching implications, including postsecondary and career aspirations, it was critical to gather evidence that would speak to the efficacy of the screening process.

Accuracy of the current screening process was determined to be true for approximately 90% of the 150 students enrolled in the five most recent cohorts. The teachers' perceptions indicated that two of the three current criteria are valued as accurate tools to determine placement. Those perceptions were further supported by the student data indicating that there was no correlation between the third criteria of the students' cumulative fifth grade math average and success in the accelerated pathway. Although none of the three criteria were shown to be the single best indicator for a student's likelihood of success in the accelerated mathematics pathway, certain analyses provided thresholds of scores on the T.O.M.A. and curriculum-based assessment that would point to a greater accuracy of advanced placement of students, as well as their long-term success in the accelerated pathway.

The considerations taken from all of this analyzed data will convert into recommendations for the district, as well as additional, recommended research topics that may need to be considered or conducted before any changes are implemented. These recommendations and potential research will be discussed in the next chapter.

CHAPTER V

Conclusions and Recommendations

The purpose of this study was to validate or recommend revisions to the district's screening process for placement of students in the advanced mathematics coursework pathway at South Fayette Township School District. This process, as previously described, is exclusionary and only permits students who qualify to have access to the highest level of mathematics courses as a result of a screening process that occurs prior to students entering sixth grade. As research has indicated, taking advanced level mathematics courses in high school leads to higher assessment scores, a higher likelihood of enrolling in college and completing a bachelor's degree, greater career earnings, and increased career satisfaction (Altonji et al., 2012; Bozick & Lauff, 2007; Chen, 2009; Nord et al., 2011; Pellegrino & Hilton, 2012). Therefore, this decision of accurately accelerating students is of paramount importance and can drastically impact the students' futures. In order to determine if the screening process was effectively identifying students for acceleration in mathematics, multiple sets of data were reviewed. Those sets included data related to 150 students' performances on the three criteria of the screening process, the cumulative grade averages for all of the students in the advanced mathematics courses they had finished, and teachers' responses to a questionnaire.

Conclusions

In order to inform the South Fayette Township School District if its screening process for placing students in advanced mathematics courses at the secondary level was accurate, five cohorts of student data were reviewed. These cohorts contained 150 students who had already qualified for acceleration due to the screening process that has existed for the past eight years. With a 90.7% retention rate of students who had qualified originally and remained in the accelerated course pathway, the screening process seems to be accurate for the majority of students. However, there was a discrepancy with the total population of students who remained as accelerated when those who chose to exit the pathway on their own were also included. The accuracy rate then dropped to 73.3% of students remaining in the accelerated pathway. Therefore, the screening process may be accurately identifying students based on their mathematical knowledge and skills; however, the process may account less for students who may not be interested in pursuing advanced mathematics courses through high school.

An additional conclusion drawn about the retention of students in the accelerated pathway was that students remain in the advanced level courses in middle school at a higher rate than in high school. The retention of all five cohorts for Pre-Algebra and Algebra I was 100% and three of the five cohorts dropped to approximately 95% with each of them losing one student each from the original cohort for Geometry in eighth grade. The rate starts to decrease more significantly as the students progress through high school. The data showed that there was between a 3% to 12% decline in enrollment after Honors Geometry in eighth grade. That was followed by between a 9% to 16% decrease in enrollment after Algebra II in ninth grade. Lastly, there was between a 15% to 23% decrease in student enrollment after Honors Pre-Calculus in tenth grade. Related to the two cohorts that finished the entire sequence of courses, there was a loss of only one student in one of the two cohorts by the end of middle school compared to a loss of 40% (20 students) of the students in the first cohort and 37.5% (9 students) of students in the second cohort during high school.

Considering the decline of students throughout the sequence of accelerated courses in high school, the first significant number of students exiting the accelerated cohort consistently occurred after Honors Algebra II and prior to Honors Pre-Calculus. The three cohorts that have gotten this far in the sequence showed a drop in retaining the full group of students who qualified in each cohort by a loss ranging between 9% and 16%. This is in alignment with a reported national trend, but the underlying reasons were not investigated nor revealed in this study (National Assessment of Educational Progress, 2009/20018). The drop-off that occurs within these cohorts of students is a result of both students not qualifying due to their cumulative grade average, as well as students who elected to exit the accelerated pathway. Since Honors Algebra II is taken in ninth grade as the highest level course, those who opted to exit on their own still had to take two more mathematics courses in order to fulfill local graduation requirements. The data shows, however, that they are not taking the highest level course that is expected in the accelerated sequence and for which they demonstrated requisite knowledge and skills. There is another significant decrease in the population of students in the accelerated pathway after Honors Pre-Calculus. For the two cohorts who have completed the full sequence of this study by finishing Advanced Placement Calculus AB, only approximately 56% and 59%, respectively, of the students remained compared to their original cohort population. This decrease, however, does not align with the results from the High School Transcript Study of 2009. That study saw a slight increase in students taking Pre-Calculus in tenth grade when compared to those taking Calculus in eleventh grade (National Assessment of Educational Progress, 2009/2018).

Based on the results that 67%, or four out of the seven, teachers who completed the item of the question rated their perception of the accuracy of the screening process a 4 out of 5 rating on a Likert scale, it can be concluded that their perceptions of the accuracy of the screening process are more favorable than not. No teacher gave a complete endorsement of a 5 rating, or “extremely accurate,” nor did any teacher rate the accuracy level lower than a 3. Considering the sample size, seven teachers is not a large population, however, that group is inclusive of every mathematics educator that teaches the highest level of mathematics between grades six and twelve.

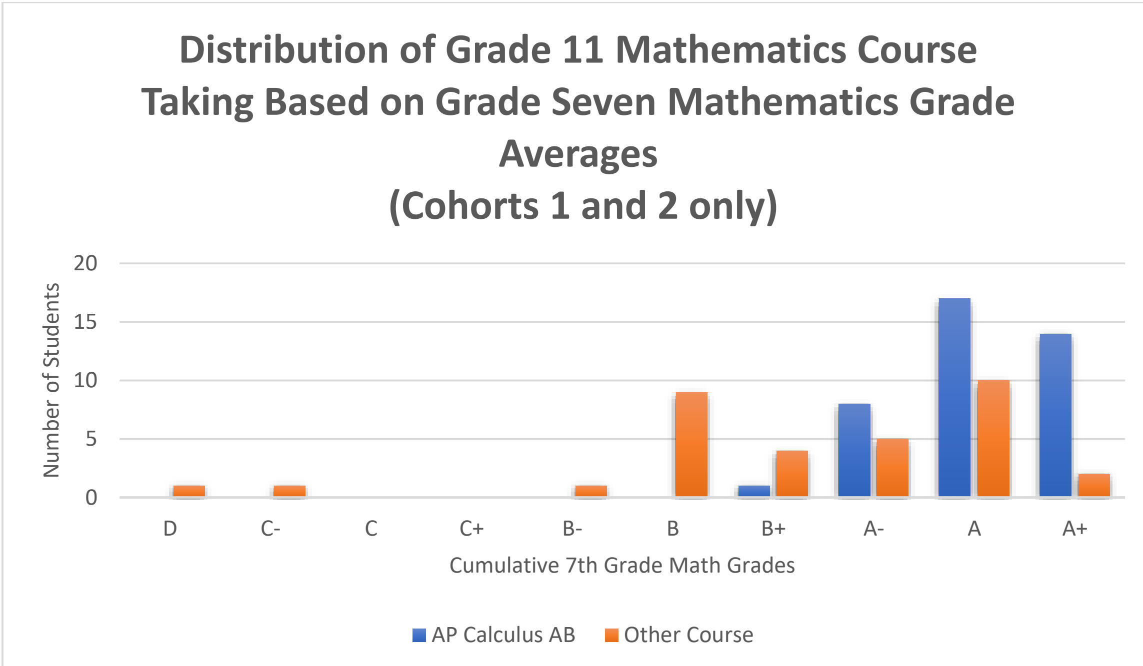
Based on the review of the teachers’ responses to which criterion they believed to be the most accurate for advanced placement, it was concluded that the teachers only validated two of the three criteria. The use of the cumulative fifth grade mathematics average was not identified by any of the participants as being the most accurate tool. Overall, 58.8% of the teachers endorsed the T.O.M.A. 3 as the most accurate criterion used in the screening process for advanced placement; whereas, 41.2% selected the curriculum-based assessment. The cumulative fifth grade averages from the student data were also determined to have the least impact on determining a student’s likelihood for success in the accelerated mathematics pathway. With the exception of students who had a cumulative fifth grade math average of 100% and 92%, all other grade averages led to students who exited the accelerated pathway, either by performance or choice. Thus, there shows to be no correlation with this grade average and a student's likelihood to remain on the accelerated pathway. Conversely, data related to the other two criteria, the T.O.M.A. and the curriculum-based assessment, presented enough evidence to indicate their usefulness and accuracy as tools in the screening process. Specifically, for students' raw scores from the T.O.M.A. assessment, if they earned a 52 or greater, their likelihood of remaining on the accelerated pathway was significant. From the five cohorts, 100% of the students scoring in this range remained on the pathway. The curriculum-based assessment had a comparable indication, although not as strong. For students who scored an 81% or greater on the curriculum-based assessment, there was a high likelihood that they were accurately placed and will remain in accelerated courses through high school. This was determined to be true for 91.2% of the students who scored in this range from the five cohorts.

As previously proposed, if the use of the fifth grade cumulative mathematics average was to be replaced by another tool, there could be financial implications for the district, depending on what would be utilized as the new criterion. If standardized tests were selected, as some teacher participants suggested, there would be no cost to the district to incorporate the results as a measure in the screening process. The assessments are mandated and funded by the state, and comprehensive results are provided to the district on an annual basis. Similar to collecting and utilizing the cumulative fifth grade mathematics averages, an administrator would have to sort and organize the standardized test data to incorporate into the screening process spreadsheet for each cohort. The challenge with incorporating the state standardized test results is the time in which the scores are received compared to when the screening process concludes. Scores have historically come in after the existing screening process has already finished and students have been scheduled for the accelerated courses in sixth grade. If these results were to be included, there may need to be a shift in the completion of the process, communication of results to parents, and the scheduling of these students for sixth grade mathematics. This recommendation of utilizing the standardized test results, however, should not be implemented until further research is conducted. Using the same cohorts of students that were included in this study, a correlational analysis could be completed to compare their achievement levels on the state standardized assessments with their success of remaining in the accelerated pathway. In addition, the district may want to seek out and consider other tools to replace the cumulative fifth grade mathematics average that were not mentioned by the teacher participants.

One measure that should not be used as a potential replacement for the cumulative fifth grade mathematics average, based on research from literature and the teachers' responses to the questionnaire, would be parental input. Parental influence has demonstrated to be an inequitable consideration because it favors students of families from higher economic status (Baker & Stevenson, 1986; Lareau & Shumar, 1996; McGrath & Kuriloff, 1998; Useem, 1992). Additionally, teachers have expressed that when parents have influence in the accelerated placement process, it is not advantageous and the placements do not accurately represent the students' true ability levels (Spear, 1994). None of the 13 teacher participants in this study's questionnaire who provided recommendations on improving the screening process included parent input. Actually, the input that respondents valued the most, which is currently not a part of the process and was mentioned three times, was teacher recommendation. One teacher described this sentiment in an open-ended response by stating, “The teacher ultimately knows what the students are capable of and shouldn’t feel pressured by parent concerns.”

A particular conclusion, not specifically related to a research question, yet one that can be compared to research from literature was how the cumulative average of the students from the first two cohorts in seventh grade compared to their subsequent courses taken in mathematics. Finkelstein et al. (2012) had concluded that a student’s performance in grade seven mathematics is a strong predictor for high school mathematics course selection. When looking at South Fayette’s accelerated population related to the two cohorts that have completed the sequence of courses in this study, a trend similar to that of Finkelstein et al. (2012) was found. Specifically, the results from these two cohorts indicated that students with cumulative averages in the A and A+ ranges in Algebra I are most likely to enroll in the highest level eleventh grade mathematics course of Advanced Placement Calculus AB (Figure 27). Conversely, the number of students who elect to take non-accelerated mathematics courses increases as the cumulative averages in seventh grade occur in the B+, B, and B- ranges. It should be noted that the two students in the A+ range who did not enroll in Advanced Placement Calculus AB were qualified to do so but had elected on their own accord to exit the accelerated pathway.

Figure 27



Note. The comparison of the seventh grade cumulative mathematics averages for students in cohorts 1 and 2 and their course enrollment for eleventh grade mathematics

Limitations

A particular limitation that may have impacted the interpretation of the findings would be that all of the cumulative mathematics grades from the 2019-2020 school year had the potential to be skewed. Due to the global pandemic and the shutdown of schools, South Fayette Township School District elected to implement a “Pass/Fail” grading system for the fourth nine weeks of that school year. If a student earned a “Pass,” that would be equivalent to a 100% average for that grading period. If a student received a “Fail,” that would be equivalent to a 50% average for that grading period. The fourth quarter grade was factored into each student’s overall cumulative average. Therefore, the alignment of the students' cumulative averages to what their actual achievement would have been if the grading system was not impacted could be different.

Another limitation to the study was that all of the open-ended questions were optional for participants to complete. Therefore, some of the results contained less than a 50% response rate from the total participant population. Due to this, the conclusions that were drawn may not be fully representational of all possible responses and perceptions.

The final limitation that existed would be that not all of the cohorts of students involved had progressed far enough to finish the full sequence of advanced mathematics courses. Although two of the cohorts did complete the sequence, the remaining three cohorts only had cumulative averages up to the last course that they finished. Without the completion of all courses by the remaining three cohorts, some of the data related to remaining in the accelerated pathway through Advanced Placement Calculus AB may not be fully accurate and representational of all students. This study, however, was inclusive of all of the cohorts from when this screening process was officially implemented.

The summation of these conclusions will be used to inform the South Fayette Township School District of next steps for their screening process for the placement of students in advanced mathematics. The district should feel validated that, based on mathematical knowledge and skills, the criteria of the screening process was accurately identifying students at a 90.7% rate for advanced placement in courses. However, based on the outcome of student data and teacher feedback, the district may want to consider exploring the replacement of one of the criteria, the cumulative fifth grade mathematics average. Although teachers expressed that they are mostly in agreement with the accuracy of the placement of students, this particular measure was not valued by the teachers, nor did the averages show correlation to the populations of students who remained in the accelerated pathway versus those who exited. Also, these fifth grade mathematics averages did not correlate with the cumulative grade performances students earned in the sequence of accelerated courses following the screening process. The district now also has evidence to inform families about a student's likelihood for success in the accelerated course sequence. The profile of a student with the most success would earn a score greater than a 52 on the T.O.M.A. 3 assessment and greater than 80% on the curriculum-based assessment. Also, the district now has local data that parallels national studies that show a student's performance in Algebra I serves as a predictor for high school mathematics course taking. This can be a useful statistic as students select courses for high school and consider their plans for post-secondary and goal aspirations.

Recommendations for Future Research

With any meaningful research comes the potential for more unanswered questions that are worth investigating as an outcome. That experience occurred with this study, and those unanswered questions led to the following recommendations for future research or considerations. Each of these could be rich, comprehensive studies on their own; however, collectively, they all have potential implications, not only for the success students can experience in the accelerated pathway, but for their likelihood of qualifying for acceleration.

A consideration for additional research would be to analyze the demographics of the students who qualified for the accelerated pathway, as well as those that subsequently exited. Existing research acknowledges that the make-up of students in accelerated courses is imbalanced based on race (Braddock, 1989; Domina, 2014; Gutiérrez, 2008; Lubienski & Gutiérrez, 2008; Webel & Dwiggins, 2019). The races and demographics of students were not considered in this study. However, it would be beneficial to determine if racial divides exist in the composition of the cohorts of students who have qualified for acceleration. Also associated with race, further research could be done relative to the Asian population enrolled in the accelerated course pathway compared to other underrepresented races and to the race representations for the whole student population. The district's Asian population is approaching 20% and has significantly increased over the last ten years, which makes it a particular demographic worthy of studying.

Not only has research indicated that students of color are underrepresented in accelerated courses, it has also been determined that students from higher economic status are two times as likely to take advanced mathematics in middle school than peers from a low economic status (Walston & McCarroll, 2010). South Fayette Township School District has a population of approximately 10.7% of students who are identified as economically disadvantaged. Although this study did not analyze the economic status of the students in the cohorts, there is potential to study how the overall economically disadvantaged population aligns to those of the students who are accelerated.

The focus of the research for this study only incorporated the results of the students who had qualified for acceleration as a result of the screening process. Another potential study could be looking at the data and course sequences for the students who did not originally qualify and how they fared in regular and advanced level courses. This consideration leads to questions such as: How many students who were not originally accelerated take additional measures in order to end up in the highest level of mathematics in high school? How many students move into advanced level courses by the time they complete high school but were in the general mathematics pathway in middle school? Is there need to provide students the opportunity to enter the accelerated pathway after the screening process occurs at the end of fifth grade? This last question is one that is of particular interest as a result of comments in the teacher questionnaire. Four of the teachers expressed in open-ended responses that, through their observations, there have been students who did not qualify for acceleration through the screening process but later demonstrated the maturity and ability to be a part of this exclusive group.

The teachers of the accelerated mathematics courses have not changed significantly over the past eight years. However, there is always potential for changing the assignments of educators, especially at the high school level. Therefore, a possible further study related to students' maintaining their accelerated course status would be to do a comparative study of outcomes related to different teachers. With some courses, this may be difficult because there is only one section and one teacher. The only comparative study that could occur would be if that single teacher changed over time. Research found that, when teachers are assigned to high level courses, they display more enthusiasm and employ a greater set of instructional strategies. Therefore, it may be worthwhile to investigate the impact that different teachers could have as the teacher of the most advanced course in various grade levels (Oakes, 1985, 1992).

Lastly, a recommendation based on this research would be to implement an exit interview or survey for students who elect to exit the accelerated pathway even when they qualify to be promoted to the next advanced level course. Multiple data analyses illuminated the existence of these students, but their reasons for exiting were not incorporated in this study. Should there be a way to gather this information in the future, the results could potentially further inform the screening process. One of the participants in the questionnaire even recommended that the screening process include “an interest questionnaire to assess students’ interest in participating in accelerated/advanced math courses, their willingness to put forth their greatest amount of effort in order to be successful, and their goals as math students.” Research found in literature indicated a variety of outcomes linking students’ self-concept to being accelerated, some that showed positive outcomes for accelerated students while others found negative ramifications (DeLacy, 2000; Gross, 1992, 1994; Olszewski-Kubilius, 1995, 1998; Rogers, 1991; Sayler, 1992; Swiatek, 1992). Self-concept has a potential outcome for the students in this study, even when their grades deem them eligible to advance to the next accelerated course. Additionally, within this potential future research, there is space to examine a possible link between students who exit the accelerated pathway and that decision being based on their plans for postsecondary or career aspirations. Ultimately, are these students leaving the accelerated mathematics pathway because they have determined that they do not need the highest level of mathematics in order to pursue their post-secondary and/or career goals?

Another factor that could contribute to students originally qualifying for accelerated placement but not remaining in the full sequence of courses could be parental influence. The magnitude of parental influence on the screening process and subsequent selection of courses by students could be an additional area for research. Literature indicates that parental involvement, especially by parents of higher economic status, often contributes to students' placement in advanced level courses (Bitter & O'Day, 2010; Hallinan, 2003; Kelly, 2007; Loveless, 1998; Meehl, 1954; Oakes, 1985; Useem, 1992). The South Fayette Township School District's screening process does not currently quantify parental influence, nor does it include parental input as a tool in the screening process. However, based on the researcher's former involvement with the process, the researcher observed parental demands for students to be considered and re-considered for the acceleration when students did not qualify for advanced placement prior to sixth grade.

Summary

The purpose of this study was to examine the screening process the South Fayette Township School District uses to determine advanced mathematics placement of students prior to entering middle school. The process, adopted eight years ago, has impacted the mathematics course pathway of over 2000 students, with 150 students qualifying for accelerated placement. This is the first study that has been conducted to determine the accuracy of the screening process, as well as to determine if the students who originally qualify for advancement remain in the program through eleventh grade. Although the results indicated that almost 91% of the students who qualified for acceleration successfully met the annual requirements to be advanced, the retention rate dropped to about 73% when the students who opted to exit the pathway were added into statistics. This result led to a recommendation for a future study involving the reasons why students choose to exit the accelerated pathway even when they demonstrate the aptitude and grade requirement to continue. Teachers expressed their endorsement of two of the three criteria, excluding the cumulative fifth grade mathematics average. In addition to their feedback, the data did not support this criterion as a strong tool for predicting student success. Therefore, another recommendation is for the district to consider replacing this measure in the screening process. The other two measures, the T.O.M.A. 3 and the curriculum-based assessment, were revealed through this study to be useful as indicators for accurate placement and long-term success based on student data. Overall, and with the consideration that multiple researchers have drawn the conclusion that advanced mathematics placement in middle and high school is linked to college and career readiness and success, coupled with the fact that students cannot reenter the accelerated pathway without exceptional efforts in high school, the district could continue to use its existing screening process. However, the two considerations relative to students choosing to exit the pathway and the lack of correlational value to the cumulative fifth grade mathematics average should be addressed.

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APPENDICES

Appendix A

Teacher Perception Survey

(This is the Action Research Survey that was developed to gather mathematics teachers' perspectives regarding the placement criteria used in identifying students for accelerated mathematics courses.)

Action Research Survey: The Accuracy of the Advanced Mathematics Placement Criteria in Identifying Students for Mathematics Course Acceleration

The mathematics course trajectory for all students as they enter middle school at the South Fayette Township School District is determined by a set of three pieces of criteria used in a screening process at the end of fifth grade. The outcome from this set of criteria can permit or prevent students from enrolling in the highest level of mathematics coursework offered by the district. The intention of this criteria is to accurately identify students for placement in accelerated mathematics courses yet there is no researched evidence supporting such accuracy.

As a teacher of mathematics in sixth through eleventh grade, you have a unique perspective on the outcomes of this screening process, including the success of students. As a result, you are asked to complete this questionnaire as part of a doctoral action research study. Your participation in this questionnaire is voluntary, and you may elect not to complete this survey. If at any time during this questionnaire, you would like to discontinue your participation, you may do so without consequence. None of your data will be received if you choose to discontinue and not submit as the final step of the questionnaire. Participation in this questionnaire presents minimal risk to all participants due to the confidential and secure manner in which responses will be received and maintained digitally through password-protected means. The minimal risk that exists is possible identification through triangulation of identifying data- gender, years of experience, response to teaching accelerated/advance courses.

All responses and results will remain confidential and anonymous, and they will be utilized to research the accuracy of the placement criteria for advanced mathematics from the teacher's perspective. You are asked to respond to the following questions based on your observations of students in your advanced and non-advanced courses over the last seven years which marks the inception of these criteria for the screening process.

This action research study is being conducted by Kristin M. Deichler, a doctoral candidate in the area of Education and Administration Leadership, at California University of Pennsylvania. You may contact Kristin M. Deichler at 412.478.5936 or dei1175@calu.edu with questions related to this research project. Kristin M. Deichler is conducting this research under the leadership of her faculty advisor, Dr. Kevin Lordon. He may be reached at lordon@calu.edu.

Submission of this questionnaire is an indication of consent to use your data and feedback.

The research study and this questionnaire have been approved by the California University of Pennsylvania Institutional Review Board. This approval is effective 09/11/2020 and expires 09/10/2021.

Please identify your gender.

◯ Female

◯ Male

Please identify your teaching certification. *

Short answer text

Please select how many years you have been teaching mathematics at South Fayette Township School District?

- ◯ Less than 10 years
- ◯ 10 to 19 years
- ◯ 20 to 29 years
- ◯ 30 years or more

Have you taught the highest level mathematics course at any of the secondary grade levels in the last seven years (Pre Algebra 6, Algebra 7, Honors Geometry 8, Honors Algebra II, Honors Pre Calculus, AP Calculus AB)?

- ◯ Yes
- ◯ No

Can you identify and name the three criteria used to screen students for student placement on the advanced mathematics course pathway?

◯ Yes

◯ No

How well could you describe the process in which students qualify in order to take the highest level of mathematics courses at each grade level?

1. Not at all
2. Somewhat
3. Well
4. Very well

Based on your teaching level and assigned courses, how important do you think it is that you are familiar with and can describe the screening criteria? *

	1	2	3	4	5	
I do not need to be made aware or familiar with the criteria.	○	○	○	○	○	I should be fully aware and extremely familiar.

The three existing criteria are the Test of Mathematical Ability 3 (TOMA 3)*, a comprehensive curriculum-based assessment of sixth-grade content, and the students' cumulative fifth-grade math averages. These are equally weighted in the screening process. Based on the results gathered from each criterion, which would you select as the most useful in accurate placement of students in accelerated mathematics coursework. *

*The TOMA 3 assessment is a test designed for 8-18 year-olds to assess the major skill areas of mathematics and any deficits that exist. The district elects to use raw data from two sub-tests from the TOMA 3 for its screening process.

○ Test of Mathematical Ability 3 (TOMA 3)

○ comprehensive curriculum-based assessment of sixth-grade content

○ fifth -grade cumulative math average

If you feel that a different tool or specific assessment should be used in place of one of these criteria, please describe it and your rationale. *

Short answer text

If you have taught the highest level mathematics course at a respective grade level in last seven years, please describe how accurate the placement of students seems to be, from your perspective, knowing that the nearly all of the students were in that course because they qualified for advanced placement through the screening process at the end of fifth grade.

	1	2	3	4	5	
Not accurate; all students seemed to be inappropriately placed in advanced level courses	○	○	○	○	○	Extremely accurate; all students seemed to be appropriately placed in advanced level courses

If you felt that students had been inaccurately placed in the highest level mathematics course, please describe the characteristics of such students.

Long answer text

If you have taught mathematics courses that are not at the highest level at each grade level, how often do you find that students in these classes should have been placed in the advanced course sequence? *

	1	2	3	4	5	
Never	○	○	○	○	○	Always

Please describe the characteristics of students that you perceive should have been placed in the advanced course sequence but were not.

Long answer text

Please describe any additional recommendations that you have related to the screening process that may improve the accuracy of student placement and the success that these students' achievement levels.

Long answer text

Appendix B

Student Data Spreadsheet Template

(This provides the headings for each of the data points that were identified in the full spreadsheet for the five cohorts of students that were accelerated. There were 150 students assigned an ID from the five cohorts.)

ID	Raw Point Total-TOMA	Percentage earned on CBA	Cumulative 5th Grade Math Average	TOMA Rubric Points	CBA Rubric Points	Cumulative Average Points	Total Earned Points from Screening Rubric	Pre Algebra Cumulative Average	Algebra I Cumulative Average	Honors Geometry Cumulative Average	Honors Alg II	Honors Pre Calc	AP Calc AB

Appendix C

South Fayette Township School District Approval Letter

(This is the letter of approval to conduct the study within the South Fayette Township School District. This letter was issued by the superintendent of schools.)

South Fayette Township School District

3680 Old Oakdale Road • McDonald, PA 15057-2580
Phone 412-221-4542 • Fax 724-693-2883 • www.southfayette.org

Dr. Kenneth F. Lockette
Superintendent of Schools

Mrs. Stephanie J. DeLuca
Assistant to the Superintendent for Elementary Education

Dr. Jeffrey D. Evancho
Assistant to the Superintendent for Secondary Education

July 23, 2020

Kristin M. Deichler
[redacted]

Dear Kristin Deichler:

I am pleased to write a letter in support of your doctoral capstone project entitled, "The Accuracy of the Advanced Mathematics Placement Criteria in Identifying Students for Mathematics Course Acceleration." The proposed research has significant value for the South Fayette Township School District in examining the legitimacy of current practices for determining appropriate course selection for mathematics.

I have reviewed the project proposal and understand the following related to participation:

- Teacher participation involves completion of survey.
- Participation will be voluntary, and teachers may withdraw from the study at any time.
- Historical data that is collected and utilized will be kept confidential and kept secure via electronic files.
- Confidentiality will be employed through the IRB process

Please accept this letter as my formal consent and support of the district's participation in the proposed research project.

Sincerely,

Dr. Ken Lockette
Superintendent of Schools

Appendix D

Institutional Review Board Approval Application

(This contains the application materials that were submitted to the IRB for approval to conduct the action research study as outlined.)

California University of Pennsylvania

IRB Review Request

Institutional Review Board (IRB) approval is required before beginning any research and/or data collection involving human subjects

Submit this form to instreviewboard@calu.edu or Campus Box #109

Project Title: **The Accuracy of the Advanced Mathematics Placement Criteria in Identifying Students for Mathematics Course Acceleration**

Researcher/Project Director ***Kristin M. Deichler***

Phone # [redacted] ***E-mail Address*** [redacted]

Faculty Sponsor (if researcher is a student) ***Dr. Kevin Lordon***

Department ***Education***

Anticipated Project Dates ___***August 2020***___ ***to*** ___***August 2021***___

Sponsoring Agent (if applicable) ____________________

Project to be Conducted at ___***South Fayette Township School District***___

Project Purpose: ☐ ***Thesis*** ☒ ***Research*** ☐ ***Class Project*** ☐ ***Other***

Keep a copy of this form for your records.

Required IRB Training

All researchers must complete an approved Human Participants Protection training course. The training requirement can be satisfied by completing the CITI (Collaborative Institutional Training Initiative) online course at http://www.citiprogram.org *New users should affiliate with "California University of Pennsylvania" and select the "All Researchers Applying for IRB Approval"course option. A copy of your certification of training must be attached to this IRB Protocol. If you have completed the training within the past 3 years and have already provided documentation to the IRB, please provide the following:*

Previous Project Title ____________________

*Date of Previous Project IRB Approval*____________________

Please attach a typed, detailed summary of your project AND complete items 2 through 6.

1. *Provide an overview of your project-proposal describing what you plan to do and how you will go about doing it. Include any hypothesis(ses)or research questions that might be involved and explain how the information you gather will be analyzed. All items in the Review Request Checklist, (see below) must be addressed.*

2. *Section 46.11 of the Federal Regulations state that research proposals involving human subjects must satisfy certain requirements before the IRB can grant approval. You should describe in detail how the following requirements will be satisfied. Be sure to address each area separately.*
(text boxes will expand to fit responses)

a. How will you ensure that any risks to subjects are minimized? If there are potential risks, describe what will be done to minimize these risks. If there are risks, describe why the risks to participants are reasonable in relation to the anticipated benefits.

Risks will be minimized by actions that are taken by the researcher. Data that is utilized in this research study will be maintained in secure, electronic files that are password-protected, as well as contain no identifying information. All screening process data points will be confidential and anonymous. No children under 18 will be involved in this research. Additionally, for the teacher survey, participation is voluntary and all responses will be confidential and anonymous. The voluntary survey will not collect any email addresses, names, or identifying information.

The confidentiality of the both the data sets and the survey results will minimize any risk presented in this study. The beneficial outcome of validating or making improvements to a screening process used by the South Fayette Township School district that impacts the educational program for all students will outweigh these minimal risks.

Since there will be no in-person or face-to-face encounters or interviews involved in this study, no risk will be present related to COVID-19. The surveys will be electronic and can be completed in a safe environment of the willing participants' choosing.

b. How will you ensure that the selection of subjects is equitable? Take into account your purpose(s). Be sure you address research problems involving vulnerable populations such as children, prisoners, pregnant women, mentally disabled persons, and economically or educationally disadvantaged persons. If this is an in-class project describe how you will minimize the possibility that students will feel coerced.

Since the research is targeted at the criteria used in the screening process for advanced mathematics coursework at the South Fayette Township School District, all teachers of mathematics from the point of screening on will be able to participate in a voluntary survey. No teachers will be excluded or eliminated from having the option to complete the survey, maintaining equity of participants.
Additionally, the data sets that represent multiple cohorts of student performances during the screening process, as well as in academic courses subsequently, will

include all results, anonymously coded, applicable to the problem statement and research questions. Although the research takes into account the data from student performance during the screening process and in academic courses, no children will be involved in this research study. Only data points will be included, which will be gathered, utilized, and analyzed, in a coded, non-identifiable way.

c. How will you obtain informed consent from each participant or the subject's legally authorized representative and ensure that all consent forms are appropriately documented? Be sure to attach a copy of your consent form to the project summary.

Consent would only be necessary for the voluntary survey that will be distributed to the South Fayette Township School District's mathematics teachers in grades six through twelfth. Consent will be obtained from each participant by their submission of responses to the electronic survey. *The consent documentation will be embedded into the electronic survey for documentation purposes before any questions are asked of the participants.*

d. Show that the research plan makes provisions to monitor the data collected to ensure the safety of all subjects. This includes the privacy of subjects' responses and provisions for maintaining the security and confidentiality of the data.

Participants of the electronic survey will have anonymity. The survey will not collect email addresses, names, or identifying information. Also, the results of the survey will be secured through password-protected means in which only the researcher has knowledge and can access. The data sets from the screening process and subsequent math courses will be organized in a confidential, secure spreadsheet. It will be similarly housed electronically in which only the researcher will have the knowledge of a complex password in order to access. All of the data points in the multiple sets will be coded in the spreadsheet.

3. *Check the appropriate box(es) that describe the subjects you plan to target.*

☒ *Adult volunteers*	☐ *Mentally Disabled People*
☐ *CAL University Students*	☐ *Economically Disadvantaged People*
☐ *Other Students*	☐ *Educationally Disadvantaged People*
☐ *Prisoners*	☐ *Fetuses or fetal material*
☐ *Pregnant Women*	☐ *Children Under 18*
☐ *Physically Handicapped People*	☐ *Neonates*

4. *Is remuneration involved in your project?* ☐ *Yes or* ☒ *No. If yes, Explain here.*

5. *Is this project part of a grant?* ☐ *Yes or* ☒ *No* *If yes, provide the following information:*

   Title of the Grant Proposal ____________________

   Name of the Funding Agency ____________________

   Dates of the Project Period ____________________

6. *Does your project involve the debriefing of those who participated?* ☐ *Yes or* ☒ *No*

   If Yes, explain the debriefing process here.

7. *If your project involves a questionnaire or interview, ensure that it meets the requirements indicated in the Survey/Interview/Questionnaire checklist.*

California University of Pennsylvania Institutional Review Board
Survey/Interview/Questionnaire Consent Checklist (v021209)

This form MUST accompany all IRB review requests

Does your research involve ONLY a survey, interview or questionnaire?
YES—Complete this form
NO—You MUST complete the "Informed Consent Checklist"—skip the remainder of this form

Does your survey/interview/questionnaire cover letter or explanatory statement include:

[X_] (1) Statement about the general nature of the survey and how the data will be used?

[X_] (2) Statement as to who the primary researcher is, including name, phone, and email address?

[X_] (3) FOR ALL STUDENTS: Is the faculty advisor's name and contact information provided?

[X_] (4) Statement that participation is voluntary?

[X_] (5) Statement that participation may be discontinued at any time without penalty and all data discarded?

[X_] (6) Statement that the results are confidential?

[X_] (7) Statement that results are anonymous?

[X_] (8) Statement as to level of risk anticipated or that minimal risk is anticipated? (NOTE: If more than minimal risk is anticipated, a full consent form is required—and the Informed Consent Checklist must be completed)

[X_] (9) Statement that returning the survey is an indication of consent to use the data?

[X_] (10) Who to contact regarding the project and how to contact this person?

[X_] (11) Statement as to where the results will be housed and how maintained? (unless otherwise approved by the IRB, must be a secure location on University premises)

[X_] (12) Is there text equivalent to: “Approved by the California University of Pennsylvania Institutional Review Board. This approval is effective nn/nn/nn and expires mm/mm/mm”? (the actual dates will be specified in the approval notice from the IRB)?

[X_] (13) FOR ELECTRONIC/WEBSITE SURVEYS: Does the text of the cover letter or

explanatory statement appear before any data is requested from the participant?

[X_] (14) FOR ELECTONIC/WEBSITE SURVEYS: Can the participant discontinue participation at any point in the process and all data is immediately discarded?

California University of Pennsylvania Institutional Review Board
Review Request Checklist (v021209)

This form MUST accompany all IRB review requests.
Unless otherwise specified, ALL items must be present in your review request.

Have you:
[X_] (1.0) FOR ALL STUDIES: Completed ALL items on the Review Request Form?
Pay particular attention to:

[X_] (1.1) Names and email addresses of all investigators

[X_] (1.1.1) FOR ALL STUDENTS: use only your CalU email address)

[X_] (1.1.2) FOR ALL STUDENTS: Name and email address of your faculty research advisor

[X_] (1.2) Project dates (must be in the future—no studies will be approved which have already begun or scheduled to begin before final IRB approval—NO EXCEPTIONS)

[X_] (1.3) Answered completely and in detail, the questions in items 2a through 2d?

[X_] 2a: NOTE: No studies can have zero risk, the lowest risk is "minimal risk". If more than minimal risk is involved you MUST:

[_] i. Delineate all anticipated risks in detail;

[_] ii. Explain in detail how these risks will be minimized;

[_] iii. Detail the procedures for dealing with adverse outcomes due to these risks.

[_] iv. Cite peer reviewed references in support of your explanation.

[X_] 2b. Complete all items.

[X_] 2c. Describe informed consent procedures in detail.

[X] 2d. NOTE: to maintain security and confidentiality of data, all study records must be housed in a secure (locked) location ON UNIVERSITY PREMISES. The actual location (department, office, etc.) must be specified in your explanation and be listed on any consent forms or cover letters.

[X_] (1.4) Checked all appropriate boxes in Section 3? If participants under the age of 18 years are to be included (regardless of what the study involves) you MUST:

[_NA] (1.4.1) Obtain informed consent from the parent or guardian—consent forms must be written so that it is clear that the parent/guardian is giving permission for their child to participate.

[NA_] (1.4.2) Document how you will obtain assent from the child—This must be done in an age-appropriate manner. Regardless of whether the parent/guardian has given permission, a child is completely free to refuse to participate, so the investigator must document how the child indicated agreement to participate ("assent").

[X_] (1.5) Included all grant information in section 5?

[X_] (1.6) Included ALL signatures?

[NA_] (2.0) FOR STUDIES INVOLVING MORE THAN JUST SURVEYS, INTERVIEWS, OR QUESTIONNAIRES:

[NA] (2.1) Attached a copy of all consent form(s)?

[NA_] (2.2) FOR STUDIES INVOLVING INDIVIDUALS LESS THAN 18 YEARS OF AGE: attached a copy of all assent forms (if such a form is used)?

[NA_] (2.3) Completed and attached a copy of the Consent Form Checklist? (as appropriate—see that checklist for instructions)

[X_] (3.0) FOR STUDIES INVOLVING ONLY SURVEYS, INTERVIEWS, OR QUESTIONNAIRES:

[X] (3.1) Attached a copy of the cover letter/information sheet?

[X] (3.2) Completed and attached a copy of the Survey/Interview/Questionnaire Consent Checklist? (see that checklist for instructions)

[X_] (3.3) Attached a copy of the actual survey, interview, or questionnaire questions in their final form?

[X_] (4.0) FOR ALL STUDENTS: Has your faculty research advisor:

[X_] (4.1) Thoroughly reviewed and approved your study?

[X] (4.2) Thoroughly reviewed and approved your IRB paperwork? including:

[X] (4.2.1) Review request form,

[X] (4.2.2) All consent forms, (if used)

[NA_] (4.2.3) All assent forms (if used)

[X] (4.2.4) All Survey/Interview/Questionnaire cover letters (if used)

[X] (4.2.5) All checklists

[X_] (4.3) IMPORTANT NOTE: Your advisor's signature on the review request form indicates that they have thoroughly reviewed your proposal and verified that it meets all IRB and University requirements.

[X] (5.0) Have you retained a copy of all submitted documentation for your records?

The Doctoral Capstone Project Proposal

Identifying Information

a. Doctoral Student Name: **Kristin M. Deichler (email: dei1175@calu.edu)**
b. Proposed Doctoral Capstone Project Title: **The Accuracy of the Advanced Mathematics Placement Criteria in Identifying Students for Mathematics Course Acceleration**
c. Doctoral Capstone Project Committee
   Faculty Capstone Committee Advisor: **Dr. Kevin Lordon (email: lordon@calu.edu)**
   External Capstone Committee Member: **Dr. Jeffrey Evancho**
d. Anticipated Doctoral Capstone Project Dates: __**August 2020**________ to _**August 2021**______

Description of what you plan to research (problem statement)

The mathematics course trajectory for all students entering middle school is determined by a set of three pieces of criteria at the end of fifth grade. The outcome from this set of criteria can permit or prevent students from enrolling in the highest level of mathematics coursework. The intention of this criteria is to accurately identify students for placement in accelerated mathematics courses yet there is no researched evidence supporting such accuracy.

Description of why this problem is in need of research.

This problem needs to be researched because there has never been a study done to determine if the placement criteria accurately identifies students at an early grade level for math advancement. Since the qualification process is an exclusionary academic decision prior to middle school, the research will be informative to determine if the criteria are accurately identifying the mathematics placement of students.

The three pieces of criteria include: cumulative grade average for fifth grade mathematics, the raw cumulative score from two subtests from the Test of Mathematical Ability (T.O.M.A. 3), and the percentage correct on a comprehensive, summative assessment based on the general sixth grade mathematical course. Since these three criteria are from different sources and are on different scales, the performances on each are converted to points ranging from 0 – 5, and students earn a total out of 15 points.

Description of how you plan to go about doing your action research (research method)

This research will be conducted through a mixed methods approach. One of the ways in which both descriptive and quantitative research will be conducted is through survey research of the mathematics teachers. These district teachers, from grades five to twelve, will be asked to complete a survey on their perceptions of the accuracy of the accelerated placement criteria based on their observations of student achievement in their courses. The remaining research will quantitative in nature and will be done to determine the accuracy of the advanced mathematics placement criteria, as well as the potential pattern between three criteria and likelihood for predicting a student's success in math advancement. The research will occur for multiple cohorts of students who were screened through identical accelerated placement criteria prior to entering sixth grade.

A thorough Literature Review will occur in the fall of 2020 as the researcher completes a course (EAL 706) which is focused on this comprehensive process. The collection of literary evidence will be included in this research project.

Research Questions

Is the screening process for advanced mathematics coursework accurately identifying students for acceleration based on the criteria?

Do teachers perceive that students are accurately placed in advanced mathematics courses based on the qualification process that occurs prior to the start of sixth grade?

Of the three criteria used in the screening process, does a pattern exist as to a certain criterion indicating a greater likelihood of success in math advancement?

Explanation of how you plan to collect your data for each of the research questions. (Include attachments of data collection instruments i.e. surveys, interview questions)

1) Use of collected data from multiple past cohorts of students relative to their placement in the advanced mathematics course in sixth grade, as well as their successful completion (earned at least an 80% cumulative average) in the subsequent advanced course sequence through junior year. The collected data will stop at the junior year in order to be valid because the district's graduation requirement is a minimum of three years of mathematics courses. The data may also reveal if there is a "drop off" point in which the greatest number of students identified for acceleration do not continue on the advanced course pathway. (Research Question 1 and 3).

   A spreadsheet will be built for each cohort of students included in the study. The spreadsheet will have columns that have their results from each of the three criteria, their overall score in the screening process, and each of their subsequent math courses with the cumulative grades for each.

2) Use the results of a survey given to district mathematics teachers regarding their perception of the accuracy of the current placement indicators based on their observations of students in advanced mathematics courses (Research Question 2 and 3).

Develop a timeline for data collection.

July – August 2020	• Seek necessary approvals (IRB, School District) related to developed survey and use of district data • Gather data from past years related to students' math acceleration and long-term math coursework
August- October 2020	• Gather multiple literary sources and pieces to review and include in a literature review related to the topic and research • Organize literature and execute a thorough review • Distribute survey for mathematics teachers to complete

October-December 2020	• Organize, sort, and outline the collection of various data points in preparation for data analysis
January – April 2021	• Analyze and interpret data from both spreadsheet and teacher surveys • Begin to develop tables, charts, and graphs related to analyzed data
May – July 2021	• Embed data into written portion of research project, articulate findings, and develop recommendations
July-August 2021	• Share and present research and findings

Explanation of how you plan to analyze your data

This action research plan is data-heavy and will consist of numerous spreadsheets, charts, tables, and/or graphs. There will be multiple cohorts of students on detailed spreadsheets revealing their placement scores, as well as subsequent math courses and cumulative averages. This data will be analyzed for correlations as proposed in Research Q1 and Q3. Also, the data collected from the surveys completed by district mathematics teachers will be analyzed for magnitudes of similar responses and how their responses may also correspond with Research Q2 and Q3 and triangulate with the data from the screening criteria.

Appendix E

First Response from the Institutional Review Board

(This was the first response received from the IRB indicating that there were issues that needed to be addressed in order for approval to be obtained.)

Institutional Review Board
California University of Pennsylvania
Morgan Hall, 310
250 University Avenue
California, PA 15419
instreviewboard@calu.edu
Melissa Sovak, Ph.D.

Dear Kristin,

The IRB is in the process of reviewing your proposal titled "The Accuracy of the Advanced Mathematics Placement Criteria in Identifying Students for Mathematics Course Acceleration." (Proposal #19-079) the following issues have arisen:

Please resubmit the following:

The researcher states the following from various parts of the proposal:

- *No children under 18 will be involved in this research*
- *Gather data from past years related to students' math acceleration and long-term math coursework*
- *The research will occur for multiple cohorts of students who were screened through identical accelerated placement criteria prior to entering sixth grade.*

As many of the high school seniors will only reach their 18th birthday throughout the school year, I believe that Parental Consent Forms are needed. We are dealing with the math performance records of students going back several years. Before any data on any student can be obtained for this research, I feel that parental consent must be obtained. This would apply to all students for which data is collected --- not just the students who were accelerated.

Adult volunteers are part of the Survey portion of this research, but Children Under 18 are involved in the Data Collection.

3. *Check the appropriate box(es) that describe the subjects you plan to target.*

☒ *Adult volunteers*	☐ *Mentally Disabled People*
☐ *CAL University Students*	☐ *Economically Disadvantaged People*
☐ *Other Students*	☐ *Educationally Disadvantaged People*
☐ *Prisoners*	☐ *Fetuses or fetal material*
☐ *Pregnant Women*	☒ *Children Under 18*
☐ *Physically Handicapped People*	☐ *Neonates*

Also:

-The teacher survey portion of the study basically appears to meet OHRP and CALU IRB requirements, However, the consent form should be edited to include a statement that although responses are kept confidential, there is a risk that individuals could be identified by triangulation of identifying data—e.g. gender, certifications held, grades taught, courses taught.

-The researcher states that no children under 18 will be involved in the study. However-mention is made of accessing student performance data sets which is contradictory to that statement. There is no explanation of what data is being obtained and how detailed it is, etc. No mention is made of obtaining parental consent or student assent for student data to be used in this study. These items need to be clarified.

Please respond to these issues so the Board may continue its review. Email responses (with attachments as needed) are preferred. If hard copies are submitted in response, they must be sent to Campus Box #109.

If you have any questions or comments, do not hesitate to contact me.

Melissa Sovak, Ph.D.
Chair, Institutional Review Board

Appendix F

Researcher's Response to Institutional Board Review Request

(After issues were outlined in the first response from the IRB Chair, this is the researcher's response, including revisions and further clarification to appeal to IRB Chair's request.)

Dear Dr. Sovak,

Thank you for reviewing my research proposal. In response to the issues that have arisen, I am responding with and providing the following:

In regards to the use of student data, the district has granted permission to use the data identified for this study. The reason that it was stated that no children under 18 would be involved is because no students will be interviewed, questioned, or actively participating in the study. The researcher will strictly be using data points only for which no identifying information relative to any student will ever be revealed or used in the study, nor included by the researcher. Additionally, the researcher will have a district-level administrator code every student who would have data used in this study so that, prior to the researcher using any of the students' data, the researcher will not have names and will be independent of any identifying information. Based on not having nor using identifying information related to the student data, the researcher does not believe that parent consent or student assent is necessary.

The data that is proposed to be obtained is the accelerated students' scores on the qualifying criteria (3 pieces of criteria and 3 scores), as well as their cumulative grade average in each of the subsequent accelerated math courses after qualifying for this advanced mathematics track. The details that are included would be a coded identification for each student (no name), the numeric score for each of the three criteria, the equivalent points earned for each of these criteria based on the district's point system for qualification, and the cumulative grade percentage for each subsequent accelerated math course for each student.

Relative to the consent form for the teachers including a statement about triangulation, it has been added to the Google Form. This is evident in the highlighted statement that was added to the consent form: (Link t Full Consent Form and Survey: https://forms.gle/aEvgAPFXWfaVpCmR9)

Action Research Survey: The Accuracy of the Advanced Mathematics Placement Criteria in Identifying Students for Mathematics Course Acceleration

The mathematics course trajectory for all students as they enter middle school at the South Fayette Township School District is determined by a set of three pieces of criteria used in a screening process at the end of fifth grade. The outcome from this set of criteria can permit or prevent students from enrolling in the highest level of mathematics coursework offered by the district. The intention of this criteria is to accurately identify students for placement in accelerated mathematics courses yet there is no researched evidence supporting such accuracy.

As a teacher of mathematics in sixth through eleventh grade, you have a unique perspective on the outcomes of this screening process, including the success of students. As a result, you are asked to complete this questionnaire as part of a doctoral action research study. Your participation in this questionnaire is voluntary, and you may elect not to complete this survey. If at any time during this questionnaire, you would like to discontinue your participation, you may do so without consequence. None of your data will be received if you choose to discontinue and not submit as the final step of the questionnaire. Participation in this questionnaire presents minimal risk to all participants due to the confidential and secure manner in which responses will be received and maintained digitally through password-protected means. The minimal risk that exists is possible identification through triangulation of identifying data- gender, years of experience, response to teaching accelerated/advance courses.

Thank you for your consideration,

Kristin M. Deichler

Appendix G

Approval from Institutional Review Board

(This is the letter of approval that was received after the researcher made revisions to address the initial issues with the proposal.)

Institutional Review Board

California University of Pennsylvania

Morgan Hall, 310

250 University Avenue

California, PA 15419

instreviewboard@calu.edu

Melissa Sovak, Ph.D.

Dear Kristin,

Please consider this email as official notification that your proposal titled "The Accuracy of the Advanced Mathematics Placement Criteria in Identifying Students for Mathematics Course Acceleration" (Proposal #19-079) has been approved by the California University of Pennsylvania Institutional Review Board as submitted.

The effective date of approval is 9/11/20 and the expiration date is 9/10/21. These dates must appear on the consent form.

Please note that Federal Policy requires that you notify the IRB promptly regarding any of the following:

(1) Any additions or changes in procedures you might wish for your study (additions or changes must be approved by the IRB before they are implemented)

(2) Any events that affect the safety or well-being of subjects

(3) Any modifications of your study or other responses that are necessitated by any events reported in (2).

(4) To continue your research beyond the approval expiration date of 9/10/21 you must file additional information to be considered for continuing review. Please contact instreviewboard@calu.edu

Please notify the Board when data collection is complete.

Regards,

Melissa Sovak, PhD.

Chair, Institutional Review Board

Appendix H

Current Screening Process Rubric

(This is the current rubric used for the screening process of accelerated mathematics placement in the South Fayette Township School District. This rubric applies to the raw scores associated with the Third Edition of the Test of Mathematical Ability (T.O.M.A. 3). This rubric applied to the three most recent cohorts of accelerated students used in this study.)

Pre-Algebra 6 Placement Criteria

	5	4	3	2	1	0
T.O.M.A. Assessment (Computation ONLY)	Raw score of 56 or greater	Raw score of 53-55	Raw score of 50-52	Raw score of 47-49	Raw score of 44-46	Raw score of 43 or less
Curriculum Based Assessment (Math Functions 6)	93 – 100%	83 – 92%	73 – 82%	65- 72%	50 – 64%	49% or lower
Cumulative Percentage Math 5	98 – 100 A+ range	93 -97 A range	90 – 92 A- range	N/A	N/A	89 and below

Appendix I

Initial Screening Process Rubric

(This rubric was used for the first two cohorts and included the raw scores from the Second Edition of the Test of Mathematical Ability (T.O.M.A. 2). The distribution of rubric points based on raw scores earned are different in this rubric than the current version that is used. This rubric was used for the first two student cohorts that were a part of this study.)

Pre-Algebra 6 Placement Criteria

	5	4	3	2	1	0
T.O.M.A. Assessment (Computation ONLY)	Raw score of 42 or greater	Raw score of 40-41	Raw score of 38-39	Raw score of 36-37	Raw score of 30-35	Raw score of 29 or less
Curriculum Based Assessment (Math Functions 6)	93 – 100%	83 – 92%	73 – 82%	65- 72%	50 – 64%	49% or lower
Cumulative Percentage Math 5	98 – 100 A+ range	93 -97 A range	90 – 92 A- range	N/A	N/A	89 and below