Math College Readiness: A Case Study at a Small Parochial School

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Abstract

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College readiness is a challenge for numerous college-bound students in the United States. A recent high school graduate or returning to school student has to contend with collegiate curricula, unfamiliar faculty, and new peers at a foreign institution. Therefore, acclimating to the new environment and new routine of college is necessary for a student's success. A natural question that begins to arise is whether or not this experience is different for various subjects and disciplines. Mathematics is among one of the main disciplines in which college readiness is a main concern. Further complicating the situation, a true definition of college readiness is yet to be agreed upon.

This qualitative study investigates the perceptions of math college readiness (MCR) of ten participants at a small parochial school. A purposeful sample of three types of individuals participated in the study. In particular, it documents teachers', administrators', and alumni's experiences and how these experiences connect to their definitions of MCR. The primary data collection method was semi structured interviews and observations.

Three main ideas emerged from the data relating to the definition of MCR: (1) content, (2) student behavior, and (3) school culture. Specifically, the cumulative characteristic of mathematics requires that gaps in knowledge need to be addressed as early as possible to ensure mastery. Student's behavior allows for the material to be absorbed more efficiently. School culture plays a role in how this environment is formed in which students become learners and citizens in their community.

Investigating how MCR is perceived can shed light on how we will better address the needs of a body of students in mathematics remediation. By examining the learning of mathematics we are offered an opportunity to explore the issues to better understand a remedy. This study provides recommendations for other practitioners in mathematics education.

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Mathematics College Readiness: A Case Study at a Small Parochial High School

Chapter 1--Introduction

Introduction

Every year, about three and a half million students in the United States graduate high school with a large majority of them pursuing college careers for the next two to four years of their lives (NCES 2019). Attending college and obtaining a postsecondary degree is correlated with higher income and increased employment rates and thus an important endeavor for many students (Baker, Klasik, & Reardon, 2018). Several presidents have implemented policies in order to promote postsecondary studies such as the federal student aid system, college preparation programs, and increasing accessibility for students (Lederman & Fain, 2017).

After observing an increase in attrition rates, President Obama proposed that the United States strive to become the nation with the highest proportion of college graduates. In more recent times, the Trump administration believed that colleges and higher institutions should become more aligned with the needs of the nation's workforce (Camera, 2019). Research has found that by 2025 the number of jobs in the United States requiring postsecondary education will be approaching as much as 66% (Carnevale et al., 2015). As such, with the increasing number of students enrolling in postsecondary studies (NCES, 2019), the need to ensure college readiness is evident.

Since the majority of colleges and universities support a liberal arts education, most students will inevitably have to satisfy a mathematics requirement at some point in their academic career. Unfortunately, a number of students who embark on their postsecondary studies are underprepared and are at risk to be placed into a remediation course that often bears no credit. Studies suggest that students who are placed into mathematics remediation experienced difficulty in their secondary mathematics courses when problem-solving with algebra (Mathai, 2014; National Council of Teachers of Mathematics, 2000). Even if students manage to achieve passing scores in their high school mathematics, this does not imply adequate preparation for the rigor of a postsecondary mathematics course (Benken et al., 2015). As a result, the secondary-postsecondary transition has become a major point of investigation (Jackson & Kurleander, 2014).

Research finds that more students are placed into mathematics remediation compared to English remediation (Attewell et al., 2016; Bailey et al., 2010; Bonham & Boylam, 2011). Bailey (2009) found that upon admission, over 60% of community college students across the United States are placed into a remedial mathematics course. Moreover, other research finds that one third of these students do not graduate college nor move on to higher level mathematics and thus, remedial coursework becomes an obstacle for graduation (Bahr et al., 2010; Bonham &Boylan, 2011; Harrington & Rogalski, 2020; Sreenivasan & Woodruff, 2019). Literature also suggests that students who are placed into mathematics remediation courses experience greater difficulty in completing their postsecondary studies (Burley et al., 2009). Consequently, mathematics has become the focal point of concern for college bound high school graduates (Proctor, 2011).

Placement into a college mathematics remediation course indicates a lack of mathematics college readiness acquired at the secondary level. Accordingly, secondary teachers carry the responsibility to prepare students for college in their subject areas (Duncheon & Munoz, 2019; Kolluri, 2018). However, since there is no consensus regarding a definition of college readiness amongst educators and policymakers (Conley, 2015; Duncheon & Munoz, 2019; Floyd, 2016), this becomes a difficult task for teachers to accomplish.

The United States Department of Education under the Obama Administration focused on ensuring “college and career readiness”, indicating that a medley of factors is necessary for postsecondary success (U.S. Department of Education, 2010). Researchers have begun to define the meaning of college readiness by using cognitive and non-cognitive factors (An & Taylor, 2015; Conley, 2011). Specifically, Conley (2011) identifies four dimensions of college and career readiness: (1) key cognitive strategies (i.e. behaviors that are conducive to understanding, retaining, analyzing, etc.), (2) key content knowledge, (c) academic behaviors (time management skills, attitudes, and habits required for contending with academic rigor in a college setting) and (d) contextual skills and awareness (i.e. college specific information such as admissions and financial aid processes and the culture).

Compounding the issue further, professional development programs do not advance the notion of college readiness, and teachers are found relying on their notions, beliefs, and judgements to prepare their students for postsecondary studies (Moore, 2020). This implies a need for school leaders and educators to have a clear meaning of mathematics college readiness, as well as reliable indicators and factors to help teachers better prepare students.

Teachers, administrators, and parents may use benchmarks set forth by standardized exams such as the ACT and SAT in specific subject areas as a means of measuring college readiness. According to these organizations, scoring at or above the benchmarks indicates a high probability of success in a credit-bearing first year college course (American College Testing, n.d.; College Board, n.d.). According to the ACT, 49 percent of students who took the ACT in 2020 achieved a national composite score of 20.6, the lowest average the nation has seen in ten years (ACT, 2020). More specifically, only 37 percent of students nationwide met the college mathematics readiness benchmark (ACT, 2020). The dwindling achievement numbers appear to suggest that changes should be made in the way mathematics is taught at the secondary level (Gewertz, 2018).

Based on these standardized exams, teachers are tasked with interpreting the necessary skills, habits, and mindsets that are necessary to achieve their goals while still operating on a nebulous definition of mathematics college readiness. Despite the importance of investigating teachers' understanding of the meaning of mathematics college readiness, research on teachers' perceptions in general are sparse (Duncheon & Munoz, 2019).

Two other important stakeholders to consider in the exploration of mathematics college readiness are school administrators and students. To ensure a productive and successful school, administrators play a vital role with duties ranging from evaluating curriculum to maintaining student discipline (Bruens, 2020). As a result, high school administrators possess crucial information due to their direct holistic involvement with the school. Their beliefs, perceptions, and input serve as an invaluable contribution to the growing body of educational research (Gentry & Owen, 1999). Lastly, students possess a unique perspective and first-hand account of their transition.

Overall, high schools carry a particularly important responsibility to prepare students for their future academic endeavors. Without a solid foundation of the skills that postsecondary studies demand, the transition students experience may be a tumultuous one (Schudde & Keisler, 2019). Investigating a school in depth becomes an important task in understanding and tackling the math college readiness issue at hand.

After researching the type of school for this study, parochial schools were selected. Although research on parochial schools is quite sparse (Stevens & Ritten, 2022), Waasdorp et al. (2018) found that parochial schools provide a better quality education as compared to their public school counterparts. Another study found that parochial schools prepare students for postsecondary studies and highlights positive relationships and collaborative, engaging environments as key features (Fontenot, 2017). More specifically, three important characteristics that are at the heart of the parochial schools are (1) relationships, (2) culture, and (3) community (Carpenter-Aeby, Aeby & Raynor, 2012; Cook & Simonds, 2011; Fontenot, 2017; Sultmann & Brown, 2014).

Lastly, literature also suggests that since remediation is at the intersection of secondary and postsecondary mathematics, investigating secondary school is of much importance (Bahr, 2008). Current research explores teachers', students', and administrators' perceptions of college readiness and contributes to the understanding in the field (Fontenot, 2017; Evans, 2019; Moore, 2020). However, there is still a limited amount of research with regards to subject specific college readiness at the secondary level in parochial schools. Moreover, school culture as it relates to its abilities to prepare students for college mathematics at parochial schools has been scarcely investigated.

Purpose

The purpose of this qualitative case study is to describe and identify teachers', administrators', and students' perceptions of factors that promote mathematics college readiness at a small parochial school. This study also seeks to understand the types of support at a small parochial high school that prepare students for college mathematics. This study seeks to demonstrate the applicability of Conley's Four Dimension paradigm in the context of mathematics.

RQ1: How do teachers, administrators, and alumni perceive math college readiness?

RQ2: What effect do teachers, administrators, and alumni perceive that parochial school education has on math college readiness?

Theoretical Framework

After reading a large body of literature, three theoretical frameworks were chosen to guide the study: (1) Kocher's Misalignment Perspective, (2) Conley's Four-Dimensional Model (2010), and (3) Vygotsky's Sociocultural Theory. Each of the framework provides a specific perspective that is used for this investigation. Vygotsky's Sociocultural Theory will be used to examine external factors relating to the development of math college readiness, whereas Kocher's Misalignment Perspective and Conley's Four-Dimensional Model will be used for further examination of internal factors.

Vygotsky's Sociocultural Theory serves as the overarching idea of investigating the school in depth for math college readiness. This framework suggests that cognitive development is a function of experiences and cultures (McBride, 2011). According to Vygotsky, for learning to occur, social interactions with others in the community are necessary (Kurt, 2020). For teachers, this may impact their teaching and pedagogy; for students this may influence their learning and understanding; and for administrators, this may affect their leadership and decision making. Accordingly, it is evident that all three groups in this parochial school community may prove invaluable in the further understanding of college readiness.

Refinement of the math college readiness investigation at a school is accomplished by Kocher's Misalignment Perspective. The framework identifies three key factors of college readiness: (1) social/behavioral, (2) learning/teaching, and (3) expectations/curriculum. The intersection of the three key factors of college readiness is essential for adequate preparedness

(Kocher, 2017). Kocher (2017) suggests that students experience a turbulent transition into their postsecondary studies due to a possible misalignment of the three key aforementioned factors. Examining Kocher's intersection of students and secondary school, learning/teaching, provided the initial impetus for investigation.

Additional refinement of math college readiness is achieved using Conley's Four-Dimensional model. Conley's framework provides four components for students' college and career readiness: (1) key cognitive strategies, (2) key content knowledge, (3) academic behaviors, and (4) contextual and awareness skills (Conley, 2007, 2010, 2014; Lombardi et al., 2011). Within Conley's framework, students are required to develop and engage at a level that meets college expectations to be successful in postsecondary studies.

Procedures

Qualitative research is an "inquiry process" with the objective of learning and understanding a problem in a particular environment. Understanding is attained through a combination of investigation, analysis, and reporting on the views of participants in the study. (Creswell, 1998). According to Yin, a case study "is an empirical method that investigates a contemporary phenomenon in depth and within its real-world context, especially when the boundaries between phenomenon and context may not be clear" (Yin, 2018, p.15). Thus, a qualitative case study is best suited to aggregate learnings through the perspectives of the teachers, administrators, and students to further understand the mathematics college readiness phenomenon within the context of a parochial school.

Purposeful selection is another important component to consider when engaging with qualitative research. Before the data collection process, the researcher should establish the method of selection which includes the rationale of choosing the participants, site(s), documents, etc. (Creswell & Creswell, 2018). This selection process relies predominantly on the ability of the researcher to choose participants who may provide answers to the research questions (Mertler, 2018).

The participants of the study include teachers, administrators, and students. At the school in question, all high school mathematics teachers and administrators will be asked to participate Students will be asked to participate based on the following selection criteria: (1) are graduates of the high school, (2) have had at least one teacher from the mathematics department at the high school, and (3) took or are currently enrolled in a postsecondary mathematics course. An email will be sent out to cohorts of graduated classes to request their participation.

The next stage in the research process involves data collection. Qualitative data collection takes four forms: (1) observations, (2) interviews, (3) document review, and (4) audiovisual and digital material review (Creswell & Creswell, 2018). During observations the researcher takes field notes that capture the views and perceptions of the participants (Creswell & Creswell, 2018) as well as provide information about the culture of the school (Yin, 2018). Researchers may also utilize qualitative interviews to elicit opinions and perceptions of participants (Creswell & Creswell, 2018; Yin, 2018). Qualitative document review is a procedure that involves careful document collection analysis, and interpretation of the data with the objective of further developing ideas and themes of specific populations (Lankshear & Knobel, 2004).

For this study, observations, interviews, and document review are suitable sources of data collection. More specifically, the study employs three forms: (1) observations of secondary mathematics classrooms, (2) questionnaire and interviews with graduated students, secondary mathematics teachers, and administrators, and (3) analysis of documents such as institutional data, course syllabi and lesson plans. An observational and document template was adapted from

Billups (2021) with the expectation of maintaining a systematic method of gathering pertinent data. An interview protocol was also developed using the template provided by Billups (2021) to ensure consistency in the collection of data.

To maintain reliability and validity, triangulation of the data will occur via interviews, institutional documentation, and direct observations. A reliable, valid instrument developed by Moore (2020) will be used in the questionnaire and interview questions for teachers. Interview questions for administrators and students were created based on Moore's study (2020). The first draft of questions is structured in a similar format, which include changes that consider the type of participant, i.e., student or administrator. A first draft of the questions will be submitted to a panel of experts for review, with revisions made based on feedback.

Before conducting the interviews, the theoretical frameworks will be reread carefully, notes will be written with detail, and several key concepts will be identified. Upon retrieval of the concepts, two independent colleagues will perform the same task to ensure validity of the codes. An 80% match will be used as a benchmark for verification. The key concepts serve as a lens after data collection. After the coding phase during the study, the researcher will determine how the codes align with the larger themes generated from the theoretical frameworks. All outliers will be reported, inspected, and further analyzed.

To answer research question 1 and 2 , teachers, administrators, and alumni will be contacted for their participation in the study. Subsequently, one-hour interviews will be conducted, and audio recorded where participants may elaborate on their approaches to areas that pertain to college math readiness as well as areas of concern for post secondary mathematics transition. Graduates of the parochial school will be contacted for semi structured individual interviews to gather their perceptions of their own post-secondary mathematics transition.

Teachers will subsequently be contacted to schedule classroom observations in an effort to triangulate the data collected from the interviews and document review. Classroom observations will take place to explore the ways in which teachers implement techniques, utilize school resources, and develop a college-going culture. Lastly, data collection of high school mathematics course syllabi, lesson plans, and teacher evaluations will complete the triangulation. In addition, students may self-report their post secondary mathematics course grade if available.

After gathering a large body of data, the researcher may proceed to the inductive analysis stage. During this stage, the researcher is tasked with reducing the data by “coding”. Coding includes identifying patterns and themes without “minimizing, distorting, oversimplifying, or misinterpreting” the data (Creswell & Creswell, 2018; Mertler, 2019, p. 181). Coded themes may include those that are expected and surprising (Creswell & Creswell, 2018). Codes that are expected are anticipated from the literature review, while surprising codes are not able to be anticipated prior to the study (Creswell & Creswell, 2018).

Using the lens of Conley’s Four Dimension Model common themes and ideas of math college readiness will be identified using the devised pattern matching according to the theoretical proposition of Kocher’s (2017) framework. The two frameworks concern research question 1. In particular, course syllabi, lesson plans, class handouts, and interviews will be reviewed to obtain the strategies and activities for math college at this school. Subsequently, to answer research question 2, the lens of Vygotsky’s framework, classroom observations will be used to investigate the culture and community of the school. Data from all three sources will be coded, which will then be examined for alignment with the theoretical framework ideas and themes. With this analysis, the expectation is to bring together the teachers’, administrators’, and students’ perceptions of college readiness and the selected theoretical propositions from the literature.

Chapter 2

Review of Literature

The literature review in this chapter consists of five main sections. The first section gathers current definitions of college readiness, presents various predictors of college readiness, and explores several variables pertinent to college placement. Since college readiness can also manifest as the need for remediation, the second section contains an overview of the college remediation situation in the United States, with a focus on mathematics. The third section explores relevant research involving college and secondary mathematics with a focus on content and pedagogy as it relates to math college readiness. The fourth section provides an overview of private schools and their unique qualities. The fifth section details the necessary framework for the study by discussing three theories: Kocher's (2017) misalignment perspective, Vygotsky's (1987) sociocultural theory (and the zone of proximal development, and Conley's (2007) four-dimensional model.

College Readiness

Research indicates that developing a definition of college readiness requires identification of the major components, criteria, and formal terminology (Baker et al, 2005; Conley, 2007). Several researchers have set forth definitions that encompass the meaning of college readiness. Baker et al. (2005) suggest that college readiness consists of three elements: college awareness (educating parents/guardians and students on a timely basis on college procedures), college eligibility (satisfying college perquisites), and college preparation (students preparation of emotional, social, ad academic skills) (p. i). Kurlaender et al. (2019) define college readiness as a "dynamic process between choices, actions, and beliefs bounded by structural constraints in opportunities often at the school level" (p. 1). In addition, Kurlaender et al. (2019) conceptualize college readiness as a function of four variables: (a) aspirations and beliefs, (b) academic preparation, (c) knowledge and information, and (d) fortitude and resilience. Schools are thus directly responsible for promotion and development of these cognitive and noncognitive factors before their students progress to postsecondary studies (Kurlaender et al., 2019).

Regarding the specific terminology required for engaging in mathematics, Pimm (1987) asserts that learning mathematics should be viewed with the lens of how a mathematician speaks mathematical language. With the perspective of mathematics as a language, Pimm (1987) acknowledges that mathematics borrows terms from the English language as well as mathematic specific terms/phrases that are only applied in its domain. Thus, a learner must learn when and how to use the appropriate grammar while considering the context surrounding the mathematical ideas.

Initiatives for College Readiness

The concept of college readiness emerged in the 1990s, when several states devised a set of standards to help students ascertain their level of college readiness (Conley, 2017). Since then, a number of studies—such as Crossroads, Standards for Success, the Vision Report, and the American Diploma Project—have provided guidance and standards to avoid the pathway into remedial mathematics courses (Golfin et al., 2005).

The most recent initiative has been the Common Core State Standards in Mathematics (CCSSM), which provides a guide for students to successfully transition to nonremedial postsecondary mathematics (ACT, 2010; Kamin, 2016). Within the CCSSM, the Standards for Mathematical Practice provide further refinement of the "habits of mind" students should adopt (Kamin, 2016, p. 53). The eight Standards for Mathematical Practice in the CCSSM are as follows:

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

Researchers investigating the degree of alignment between the CCSSM and college readiness have reported conflicting results, strengthening the argument that a definition of college readiness has yet to be determined (Abhari, 2018; Kamin, 2016).

Academic Rigor in High School

Academic rigor at the secondary level plays a critical role in the preparation of high school students for postsecondary studies (ACT, 2006; The Education Resources Institute, 2007; Pierson, 2015), and educators achieve academic rigor through curriculum content and instructional strategies (Epps, 2019). However, critics have drawn attention to the lack of rigor at the high school level and the exceptionally poor mathematics skills possessed by students when they enter high school (Nomi & Allensworth, 2009).

Engaging students with rigorous coursework requires focus in classes on content, fostering cognitive abilities, and instilling important learning habits (The Education Resources Institute, 2007). Successful implementation of a rigorous curriculum requires individualized instruction adapted to the needs of each class (The Education Resources Institute, 2007). Establishing rigor is a process in which a teacher actively engages students to increase the "depth, complexity, sophistication, and novelty of thinking" alongside the learning process (Epps, 2019, p. 51). Measuring academic rigor at the secondary level can be difficult because of its multidimensionality, which consists of a mixture of a students' course history and level of difficulty, the instruction, student behavior and engagement, and alignment with postsecondary expectations and norms.

In mathematics, a rigorous curriculum includes higher level mathematics and advanced courses such as Advanced Placement and dual enrollment (O'Brien & Devarics, 2012). American high school students have been taking more mathematics courses before postsecondary study than students did in the late 1970s (Schneider, 2009). Researchers have reported conflicting results regarding whether increasing the rigor of high school mathematics courses and exposure to more difficult courses improves mathematics college readiness (Norman et al., 2011; Lakhani, 2018; Pierson, 2015; Schneider, 2009).

Predictors and Metrics of College Readiness

Counselors, parents, and schools have tended to use certain predictors to determine whether students are ready to tackle college courses. High school transcripts have been among the most common predictors (Eafford, 2015). In most instances, universities use course titles, numbers of credit hours, and GPAs on high school transcripts to determine level of rigor and extent of secondary school courses (Eafford, 2015). However, achieving consistency across all secondary schools is difficult, so using high school transcripts as a sole predictor may be flawed (Porter & Polikoff, 2012).

Standardized exams have also been commonly used predictors of college readiness, especially the SAT and ACT, first introduced in 1926 and 1959, respectively (Nettles, 2019; Porter & Polikoff, 2012). The College Board (responsible for the SAT) and ACT have created benchmarks students can use to determine whether they have achieved college readiness in subject areas such as English, mathematics, writing, and science (ACT, n.d.; College Board, n.d.). For the SAT and ACT benchmarks, a student scoring at or above the threshold has a 75% chance of earning at least a C in a first-semester nonremedial college mathematics course, including algebra, statistics, precalculus, or calculus (College Board, n.d.).

Once students are engaged at a level that is conceivably college ready, it is natural to explore the extent to which they are college ready and which indicators reliably determine their college success. One of the most commonly used indicators is freshman GPA (Porter & Polikoff, 2012). College success is a function of freshman success, and so monitoring students' 1st-year academic records can be vital for determining their likelihood of degree completion and predicting college retention (Allen, 1999; Porter & Polikoff, 2012). Unfortunately, achieving a satisfactory grade in one course at one institution may not mean the same thing as doing the same at another institution, thus achieving uniformity with this indicator may be difficult.

College Placement

Colleges and universities have used students' ACT and SAT scores in mathematics to place them at an appropriate level. Deil-Amen and Rosenbaum (2002) found that placement into remedial mathematics courses was one factor contributing to dropouts at the postsecondary level. Placement policies should effectively help students find an appropriate starting point so that they may reach their educational goals (Marwick, 2002). Placing students correctly in mathematics courses is critical for student success.

Because of the important role placement has, placement policy has been among predictors of college readiness used. A college's placement policy may be used as a proxy to predict a student's success in a remedial program, which may negatively or positively affect the college's retention rate (Goeller, 2013). Armstrong (2000) found a positive correlation between placement testing and student learning, college outcomes, and retention rates. Retention rates are about 65% at 4-year colleges (that do not require remediation courses) and 50% at 2-year colleges (Achieve, 2012).

Placement exams form the typical bridge between secondary school and college (Gordon, 2006). Commonly used placement exams have included the Accuplacer or Compass (now discontinued) as their primary measure (Bettinger et al., 2013). Some colleges have created their own placement exams tailored to their standards and expectations. In addition, the cutoff scores for remediation have varied from college to college, affecting the remedial distribution (Parker, 2007). The lack of uniformity of exams and their grading criteria has meant that the results have varied drastically from institution to institution (Attewell et al., 2006).

The purpose of a mathematics placement exam is to ensure each student is placed in a mathematics course of an appropriate level that lays a solid foundation for all subsequent required mathematics courses (Goeller, 2013). Students who are correctly placed at the beginning of their postsecondary careers are more likely to persist toward their goals than those who are incorrectly placed (Ngo & Melguizo, 2016). Ngo (2020) referred to the misplacement of overprepared and underprepared students in mathematics classes not aligned with their skill sets as "redundant mathematics." Scott-Clayton et al. (2014) found that up to 25% of students were misplaced, many into math classes beneath their level, which often led them to spend more time and money than necessary on degree completion (Ngo & Kwon, 2015). This phenomenon suggests the need for further examination of the efficacy of placement policies (Bettinger et al., 2013).

Using a placement exam as the sole determiner may not produce the most accurate predictions possible of students' performance in their college courses, because not all students exhibit their best work in one high-stakes assessment (T. R. Bailey et al., 2015; Belfield & Crosta, 2012). Placement policies that incorporate multiple measures may lead to more appropriate placement of students (T. R. Bailey et al., 2015). Other measures to consider during placement include high school transcripts (with a focus on math and English courses), honors classes, and the number of failed and repeated courses (T. Bailey & Jaggars, 2016; Belfield & Crosta, 2012).

Improving Mathematics College Readiness

Schools and colleges have implemented a variety of approaches to improve students' academic preparedness for postsecondary studies, such as summer bridge programs, learning communities, and bootcamps (Bettinger et al., 2013; Hagedorn & Kuznetsova, 2016; Wathington et al., 2016). Postsecondary institutions have also focused on the non-academic needs of students, such as childcare and transportation, that tend to affect nontraditional students (Bettinger et al., 2013).

Bridge Programs. With regard to bridge programs, Barnett et al. (2012) suggested that secondary–postsecondary partnerships for college readiness come in two types: those that focus on academic subjects and those that focus on college knowledge. Harrington and Rogalski (2020) argued that students who do not feel ready for a college mathematics course after high school graduation may benefit from supplemental instruction while receiving academic support. Bridge courses are "the message transmitted by university to secondary education about what mathematical skills, competencies, practices, and contents students need but do not have" (Gueudet et al., 2016, p.109). Hart (2017) proposed that collaborative programs between high schools and community colleges benefit students, especially in mathematics. Others have demonstrated a positive relationship between rigor in high school mathematics and college readiness (Morgan et al., 2018; Pierson, 2015).

Administration of bridge programs can take a variety of forms to tend to the needs of students. Bridge programs, especially those that occur during the summer, can benefit students at risk of a so-called summer melt, a phenomenon experienced by high school graduates who plan to attend a postsecondary institution but unfortunately do not manage to do so in the fall semester (Executive Office of the President, 2014). Bootcamps—shorter, condensed bridge programs—prepare students for placement exams and teach study skills for future success in postsecondary courses (Hagedorn & Kuznetsova, 2016). There are mixed feelings about bridge programs. Thayer (2000) argues that these programs have been especially successful at increasing student retention and the academic success of at-risk populations. On the other hand, Gueudet et al. (2016) posit that bridge programs focus on the differences between secondary and postsecondary institutions instead of helping students identify the skills they already possess that are helpful during their transition.

Learning Communities. Learning communities are another strategy for improvement of college readiness. Within such communities, students engage in social and academic support networks and maintain these connections through cohorts created by institutions (Hagedorn & Kuznetsova, 2016; Weiss et al., 2015). The students benefit from peer support and increased faculty interaction as they move from remediation to college-level coursework (Bettinger et al., 2013). Moreover, curriculum content is often themed so that students take an active interest while building the skills needed for college-level courses (Weiss et al., 2015). Some learning communities are organized around career clusters, so that students have more opportunities to interact with peers who share common interests (Floyd, 2016).

Supporters of learning communities have argued that the technique improves student interest, engagement, and motivation relative to traditional methods of teaching (Bettinger et al., 2013). Learning communities provide small-scale settings in which students can learn, in contrast to large-scale settings in which students may feel discouraged to participate during class (Floyd, 2016). However, critics of learning communities have found that the strategy has negligible impact on student persistence (MDRC, 2012) and so has only a minor effect on underprepared students (Hagedorn & Kuznetsova, 2016).

In conjunction with learning communities, postsecondary institutions have also implemented accelerated curricula to increase student retention in remediation courses (T. Bailey & Jaggars, 2016; T. R. Bailey et al., 2015). Within such communities, students have been completing their remedial courses earlier in their academic careers than had previously been the case (T. R. Bailey et al., 2015). Students in these types of courses also receive additional academic support to help them successfully exit (Jaggars et al., 2015). Incorporating learning communities, supplemental instruction, and bridge programs alongside mathematics remediation courses has led to improvements in student success (Davidson, 2015).

College Preparatory Programs

A number of school districts and states have adopted or incorporated college preparatory programs to improve their students' college readiness (Haskins & Kemple, 2009; Swail, 2000). Common objectives of college preparatory programs include increasing student motivation and interest in postsecondary studies while engaging students in college preparatory courses (Haskins & Kemple, 2009; Schultz & Mueller, 2006). The U.S. Department of Education has been a strong proponent of the use of college preparatory programs since the 1960s; the most recent example of this support has been the Gaining Early Awareness and Readiness for Undergraduate Programs (Haskins & Kemple, 2009). These types of programs focus on students unlikely to pursue postsecondary education.

Haskins and Kemple (2009) recommended that high schools implement college preparatory programs—either through separate organizations or embedded within curricula—to improve students' academic skills and depth of knowledge in specific subjects. These authors also suggested providing students with advice about choosing colleges that best fit their needs and future career intentions (Haskins & Kemple, 2009). Corbett and Huebner (2007) suggested that a college preparatory program should engage students in a rigorous curriculum and hold students to high standards like those of postsecondary institutions. Despite all these efforts, a large number of students have remained underprepared for college, even those who have taken college preparatory courses in high school (T. Bailey & Jaggars, 2016; Hoyt & Sorensen, 2001).

School Culture

According to Fullan (2007), school culture is the guiding beliefs and values that shape the way a school operates and functions. The school culture should be unifying and representative of its members. Cheong (2000) suggests a framework depicting the hierarchical nature of "culture". Society's culture affects its community's culture. Since a school is located in a community, its culture is also affected (Cheong, 2000). Ultimately, classroom culture is the last to be affected in the chain of events (Cheong, 2000). The more widespread the guiding beliefs and values are among its members, the stronger the school culture (Tamir et al., 2021).

College-Going Culture and High School Mathematics College Readiness. Within a school's culture are subdivisions of narrow focused ideas that A smooth postsecondary transition involves the college-going culture of the high school. Corwin and Tierney (2007) defined college culture in a high school as beliefs and practices that "cultivate aspirations and behaviors conducive to preparing for, applying to and enrolling in college" (p. 3). All members of a school's community—teachers, students, parents, and administrators—are responsible for creating and maintaining an equitable and accessible college-going culture (Aldana, 2014). To create a college-going culture, the school must be able to provide adequate resources to its students (Aldana, 2014).

A school with a college-going culture provides a rigorous course selection and supports the development of college preparatory behaviors (Corwin & Tierney, 2007). Five components are essential for the creation of a college-going culture: (a) academic momentum, (b) an understanding of how college plans develop, (c) a clear mission statement, (d) comprehensive services, and (e) coordinated systemic college support (Corwin & Tierney, 2007).

School counselors are vital to the manifestation of a school's college-going culture (Gilfillan, 2018) and can be considered "institutional agents" (Aldana, 2014, p. 150) pivotal in the maintenance and reinforcement of the culture. Several researchers have found that school counselors improve students' college readiness by providing postsecondary knowledge, assisting with completion of college applications, and encouraging parents' impact on their children's college aspirations (Hurwitz & Howell, 2014; Lapan et al., 2012; McDonough, 2017; Robinson & Roksa, 2016). Through school community and ongoing discourse on secondary and postsecondary expectations, a college-going culture benefits students in their transition from secondary to postsecondary education (Aldana, 2014).

Remediation

Remedial education was first introduced in the United States at the time when postsecondary institutions began implementing admissions requirements of fluency in Latin and Greek; however, a large majority of prospective students were found to be deficient as a result of the waning American public school system (Arendale, 2002). As a result, parents sent their children to attend tutorial services, where students were prepared for postsecondary admissions tests (Arendale, 2002). It was not until the 1750s that Yale University also observed the abundance of students' low mathematics achievement that an arithmetic exam was introduced as part of the admissions requirements (Arendale, 2002). Fifty years later, the problem continued to persist as colleges and universities were inundated by students needing remediation as a result of the lack of public education in the United States (Arendale, 2002). The 1940s brought a need to address the academic deficiencies of returning World War II soldiers (Turner & Bound, 2002). Due to the growing number of under prepared admitted college students, universities began to see a need to create departments with a focus on tending to the needs of such students, and providing instruction for reading, writing, and especially mathematics (Arendale, 2002). Although remedial mathematics has changed since the 1700s, a remedial continuum has persisted.

Earning a postsecondary degree is positively correlated with income and employment (Baker, Klasik, & Reardon, 2018). Obtaining some form of postsecondary degree has become increasingly necessary as the "college wage premium"—that is, the difference in income between those with a college degree and those with a high school diploma—has continued to rise (Perna, Jones, & Heller, 2016, p. 96). According to Scott-Clayton (2017), receiving an undergraduate education has become a conduit to opportunity in American society.

By 2025, an estimated 66% of jobs will require postsecondary education (Carnevale et al., 2010). However, workers' skills and employers' expectations have been mismatched (Abraham et al., 2014). High levels of college remediation indicate that high school graduation requirements and postsecondary instruction and curricula have also been mismatched (Baber et al., 2010; Conley, 2007; Parker, 2007). American policy makers and scholars have attributed the need for remediation to misalignment between high school graduation standards and college academic expectations, yet colleges and universities have been raising admission standards, suggesting an incomplete response to the main issue (Barnett et al., 2012; Parker, 2007).

A growing number of countries have been surpassing the United States in educational attainment (Skolniks, 2016), further indicating a need to investigate the underpreparation of college-bound American students. Students can be underprepared in three ways: culturally, emotionally, and academically (Anderson, 2017). To ameliorate the effects of the mismatch between skills and expectations and reinforce the importance of postsecondary education, President Obama proposed the Race to the Top education program (Boser, 2012). The objectives of the program were to promote education reforms and improve education conditions around the country (Boser, 2012). The ultimate goal was to bring the nation forward in the world by having the largest proportion of adults with postsecondary degrees (Perna, Jones, & Heller, 2016). The motivation for the program was that the United States was falling short not only in college access, but also in persistence toward degree completion (Perna, Jones, & Heller, 2016). Researchers have often found low persistence and degree attainment rates to depend directly on the need for remediation (Parker, 2007).

Despite efforts to improve student college achievement, such as increasing course requirements for high school diplomas, researchers have found that $7,000,000,000 has been spent annually on remediation to prepare students for postsecondary studies (Achieve, 2004; Ngo, 2020). Despite the spending, and increased attendance rates, postsecondary degree attainment rates have remained unchanged (Kamin, 2016). Of those students who do graduate, fewer than 60% do so within 6 years (M. J. Bailey & Dynarski, 2011). A student who is college ready is twice as likely to earn a postsecondary degree as their peer who requires some form of remediation before entering credit-bearing courses (DeAngelo et al., 2011). Moreover, students have often repeated remedial courses to achieve a satisfactory prerequisite grade, delayed their mathematics requirement, or changed majors, and have often viewed mathematics courses as hurdles to overcome to achieve graduation (Frost & Dreher, 2017). Unfortunately, fewer than half of the students who enroll in remedial mathematics courses exit successfully, and far fewer graduate (Bahr, 2012; T. R. Bailey et al., 2015). Some researchers have attributed students' poor interactions with mathematics requirements to students' lack of understanding of the importance of the role mathematics plays in postsecondary education and its interconnections to other aspects of postsecondary education (Bryk & Treisman, 2010).

In a college context, remedial education is coursework a student takes at the postsecondary level so that the student can achieve an expected level of literacy and numeracy determined by their institution (Calcagno & Long, 2008). Some have labeled remedial courses "gateway" courses because students must complete them before they move on to college-level courses (Bettinger et al., 2013). Other scholars have defined remediation as a "remedy" meant to equalize the opportunity gap between advantaged and disadvantaged groups (Bahr, 2008, p. 422). Some scholars have regarded "remedial" and "developmental" as synonymous (Hagedorn & Kuznetsova, 2016), but others have distinguished between "educational philosophies and pedagogical approaches" (Turk & Pearl, 2021, p. 92). According to Turk and

Pearl (2021), remedial courses involve traditional lectures and rote learning, and developmental courses involve more student-centered pedagogy. Developmental education focuses on students who have an "unfinished process of learning" by providing services to develop them as learners for postsecondary studies (Parker et al., 2010). In this study, the researcher treated remedial and developmental education as distinct.

College remediation has ostensibly replicated portions of the secondary curriculum, raising questions about whether taxpayer money has been well spent (Bahr, 2008; Lagerlöf & Seltzer, 2012; Parker, 2007; Saxon & Boylan, 2001). Critics have also argued that remediation courses have lowered academic postsecondary standards (Bahr, 2008). Given the substantial amounts of money spent on these courses and their high failure rates, the effectiveness of such courses has become debatable; critics have suggested redesigning or eliminating them (Bahr, 2008; Sanabria et al., 2020). Parker (2007) found that 22 public and private systems of higher education had decided to reduce or eliminate remedial programs and coursework, and other institutions had increased admission standards to become more selective, reducing the need for remediation. Furthermore, leaders of institutions questioned the sustainability of students needing remediation, noting that students' academic deficiencies ran so deep that remedial courses could be insufficient to improve students' academic abilities to the required standard (Parker, 2007). Remedial curricula have often been disjoint from college-level curricula, anyway, leading to shaky transitions for some students (Anderson, 2017).

Compounding the issue further, students taking remedial courses are often uninvolved and uninterested, which makes traditional lecture-based teaching appear unsuccessful (Boylan & Saxon, 1999; Trenholm, 2006). Education organizations such as the National Council of Teacher of Mathematics, the American Mathematics Association of Two-Year Colleges, and the

Mathematical Association of America have made efforts to improve student success by suggesting practical techniques for teachers to implement (Smith et al., 2017). Other attempted solutions have included redesigning courses to reduce the time necessary to pass, integrating basic skills with college coursework (Zachry & Schneider, 2011), and reformulating curricula to better meet students' needs (Bettinger et al., 2013) with the ultimate goal of improving persistence and completion rates for such courses (Turk & Pearl, 2021). Understanding the efficacy of remediation courses in terms of graduation rates is important; many researchers have investigated this matter, but they have reached conflicting conclusions (Attewell et al., 2006; Bahr, 2008; T. Bailey, 2009; Bettinger & Long, 2009; Brower et al., 2017; Di Pietro, 2019; Hodara, 2012; Lundberg et al., 2018; Martorell & McFarlin, 2011; Relles, 2016).

Only about one third of American high school graduates are prepared for postsecondary studies (Bettinger et al., 2013). A high proportion of American high school graduates lack the understanding needed to solve problems in algebra (Commission on Standards, 2000). On admission to U.S. public colleges, 50%–80% of students are placed in remedial mathematics courses, indicating that the problem is national (Khatri & Hughes, 2012). In fact, mathematics is the subject with the highest frequency of remediation—some students have repeated remedial mathematics courses as many as six times (Attewell et al., 2006; Murray, 2008). Bardelle and Di Martino (2012) suggested that the secondary–postsecondary transition may be more difficult in mathematics than in any other subject because of the shift needed to support advanced mathematical thinking.

Being placed into a remedial mathematics course can add as much as 2 years to the time a student needs to graduate (Kowski, 2014). Researchers have found students of remedial mathematics to be less likely than other students to progress to credit-bearing courses, impacting timely graduation (Adelman, 2004; Attewell et al., 2006; T. Bailey, 2009; T. Bailey et al., 2010; Bryk & Treisman, 2010; Scott-Clayton & Rodriguez, 2012). Because mathematics lies at the intersection of many disciplines, the deficiency in mathematics exhibited by students has been of serious concern to educators (Melguizo et al., 2011).

The purpose of a remedial mathematics course is to prepare students to reach a level of proficiency that facilitates their success in postsecondary mathematics courses (Arendale, 2002; Coleman et al., 2017). Modern remedial mathematics courses involve topics found in Algebra I, Algebra II, and Geometry secondary school courses along with review of basic arithmetic skills (Houston & Xu, 2016). Mathematicians have decided that this course, often referred to as "College Algebra," lays the necessary foundation for students' transition into more advanced academia (Herriott & Dunbar, 2009). At some institutions, mathematics remediation takes up to three separate courses to address the needs of students more finely (Bettinger et al., 2013; Kosiewicz & Ngo, 2019).

Other Factors Related to the Mathematics Remediation Continuum

Many researchers have investigated postsecondary mathematics remediation, and they have identified several variables correlated with this phenomenon, including (a) socioeconomic status, family income, and ethnicity; (b) secondary school and student history; (c) gender; and (d) parental influences (Houston & Xu, 2016). Students from low-socioeconomic-status backgrounds are most affected by academic barriers as they transition to postsecondary study because they lack access to other academic resources, such as technology and tutoring services, accessible to students from backgrounds of higher socioeconomic status (Corrigan, 2003). Bahr (2010) found that African American and Hispanic students tended to be overrepresented among those with the lowest mathematics achievement from kindergarten through the end of high school. As a result, these mathematical deficiencies are exacerbated, which leads to a need for remediation at the postsecondary level (Bahr, 2010).

With regard to curriculum, researchers have found evidence of a correlation between the highest mathematics course taken in high school and college readiness (Houston & Xu, 2016; Lakhani, 2018). Houston (2017) found grade point average (GPA), highest high school mathematics course taken, and admissions test scores were among the variables associated with remediation disparities. Others have found an inverse correlation between parents' involvement in their children's education and the chances that those children need postsecondary remediation (Chiu & Xihua, 2008; Wang, 2004). However, first-generation college students, who often belong to underrepresented minority groups, such as African American and Hispanic origins are at a disadvantage relative to other students, whose parents possess college knowledge from their prior experiences (McDonough, 2017). First-generation college students often have less access to college guidance than other students and rely heavily on college counselors for information (McDonough, 2017).

Mathematics Anxiety

Dreger and Aiken (1957) coined the term "mathematics anxiety" to describe the attitudes of many students who struggle with the study of mathematics (Garcia-Santillan et al., 2017). Mathematics anxiety "involves feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations" (Richardson & Suinn, 1972, p. 551). Such anxiety can cause physical and emotional stress (Henschel & Roick, 2020), which can affect an individual's relationship with the subject. Feelings of apprehension and worry about mathematics, and avoidance of the subject, can be major factors leading to low performance on mathematics exams, weak problem-solving skills, inefficient numerical reasoning skills, and poor numeracy skills, ultimately disrupting students' future educational trajectories (Hembree, 1990; Maloney et al., 2011; Pena et al., 2013). In addition, many students suffering from mathematics anxiety spend a great deal of time worrying about their fear of mathematics instead of focusing on developing heuristics to solve the problems at hand (Mueller, 2021).

Individuals most often develop mathematics anxiety early in childhood and continue to experience it into adulthood (Mueller, 2021; Perry, 2004). Students may experience elevated mathematics anxiety when studying at institutions of higher education because of the elevated stakes, such as the need to maintain a certain GPA (Mueller, 2021). Barroso et al. (2021) found that mathematics anxiety can affect student achievement in mathematics. Yeager (2012, as cited in Chang & Beilock, 2016) found that about 25% of U.S. college students at 4-year institutions, and about 80% at 2-year institutions, experienced moderate to high levels of mathematics anxiety. Furthermore, because the scope of mathematics is wide, mathematics anxiety affects students in a multitude of majors (Helal et al., 2011). Researchers have recommended a variety of ways to help reduce mathematics anxiety, such as physical activity (Mueller, 2021), active engagement of students in recalling positive experiences with mathematics (Perry, 2004), and use of music beats (Pinnock, 2014).

Parochial Schools

A U.S. school is classified as either a public or a private entity; however, schools can be further classified based on aspects of their organization, such as skills/training, religion, philosophy (college preparatory, military, etc.), and specific interest (e.g., science, technology, etc.; Coleman et al., 1982). In particular, parochial (or religious) schools differ from other schools based on their "religious identity" (Coleman et al., 1982, p. xxviii) and are primarily private schools. The category of parochial schools can be further refined based on faith (Catholic, Greek Orthodox, Islamic, Jewish, Lutheran, etc.).

Parochial schools are eligible for both district and state funding. (Stevens & Ritten, 2022). In addition, each parochial school is associated with a parish that subsidizes the school, so the cost of tuition is often lower at a parochial school than at an elite private school (Persell, 1979). The parish has a range of responsibilities, such as to raise financial capital, hire competent teachers, and supply the necessary operating costs (Rossi & Rossi, 1961). In a broader sense, clusters of parishes are managed by diocese and are organized based on geographical locations (Kosloski, 2019). Since parochial schools operate autonomously as opposed to their public school counterparts, the diocese often appoints a superintendent who is charged with administrative responsibilities to ensure a uniformity of curriculum and standards across each parish and school (Rossi & Rossi, 1961; Walch, 2003).

History of State and Church (Parochial) Schools

Parochial schools date back centuries ago and are known to be institutions of academic excellence (Stevens & Ritten, 2022). During the colonial period, schools were categorized based on their funding and their religious affiliations (Jorgenson, 1987; Kennedy, 2021). The role of elementary school was to reinforce religious faiths; teaching of the bible and virtues were among the main objectives (Martin, 1891, as cited in Jorgenson, 1987). In fact, to the early Puritans, education and religion were inseparable (Butts, 1958). William Kilpatrick corroborated this notion and found that state and church shared governance of colonial schools, emulating the "Holland parochial system" (Jorgenson, 1987, p. X).

The blurred line between public and private parochial schooling continued well past the Civil War and appeared also in the model for the establishment of colleges. Several schools, such as the William Penn Charter School, received the appellation “public” despite operating alongside or under the governance of a church (Jorgenson, 1987). Several denominations—Quaker, Methodist, Protestant, and Roman Catholic—slowly began to erect churches as well as places of study. However, the rise of industrialization, urbanization, and European immigration led to a movement supporting schools representing an American identity.

During this Common School Period, a push for a universal, free, and nondenominational schools became a central focus; during this time, a firm delineation was established between public and private parochial schools (Jorgenson, 1987). By the 1900s, only 7.6% of students attended private schools, a dramatic reduction from 73.3% in 1879. In more current times, a large portion of private school students are attendees of parochial schools (Sander & Cohen-Zada, 2012). . In 2015-2016, about six million students were enrolled at a private school with 4.5 million of those six enrolled in a parochial school (NCES, 2019). At the time of writing, about 80% of American students were educated in public schools (Kennedy, 2021).

Education in Parochial Schools

Private parochial schools, at which parents choose to pay for tuition for a variety of reasons, provide an alternative to the free public schools. In current times, the establishment of parochial schools is predominantly driven by the poor performance of the public sector (Tooley & Dixon, 2005). Parochial schools are able to provide academic preparation while helping students develop a relationship with a religious identity. Students are enrolled in a religion class, and, in some cases, the religious figure may also be a teacher of other academic disciplines.

Parochial schools are found to adopt the curriculum standards of the state in which they are located, often integrating a college preparatory program (Rossi & Rossi, 1961). Parochial schools focus on providing an academic education alongside a religious education (Stevens &

Ritten, 2022). A central fixture in their curriculum is the development of moral values leading to "lifelong tools" (Brevetti, 2020, pg. 38). In addition to traditional education and instilling values, research also finds that parochial school students possess an understanding of the schooling structure, the role of the teacher, and their role as a student (Lenski, 1963).

Researchers investigating the effects of a parochial school education have reported a benefit when compared to public schools, noting cultural preservation, social development, and better pedagogy and quality of instruction (Carattini et al., 2012, Waasdorp et al., 2018). Students who attend a parochial school are found to have increased education attainment (Neal, 1997).

Moreover, students attending a parochial school as compared to that of private or even public schools tend to experience different social development. Fichter (1958) found that parochial students tend to have a balanced and well-rounded education, showcasing their social awareness from local to global scales, such as homelessness, hunger, and foreign aid, etc. Lenski (1963) also found that students develop long-lasting bonds with their classmates and highlighted the effect of the church on the importance of family.

Theoretical Framework

Three theories form the theoretical framework underpinning the proposed study and the relationships among students, high school, and college in the context of college readiness. The researcher chose three frameworks to create a holistic view of the issues under study (Harms, 2010). Each theory addresses a different aspect of students' mathematics college readiness. Each theory has strengths and limitations; combining the theories combines these strengths and limitations, which is advantageous in investigation of a particular problem. The overarching theory guiding the proposed study is Kocher's (2017) misalignment perspective, which identifies three key kinds of factors of college readiness: (a) social/behavioral, (b) learning/teaching, and (c) expectations/curriculum. Kocher suggested that a student experiences a turbulent transition into postsecondary study when the three kinds of factors are misaligned.

Vygotsky's Sociocultural Theory

Vygotsky's (1987) sociocultural theory provides further support for the implementation of the proposed study. This theory suggests that cognitive development is a function of experiences and culture (McBride, 2011). From a Vygotskian sociocultural perspective, "the creation of a learning environment can be conceived of as a shared problem space, inviting the students to participate in a process of negotiation and co-constructions of knowledge" (Haenen et al., 2007, p. 246). In other words, for an individual to learn, social interactions with others in the individual's community are necessary (Kurt, 2020). Through this process of learning, students and teachers engage in a "community of knowledge" (Epps, 2019, p. 37).

The sociocultural theory includes the concept of the zone of proximal development, defined as

> the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. (Vygotsky, 1987, p. 86).

In return, teachers assume responsibility for their classrooms and should make professional judgments based on their experience and training to ascertain the level of nudging and guidance appropriate during the learning processes of their students. Other factors that the theory takes into account include the environment of a learner and their peer relationships and interactions.

Social interactions affect members of a school community in different ways. For teachers, social interactions may impact teaching and pedagogy; for students, social interactions may influence learning and understanding; and for administrators, social interactions may affect leadership and decision making. In addition, the school environment and academic community of these three kinds of school community members are important because members of the community can influence one another's behavior. Social interactions, community, and experiences within this environment and with each other play important roles in shaping the perceptions of community members. All three groups and the community of a parochial school may thus provide information invaluable to the further understanding of issues involving college readiness.

Conley's Four-Dimensional Model

Conley (2010) has been studying college and career readiness for years and has considered several variables and circumstances related to these ideas. He has found that successful preparation depends on four factors (cognitive and noncognitive) internal and external to a school (Conley, 2010). The corresponding four-dimensional model includes four important components of college and career readiness: (a) key cognitive strategies, (b) key content knowledge, (c) academic behaviors, and (d) contextual and awareness skills (Conley, 2007, 2010, 2014; Lombardi et al., 2011).

The first dimension of Conley's model, key cognitive strategies, involves engaging students with a disciplined approach of thinking. These strategies include: (a) problem formulation, (b) research, (c) interpretation, (d) communication, and (e) precision and accuracy (Conley, 2010). Using these strategies, students develop an array of heuristics for problem solving and learn how to research a problem and synthesize pertinent information, analyze and evaluate possible solutions, present solutions in a comprehensive manner, and achieve the level of precision and refinement required by the subject (Lombardi et al., 2011).

Conley (2007, 2010) argued that key content knowledge is just as important as key cognitive strategies for academic college preparation. Key content knowledge consists of two crucial components: reading and writing skills and specific subject area knowledge (Conley, 2010). Students entering college have been challenged by the level of literacy required (including reading, comprehending, and synthesizing information at an advanced level), and literacy skills acquired at the secondary level have not prepared them for this challenge (Wahleithner, 2020).

Students in college mathematics are expected to "possess more than a formulaic understanding of mathematics" (Conley, 2007, p. 15). In other words, students deemed prepared for college mathematics are those with conceptual understanding; such students can analyze and interpret throughout the entire process of problem solving (Conley, 2007). However, to master content knowledge needed for academic success, students must constantly engage in key cognitive strategies that facilitate understanding, retaining, using and applying content knowledge (Conley, 2010).

With the third dimension, academic behaviors, Conley (2010) emphasized a broader range of independent habits and self-management skills, in particular (a) self-awareness, (b) self-monitoring, and (c) self-control. In this regard, students should be well-equipped with time management and study skills and be fully functional in group study sessions (Baber et al., 2010). Other researchers have emphasized the importance of adopting a proactive approach when learning college mathematics, including completing homework when assigned, reviewing and actively reading lectures notes, and engaging in consistent practice for mastery (Study International Staff, 2019).

With the fourth dimension, contextual skills and awareness, Conley (2010) emphasized what he referred to as "college knowledge" (p. 40). High school graduates bound for college bound should adapt to college culture, norms, and traditions to transition smoothly (Conley, 2010). As part of this learning process, students need to navigate the college application process, choose an appropriate school and program, take placement exams, and so on (Lombardi et al., 2011). Therefore, a successful student exhibits strong interpersonal and social skills (e.g., collaborative abilities, cooperative attitudes, ability to communicate effectively with professors, and leadership qualities; Conley, 2007).

Conley's (2007) four dimensions are further elaborated in a set of twelve attributes that college-ready students possess:

1. Consistent intellectual growth and development over four years of high school resulting from the study of increasingly challenging, engaging, coherent academic content.
2. Deep understanding of and facility applying key foundational ideas and concepts from the core academic subjects.
3. A strong grounding in the knowledge base that underlies the key concepts of the core academic disciplines as evidenced by the ability to use the knowledge to solve novel problems within a subject area, and to demonstrate an understanding of how experts in the subject area think.
4. Facility with a range of key intellectual and cognitive skills and capabilities that can be broadly generalized as the ability to think.
5. Reading and writing skills and strategies sufficient to process the full range of textual materials commonly encountered in entry-level college courses, and to respond successfully to the written assignments commonly required in such courses.
6. Mastery of key concepts and ways of thinking found in one or more scientific disciplines sufficient to succeed in at least one introductory-level college course that could conceivably lead toward a major that requires additional proficiency in mathematics.
7. Comfort with a range of numeric concepts and principles sufficient to take at least one introductory-level college course that could conceivably lead toward a major that requires additional proficiency in mathematics.
8. Ability to accept critical feedback including critiques of written work submitted or an argument presented in class.
9. Ability to assess objectively one's level of competence in a subject and to devise plans to complete course requirements in a timely fashion and with a high degree of quality.
10. Ability to study independently and with a study group on a complex assignment requiring extensive out-of-class preparation that extends over a reasonably long period of time.
11. Ability to interact successful with a wide range of faculty, staff, and students, including among them many who come from different backgrounds and hold points of view different from the students.
12. Understanding of the values and norms of colleges, and within them, disciplinary subjects as the organizing structures for intellectual communities that pursue common

> understandings and fundamental explanation of natural phenomena and key aspects of the human condition. (pp. 18–19)

Kocher's Misalignment Framework

Kocher (2017) presented a conceptual model that depicts possible misalignments among three main areas of college readiness: students, high school, and college. The misalignment framework treats the three kinds of variables through the lens of their interconnections or "overlaps" (Kocher, 2017, p. 17). According to Kocher, misalignments that affect college readiness emerge in the overlaps between any two kinds of variables: (a) learning/teaching (students and high school), (b) social/behavioral (students and college), and (c) expectations/curriculum (high school and college). In other words, college readiness is a function of: (a) adequate student learning for high school and college, (b) an understanding of the expectations of college, and (c) the development of social and behavioral skills for college (Kocher, 2017). The overlap of the three main kinds of variables corresponds to the formulation of college readiness. The researcher utilized Kocher's (2017) misalignment conceptual model to provide structure to the proposed study. The framework serves as guide, illuminating areas where issues of college readiness may occur. The proposed study will rely on the model in the context of mathematics.

Findings reported in existing literature suggest that because remediation lies at the intersection of secondary and postsecondary mathematics, investigating secondary school is important (Bahr, 2008). Several researchers have been exploring teachers', students', and administrators' perceptions of college readiness and contributed to understanding in the field. Guillaume's (2021) study revealed that teachers and administrators at a private school valued academic rigor and instructional strategies were pivotal in students' mathematics preparation. Fontenot (2017) examined students' perceptions of college readiness at a parochial school;

results revealed that positive relations fostered a smooth transition from high school to postsecondary studies. At the university level, Harms (2010) explored math faculty perceptions on freshmen preparedness and identified five key areas of concern: (1) the need for higher expectations at the high school level, an overreliance on calculators, improvements to curriculum, the lack of study skills, and expected math skills.

Chapter 3

Methodology

Research Setting

A small parochial school located in an urban setting on the northeastern coast of the United States was selected for the current investigation. For the purpose of this study, the pseudonym, “Arista” will be used to refer to the school. Since the study aims to examine math college readiness within the constraint of a small educational community, Arista was chosen.

Arista consists of two schools, one elementary and one secondary school. Parents who choose to send their children to Arista are obligated to pay tuition. Arista currently has 181 students enrolled in 7^{th} -12^{th} grade with an ethnic breakdown of 96% Caucasian, 2% Hispanic, 1% Asian, and 1% multi-ethnic. The average size of the graduating classes is 25-30 students, with nearly 100% of their graduates attending four-year postsecondary institutions. Arista has a faculty size of 45. Class size ranges from 15-18 students and the average student to teacher ratio is 10:1. Arista has 4 secondary mathematics teachers with a number of years teaching ranging from 2 – 23 years. All teachers possess a master’s degree in Mathematics Education, with the exception of one who has a second master’s in applied mathematics. In addition, Arista assigns math teachers to a variety of courses and levels, ranging from low to honors.

Arista also has a comprehensive guidance program in which students are engaged during all four years of their high school. The “college corner” program provides the following services: (1) high school-college transition, (2) individual counseling, (3) study skills, (4) time management skills, (5) high school course options, (6) career paths, (7) PSAT/SAT/ACT exams, (8) college search, (9) college preparation, (10) financial aid and scholarships, and (11) monitoring student's academic success and ensure that state requirements are satisfied for graduation. See Table 1 for the graduation rates of Arista, city, and state for 2019.

Table 1

Graduation Rate: Arista, local city schools, and state averages for 2019.

	Arista	City	State
Graduation Rate	100%	77.78%	83%

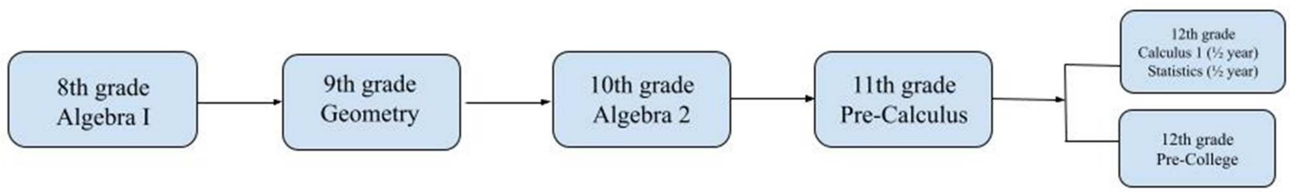
According to their website, the school's mission is to provide all students with an equal opportunity to a well-rounded education. While achieving a holistic approach towards education, Arista also creates a student-centered learning environment sustained by their faculty who are committed to a lifetime of learning. Admission criteria into Arista include standardized testing scores, classroom observations, prior school records, teachers' recommendation, and good character. In addition, prospective high school students are required to take an admissions test to assess the levels of mathematics and English language arts skills. As for mathematics, the test consists of topics such as arithmetic, number reasoning, geometry, and topics in algebra I.

Arista offers a curriculum that incorporates Common Core standards and preparation for statewide exams. The curriculum also includes a college preparatory component in which teachers are certified to teach college courses within the school building, allowing students to receive college credit, also known as dual enrollment. Such courses include Pre-Calculus, Calculus I, Calculus II, and Applied Statistics. In addition, students may take math electives such as financial mathematics, Pre-College Math, and SAT/ACT math prep courses. The Pre-College Math curriculum offers support for nationally recognized college credit exams such as College Board's College-Level Examination Program (CLEP), preparation for national standardized college entrance exams, the ACT and SAT, and aims to sharpen students' mathematical skills in preparation for their postsecondary mathematics course.

In terms of organization and structure, Arista also engages their students in ability grouping i.e., tracking begins as early as in 8th grade mathematics (see Figure 1).

Figure 1

Course Mapping for Math at Arista



The mathematics department places students in the accelerated track if they are prepared to succeed in Algebra I in the 8th grade, and typically the decision is made at the end of 7th grade, via teacher recommendations, student math records, and the level of social/emotional development. Students' achievement is closely monitored by their teachers. They are moved into a different mathematics class that better fits their academic needs. Student distribution for each grade and class is shown in Table 2.

Table 2

2022 Student Distribution in Math Courses

		2022
7th grade	Pre-Algebra "A"	12
	Pre-Algebra "B"	14
8th grade	Algebra 1	23
	Pre-Algebra	20

9th grade	Algebra 1 "A"	8
	Algebra 1 "B"	13
10th grade	Geometry	18
	Algebra 1	12
11th grade	Alg2/Precalculus	8
	Geometry B1	13
	Geometry B2	11
12th grade	Calculus1/Statistics1	5
	Pre-College Math	9
	Algebra 2	11

Participants

The study consists of ten participants, four mathematics teachers, two administrators, and four past graduates of Arista. Typically, qualitative research studies have small sample sizes (Creswell & Creswell, 2018). The small size of Arista allowed for the researcher to request participation from both administrators and the entire faculty of secondary mathematics teachers.

Participants of the study were over the age of 18 and each were assigned a pseudonym. All administrators were asked to participate because of their involvement with students in school. Teachers were asked to participate based on the criteria: (1) part of the mathematics department and (2) teach secondary school. Administrators' and faculty educational degrees range from bachelor's to doctorate levels and are all full-time employees at Arista. Specifically, teachers reported possessing degrees in mathematics and mathematics education. Students were also asked to participate based on the following criteria: (1) are graduates of the high school, (2) have had at least one teacher from the mathematics department at the high school, and (3) took or are currently enrolled in a postsecondary mathematics course (remedial, non-remedial, or both). See table below for the background information of the participants of the study.

Table 3

Demographics of participants

Participant	Gender	Race	Years Taught (If applicable)	Highest Degree Level
Amy -Teacher	Female	White	7	Master's in Mathematics Education
Ashley -Teacher	Male	White	2	Master's in Math Education
Michael -Teacher	Male	White	20	Master's in Math Education &Master's in Applied Mathematics
Nathan -Teacher	Male	White	13	Master's in Math Education
Jack -Administrator	Male	White	33	Doctorate in Leadership
Heather -Administrator	Female	White	25	Master's in History & Education
Ally -Student	Female	White		Masters in Early Childhood Education
Jennifer -Student	Female	White		Masters in Social Work
Ella -Student	Female	White		Bachelors in Business Administration
April -Student	Female	White/Hispanic		Bachelor's of Biology

Procedures

Data collection process consisted of three phases.

Phase 1: Before the interview

An email was sent to two administrators, four faculty, and a total of 52 alumni in January 2022. The administration emailed the invitation for participation to the graduating class of 2012 on behalf of the researcher. A total of ten responses indicating their participants were received: two administrators, four teachers, and four alumni. An informed consent form was then emailed to each participant, requested to be completed, and kept on file. Upon receipt of the completed consent form, interviews were scheduled with each of the participants. Participants were subsequently emailed an interview handout containing the questionnaire and interview questions in preparation for one-on-one virtual meetings. Teachers were asked to prepare course syllabi, class handouts, and exams from the course they currently teach. In addition, teachers were asked to provide various dates that permitted the researcher to join virtually to observe their classrooms.

Phase 2: During the interview

The interview process began once phase 1 was complete. Each one-on-one virtual was approximately 60 minutes and was conducted via the video conference application, Zoom. A total of ten interviews took place. Typically, qualitative interviews are face-to-face (Creswell & Creswell, 2018); however, precautions were taken due to the Covid-19 Pandemic and virtual interviews were preferred by the institution. At the beginning of the interview process, participants were requested to refer to the interview document containing questionnaire and interview questions. The video conference application allowed for recording audio only.

Participants were given a questionnaire (Appendix A, B) that collected information about their education, teaching experience (if applicable), and their general knowledge on college readiness. Demographic information was also collected through the questionnaire. Interview questions were tailored for each type of participant: teacher, administrator, and student. Questions were developed to elicit participants' knowledge and perceptions regarding issues, remedies, prevention tactics, and overall improvements of math college readiness. Both the questionnaire and interview questions were developed using Guillaime's 2021 study. Each participant was given as much time as they needed to verbally answer the questions, but interviews ran typically for about 60 minutes. The interview followed a protocol developed by Billups (2021) (See Appendix E).

Phase 3: During Classroom Observations

Observations are especially important for qualitative case studies since evidence provides supplementary information about the studied topic (Yin, 2018). Unstructured observation was the preferred technique because it provided flexibility for the researcher to focus on various events during the classroom observations of the teachers' expressions, comportments, and cognition of math college readiness at Arista (Angrosino, 2014; Mertler, 2019). Dates of observations were chosen by the teacher, on the basis that it was a normal day, i.e., no exams or special activities outside of the regular curriculum. On the day of the agreed observation, the teacher shared a Zoom link. Each class observation consisted of a full period, which is considered 40 minutes at Arista. Any handouts, lecture notes, or other materials were virtually sent to the researcher prior to the class. Field notes were recorded using a template developed by Billups (2021) (see Appendix G) to ensure that information was recorded in a systematic manner.

Phase 4: Review of Documents

Document review is often utilized in case studies to corroborate or triangulate evidence from other sources (Yin, 2018). Review of administrative, institutional, and teacher documents served as the third data source for the current study. Reviewed documents included teacher requirements curriculum, course syllabi, school data on student records, etc. Arista provided de-identified student participants, as well as corresponding overall cohort data. Specifically, the documents were reviewed for themes, ideas, details, and instances pertaining to math college readiness.

Triangulation is the “process of using multiple methods, data collection strategies, sources of data, and perhaps even researchers in qualitative research to establish their trustworthiness or verify the consistency of the facts while trying to account for their inherent biases” (Mertler, 2019, p. 306). Therefore, it was preferred to utilize three distinct data sources for the study: (1) interviews, (2) observations, and (3) institutional documents, allowing the researcher to increase the validity of the research findings. Ideally, results from each of the three sources will support the findings of the other.

Preparation for Analysis

Audio-recorded questionnaire and interview questions were transcribed and entered into a spreadsheet. The spreadsheet allowed the information to be organized via a matrix with questionnaire and interview questions along the rows and responses along the column. Observational data was entered into a separate spreadsheet along the rows, with each category of each observation along the column. In a similar fashion, document review was organized by type of document, with collected data inputted into a separate spreadsheet.

Prior to addressing each research question, keywords were determined from each of the three selected theoretical frameworks. Two colleagues were asked to verify theoretical keywords before proceeding to the next phase of data analysis. Theoretical framework keywords are matched against codes and themes during the analysis phase.

To answer both research question, I take the following steps:

(1) reviewed transcripts and notes from interviews and observations by making additional notes in margins to understand, organize, and synthesize data

(2) re-read data to obtain a perspective on information and review my reflections

(3) read line-by-line and labeled data into categories to begin the coding process

(4) perform data reduction to produce a refined set of codes

(5) examine refined codes for clusters

(6) identify emerging themes

To answer the first research question, regarding important aspects of math college readiness, I examined the emerging themes and analyzed the findings related back to the first research question. Conley's four part framework and Kocher's Misalignment Framework (2017) provide the necessary theory to allow for investigation of the first research questions. To answer the second research question, regarding the support that the parochial school environment provides for facilitating math college readiness, I examined the emerging themes and analyzed the findings relate back to the first research question. Vygotsky's Sociocultural Theory served as the backbone of the investigation of research question 2 since the environment and school culture was investigated as it relates to MCR.

Chapter 4

Results and Analysis

Chapter 4 consists of a report and analysis of results from the data collection stage of the study. Part I provides participant profiles. Part II elaborates on the codes developed from the data. Part III provides analysis of the emergent themes alongside the two research questions of the study.

Qualitative data were gathered in two segments: interviews and observations. For each participant, interview questions addressed educational background, number of years teaching (if applicable), and understanding of Math College Readiness (MCR). Participants shared open-ended observations about perceptions, influence, and implementation of MCR. The qualitative information from the interviews provided insight into methods teachers, administrators, and alumni use to interpret MCR. The information also showed the extent they felt MCR had been accomplished at Arista. To ensure participants and their answers remain anonymous, they are referred to by pseudonyms in this discussion.

During the analysis phase of this research, I adopted member checking as the data validation method. The decision to implement an alternative method resulted from the inadequate volume of data from document review. As a result, I primarily analyzed narrative and observational data. Throughout the member checking process, participants engaged in an ongoing dialogue. Consequently, the observations accurately reflected their interpretations and meanings.

Part I: Participant Profiles

Teachers and Administrators

Teacher and administrator participants agreed to engage in preliminary interviews to relay their educational and work experience, general notions and perceptions of MCR, and the extent they believe MCR can be achieved at Arista. Each preliminary interview lasted for approximately 15 minutes. I posed 10 questions to each participant, presented separately in profile discussions.

Amy

Amy earned a master's in Math Education and is a certified teacher. She had taught at Arista for seven years. During this school year, she taught algebra 1 and geometry. Her awareness for MCR began as early as high school and continued after college. She noted that MCR was incorporated minimally in her undergraduate education courses and slightly more during her graduate studies. Additionally, Amy expressed that other teachers should prepare students by implementing MCR strategies. To prepare students for college math, Amy explained, "If you narrow it down to what they [the students] are looking to do career path wise, I think that is important." When asked to rate Arista on its ability to provide MCR resources, Amy revealed that although they did not provide as much as expected, she appreciated the autonomy in her classroom. In her last remark, Amy conveyed that teachers, parents, administrations, school boards, and other educators should engage in ongoing discussions to improve and innovate MCR strategies.

Ashley

Ashley earned a Bachelor of Arts in Mathematics and had one semester remaining to complete his Master of Arts in Mathematics Education. He is certified and had taught for two years at Arista, including algebra 2 and precalculus. Ashley explained he desired to be math college ready as a secondary school student. As a teacher, his notion of MCR is embedded within his teaching: “Isn’t that part of teaching regardless of [whether] you say it or not?” His MCR strategies vary; he stressed that students do not respond similarly to different approaches. Furthermore, he asserted, “It would be nice if we could tailor [MCR strategies] for each student.” Ashley also expressed that MCR decisions should be collaborative among teachers, students, and parents. Regarding Arista’s effectiveness to supply MCR resources, Ashley rated it 5.5 out of 10.

Michael

Michael is a certified teacher and had taught math for 20 years, including 19 at Arista. At the time of the interview, he taught algebra 2, precalculus, and statistics. He earned master’s degrees in Math Education and Applied Mathematics. Michael explained he did not know about MCR expectations prior to becoming a teacher, initially encountered them “well into teaching,” and incorporated them fully during the Common Core introduction in 2009. In addition, Michael revealed he had not observed other teachers at Arista engaging with MCR strategies. Unlike other participants, Michael expressed that universities and government should handle MCR decisions. As a best practice, he preferred to prepare students for college math through dual enrollment by exposing them to college mathematics from the comfort of their secondary classrooms. Echoing Amy’s response, Michael felt the level of autonomy teachers possess at Arista facilitated making curriculum and pacing decisions. He further elaborated that “they [the administration] provide us with time by allowing an extra period of skills.” Moreover, Michael appreciated the team-like approach in the department when dealing with MCR issues and strategies, noting it as a key component to their success.

Nathan

Nathan is a certified teacher with a master's in Mathematics Education and 11 years of experience. He had been teaching at Arista for one year, tasked with 7th-grade prealgebra. When graduating from college over a decade ago, Nathan was fully trained in MCR. He further explained that the state mathematics curriculum changed, and educational officials had been "putting more difficult things into it," indicating that it was "frustrating" to constantly follow evolving MCR strategies and expectations. From observing other teachers' MCR strategies, Nathan reported being astonished by a former colleague at a previous school who engaged students with MCR in middle school. When developing his MCR strategy, Nathan required students to consider real-world applications of mathematical concepts. Nathan believed students, teachers, administrators, government officials, and universities should collaborate to determine MCR best practices for each school, classroom, and student. Moreover, Nathan emphasized that students' learning styles must be considered during teaching.

Jack

Jack had been the supervising principal at Arista for one year. His doctorate is in Education Leadership, and he began teaching in 1991. He started by teaching math to middle school students but transitioned into elementary school and eventually into administration. Having begun his career as a mathematics educator, Jack felt he was sufficiently trained in MCR expectations. He initially encountered MCR during his time as a teacher, and as principal, he had observed teachers creating "learning targets at the secondary level that relate directly to college readiness." However, he explained the learning targets did not address mathematics. In contrast, Jack stated SAT/ACT preparation courses, honors classes, and early college/dual enrollment courses are excellent avenues students can pursue for MCR: "I've recognized that it's all the above that work in conjunction to form the whole student." Regarding the resources Arista provides its teachers for MCR, Jack gave a rating of 6 out of 10.

Heather

Heather served as principal of the secondary division and as college counselor at Arista. She holds a Master of Arts in History and Education. She is a certified teacher and taught history and civics at Arista beginning in 1993. From college-counseling experience, Heather learned about college readiness and, consequently, expressed the need for a strong emphasis on math. Having engaged in seminars from the College Board and ACT, she immersed herself in terminology, language, and applicable research regarding MCR strategies. She noted she had regularly attended professional development sessions and events with college readiness as the focus. She also reported observing teachers engaging with MCR, noting that Arista offers SAT/ACT preparation classes. Heather stated that MCR decision-making "is a group effort, but I really think it should fall on the administration and the math department." She also believed in SAT/ACT preparation courses, early college/dual enrollment, and honors classes as best MCR practices, but she emphasized, "The foundations truly begin in elementary school." Concerning Arista's ability to provide MCR resources, she acknowledged being a primary resource for MCR.

Ally

Ally studied at Arista from 1999-2012, beginning in pre-school. Her parents decided to send her to a parochial school to preserve their cultural traditions. Reflecting on her education at Arista, Ally did not claim to be a "great" student but regularly gained support to elevate math skills. She also noted consistently being placed in the lower track at Arista. At graduation, Ally passed the minimum math requirements and expressed that during her senior year at Arista, she did not possess confidence in her math skills for postsecondary studies. With help and encouragement from teachers and the college counselor, she applied and attended a four-year institution. She continued with higher education and obtained a master's in Early Childhood Education.

Jennifer

Jennifer began her studies at Arista during the 9th grade. Having transferred from a public school, she explained her parents wanted a more supportive learning environment for her. Smaller class sizes and religion also affected their decision. Upon entering high school, Jennifer took a math placement exam and tested into the advanced track, but she did not consider herself an honors math student. She graduated from Arista with honors in mathematics and immediately enrolled in college courses in statistics and calculus II at a postsecondary institution. She explained that the college counselor at Arista (Heather) advised her to select a profession of interest. Afterward, she obtained a master's in Social Work.

Ella

Ella entered 7th grade at Arista and began in the medium track for mathematics. She explained her parents felt she could learn more effectively in smaller-sized classes. Ella admitted she did not prefer math over other subjects, but she welcomed learning it. Upon graduation, she had completed precalculus and then enrolled in calculus I in her postsecondary studies. Ella expressed clear elation at her level of achievement.

April

April transferred to Arista in 6th grade. Her parents wanted her to be immersed in one of their two different ethnic backgrounds. During 7th grade, she entered honors math. April recalled excelling and loving math, graduating with honors. Having completed calculus I in her senior year, she began postsecondary studies with calculus II.

Part II: Observations

I conducted classroom observations on three separate days, focusing on teachers in different tracks and grades. Additionally, I observed an applicable and essential college-readiness conversation between a student and administrator.

During my classroom observations, students engaged with teachers and lessons. Several notable moments occurred when eager students assisted one another during class. For instance, Amy asked a student to explain why a logarithm must be used to solve a variable in an equation. Amy noticed a slight hesitance from the student and prompted the class for assistance. Reflexively, another student offered a clue, enabling the class to reach a solution collaboratively.

Additionally, I observed a conversation between Heather and a student. While I waited for the interview, I observed Heather counseling a student. During the session, Heather and the student discussed important college matters, including re-reading college application essay prompts, proofreading essays, and securing all required academic, official documents. When Heather spoke with me, she indicated how "time consuming it is to conduct individual advisement with every student in the graduating class." Regarding time investment, she also mentioned the advisement process begins as early as 10th grade.

To transform interview and observation data for analysis, I engaged in multiple phases:

(7) reviewed transcripts and notes from interviews and observations by making additional notes in margins to understand, organize, and synthesize data

(8) re-read data to obtain a perspective on information and review my reflections, as shown in Table 4:

Teachers	Abstract math skills Linearity of math Math as a language Conceptual understanding Graphing skills Math gaps	Motivation Student responsibility Student accountability Self-efficacy Respect Ownership of education Learning disposition Focus	Independent learning MCR via career path Scaffolding to college classroom	Classroom autonomy Learning culture Community feeling Traditional learning Relationships Small class size Religious Environment
Administrators	Math as a language Word problems Abstract math skills Number sense Linearity of math Accuracy	Organizational skills Self-discipline Listening skills	MCR via career path	Teacher support Relationships Small class size Religion
Alumni	Word problems	Communication skills Maturity levels Time-management	Ready for challenges of college classroom Volume of content	Tracking system Small class size Family feeling Relationships

Table 4
Summary of Data From Interviews and Observations

- read line-by-line and labeled data into categories to begin the coding process
- performed data reduction to produce a refined set of codes
- examined refined codes for clusters, as displayed in Table 5: and
- identified emerging themes as shown in Table 6:

Table 5

Clusters Comprised of Refined Codes

Cluster 1	Math as a Language
Cluster 2	Linearity of Math
Cluster 3	Student Traits
Cluster 4	Expected Traits
Cluster 5	Learning Techniques
Cluster 6	Administrative Beliefs
Cluster 7	Religion

Table 6

Summary of Themes From Data Analysis

Content	Behavior	School Culture
Math as a Language (Cluster 1)	Student Traits (Cluster 3)	Administrative Beliefs (Cluster 6)
Linearity of Math (Cluster 2)	Expected Traits (Cluster 4)	Religion (Cluster 7)
	Learning Techniques (Cluster 5)	

Part III: Results

Research Question 1

To investigate the first research question, How do teachers, administrators, and alumni perceive math college readiness? I posed nineteen interview questions, T1, T2, T3, T4, T5, T6, T7, T10, T12, A1, A2, A3, A4, A5, A12, A14, S4, S5, and S7. Table 4 provides a subset of the interview questions. The complete set of questions can be found in Appendices B, C, and D.

Table 7

A Sample of Interview Questions

From your professional experience(s), what areas of concern can you identify as challenges for students when transitioning into college mathematics?

What is your experience with math college readiness?
What mathematical skills do you believe are important in order to be ready for college mathematics?
What is/was most challenging for you in your mathematics course in college?

Out of the 10 participants, six shared a common perception of the intrinsic linear behavior of mathematics, a continuous step-by-step process. One teacher simply stated that "math builds on itself." Amy referred to this notion when describing the importance of establishing a solid foundation of mathematical knowledge, such as the mastery of operations on integers. She provided an example, stating that "if students cannot perform the basic four operations with signed numbers, they will encounter difficulty when asked to produce a table of values from a function in preparation for graphing."

Heather also voiced her concern by providing an analogy with studying history. Heather stated, "A chain of events is linked through dates. Similarly, if you miss out on a link with the study of mathematics, you broke the chain." In the same context, Heather linked organizational skills with the linearity of math: "If you're not organized, I don't think you can be math ready." Heather's comments encapsulated the importance of knowledge structure when studying mathematics and highlighted the importance of the cumulative sum of ideas. In addition, Ashley emphasized the need to stress "conceptual understanding" to continue building the chain of mathematical knowledge. Amy corroborated Ashley's ideas by stating, "Mathematical gaps need to be addressed as early as possible, as these gaps surface during high school and will reappear in their college courses." Other teachers and administrators also shared this opinion, with Jack noting that engaging students with skills for MCR can begin "as early as pre-K."

Five participants viewed mathematics as a language, an observation I developed into a cluster. According to Heather, mathematical "verbiage and word problems" are concerns she observed in students "struggling how to analyze and break down math problems." Ella also expressed struggling when completing word problems. As Michael said, "The biggest issue is breaking down the words and sometimes just reading the problem to them [students] by pausing and demonstrating how to break down the sentence."

From Michael's perspective, students need to establish an understanding of the "relationship between symbols and language." He elaborated with an example: "What does $y = 3x + 4$ mean? How do you interpret the slope of 3?" Amy introduced another perspective, observing, "I also find connecting numerical data with graphing very important . . . a lot of statistical data arose from the pandemic and they're [students] looking at all these charts and can't make sense of them." Jack also shared the concern for students to develop "higher order thinking skills" and "number sense" before entering college mathematics, as exemplified by his question, "What is the difference between expressions and equations?"

Seven participants addressed student behavioral traits in relation to MCR. Nathan identified "focus" and "self-control" as important qualities necessary for good mathematical learning. He elaborated that "being able to keep clearly focused on the [math] topic" is vital "because if anything distracts you, it's very easy to get jumbled up." Additionally, Jack mentioned that students need to "pace" themselves and learn how to "put forth the correct amount of effort required to transfer knowledge." According to Amy, many students face difficulty when attempting to transfer knowledge on their own. Amy stated, "The biggest issue is that students don't know how to seek out resources properly and when left on their own they are struggling." She asserted the importance of "ownership of your studies," which Michael also expressed when saying, "being able to learn by reading the textbook." Furthermore, Amy alluded to needing to help students "formulate a general approach for the study of mathematics." Ashley observed the importance of “accountability,” “responsibility,” and “motivation.” Similarly, Ally explained her experience in mathematics college course(s): “I had to learn how to self-assess in the sense that I had to learn on my own how to identify where I needed help with the subject.” Nathan observed that “we observe kids with behavior problems, but usually that either corrects itself in their first year of college or they’re just not in college anymore.”

Three participants also identified learning techniques. Jack discussed an alternate perspective of “self-discipline,” which included “knowing when to listen and when to speak.” Ella expressed the need to exercise communication skills with peers during group work: “I had to communicate and work with people in my math classes.” When probed further, Ella felt that expressing misconceptions with classmates helped her use time more efficiently by focusing on areas for improvement. Ella explained she persisted and welcomed later challenges in college mathematics. Additionally, April recalled exercising communication skills when interacting with a professor during lecture and office hours.

Research Question 2

In response to research question 2, What effect do teachers, administrators, and alumni perceive that parochial school education has on math college readiness? ten interview questions,T8, T9, T11, A7, A8, A10, A11, S6, S8, and S9, were posed that explored participants’ perspectives. Table 8 shows a sample of interview questions. Appendices B, C, and D include the complete set of questions. School culture and administrative beliefs constituted two main ideas relating to school environment.

Table 8

Sample Interview Questions

What math college readiness programs are available at your school?

Is your school successfully preparing students to become math college-ready? Explain.
What type of support do you provide to your teachers in order to promote math college readiness?
In your opinion, what was the most important feature about your high school mathematics courses?

All participants felt strongly about the small math class size that fostered a feeling of community. Ashley said, “We have a tight-knit family here. At any moment I feel like I can speak with any of the administrators, and I can follow up with the parents of any of the students.” Heather focused on attention level, stating that “individualized attention is very, very important for their mathematical development and, therefore, readiness for college math.” In addition, Ally appreciated “the small class size. I felt like we were learning collectively, not in isolation.” Ella also noted the small class size: “I developed a close relationship with my math teachers, which enabled me to talk about my math progress.” Similarly, Jennifer commented, “The teachers really understood how to push us individually to our full potential.” April highlighted a moment of individualized attention, recalling an incident involving a question she raised that advanced beyond the topics of the course. April expressed being amazed that the teacher followed up the next day, providing an answer after class.

Classroom observations also revealed a sense of community as students engaged not only with the teacher but also with their peers. For example, during a discussion about modeling linear equations, students exchanged different approaches to the problem while the teacher took the role of moderator. By consensus, students agreed on a conclusive approach and freely discussed why some heuristics were not tractable. Clearly, students at Arista actively engaged in their mathematics community.

Two teachers and two administrators explicitly addressed the impact of teacher autonomy on MCR. As an administrator, Jack felt the need to allow teachers "to focus on teaching" by "removing the obstacles" and "providing continuity and consistency." Heather also noted the importance of teachers' "freedom" to make decisions, such as pace of instruction and choice of textbook. The impact of freedom in the classroom reverberated through teachers' observations. Michael iterated that this administrative belief facilitated his teaching style by encouraging an ongoing mathematics dialogue that "engage[s] students with methods of questioning in the classroom," emphasizing the "how" and "why." Nathan acknowledged the "traditional" atmosphere, in which he felt "free to do the things [teaching strategies and pace]" that "work." Michael also valued teaching autonomy in the classroom:

> I believe in teaching the class in front of you, not the curriculum. I mean hopefully they match, but so often nowadays they don't. Curriculum says you're supposed to spend one day on factoring. The kids in front of you can't distribute 3 into x + 4. I have the flexibility to spend a couple of days on something they do not comprehend completely, rather than following the target time as prescribed by the state curriculum.

Three participants identified cultural/religious practices as an aspect of the school culture. For example, Ashley commented, "A lot of that [student behavior] comes from the [cultural] and the religious aspect of it [the environment]." He further noted, "Even the students that can't handle the [mathematical] content have a good attitude about it. They understand what they need to do." Amy reinforced this observation: "Students respect the teacher as understanding their content [mathematics] . . . and hold them in high regard. I think the idea of structure and engaging in the rituals is something that benefits students . . . going to church regularly."

Similarly, Nathan observed, “They [administration and teachers] expect kids to be a certain way around adults, to be respectful.”

Analysis

A proper definition of college readiness requires identification of major components, criteria, and formal terminology (Baker et al., 2005; Conley, 2007). I identified three main themes from this study: Content, Behavior, and School Culture. Research question 1 revealed content, student behavior, and expectations as three vital components of MCR. Furthermore, research question 2 showed that the learning environment and school culture in which a student learns affects MCR.

Teachers

The teachers' interviews were important to the study as they provided valuable insights into the perspectives and experiences of educators in the classroom. Through the interviews, the researchers were able to gain a deeper understanding of the challenges and obstacles faced by teachers, as well as the strategies they use to overcome these challenges. The teachers' personal experiences and opinions on a variety of educational issues, such as assessment, curriculum, and student engagement, were critical in informing the researchers' findings and shaping the overall direction of the study. Moreover, their experiences helped the researchers to identify areas for improvement and suggest practical solutions for enhancing the educational experience for both teachers and students. Overall, the teachers' contribution was essential to the study as it provided a unique and valuable perspective on the education system and helped to inform recommendations for improvement.

Teachers

Amy, Ashley, Nathan, and Michael were interviewed on their perceptions of college-readiness in math. In their professional experiences, they identified abstract concepts, lack of strong foundation in algebra, and behavior problems as challenges faced by students when transitioning into college math. They also mentioned that students who struggle with these challenges tend to fall into a cycle of taking remedial classes and repeating them.

To prepare students for college-level math, the teachers implement different strategies in their classrooms. Amy emphasizes the importance of abstract thinking, working through problems, and formulating a general approach to the study of mathematics. Ashley focuses on conceptual understanding and avoiding the memorization of procedures. Michael believes in teaching the class in front of him, rather than following the curriculum, and in teaching the fundamentals of solving linear and nonlinear equations, factoring, and understanding the language of mathematics. Nathan believes that it depends on the students' future goals, with those going for high-level careers needing to take advanced classes like AP calculus. The teachers also emphasized the importance of truthful behavior, self-motivation, accountability, and self-control in college-level mathematics.

Administrators

The administrators' interview was important to the study as it provided valuable insights into the policies and practices related to the implementation of MCR at Arista. The administrators had a broader understanding of the challenges and opportunities in this area and could offer a more comprehensive view of the technology integration process in their schools. Their contributions helped to fill the gap between the teachers' perspectives and the actual policies and procedures in place for technology integration. Moreover, the administrators' viewpoints on the impact of technology on teaching and learning and the support systems provided by their schools helped to deepen the understanding of the technology integration scenario in the study.

The administrators in the interview discussed the challenges faced by students when transitioning into college mathematics. They identified language and the application of higher order thinking skills as areas of concern and emphasized the importance of analyzing and dissecting math problems. The administrators have had experiences with math college readiness through workshops, observations of teachers and lessons, and standardized assessments. They believe that basic algebraic skills, problem-solving, and a deep understanding of number sense are crucial in order to be ready for college mathematics. Organizational and self-discipline skills are also important behavioral skills for students to have in order to succeed in college math.

The administrators believe that students should start learning the skills necessary for college math as early as Pre-School or Kindergarten. They have prep courses for the SAT & ACT available at their school and believe that the teachers play a crucial role in preparing students for college math. Math college readiness can be measured through assessments, and an all-encompassing rubric focusing on skills, behaviors, and attitudes can be developed to assess the program. They believe that small class sizes and individualized attention are important factors in preparing students for college math and provide their teachers with resources and support to promote math college readiness.

Alumni

The students' interview was crucial for the study as it provided insight into their experiences and perspectives on the educational program being evaluated. Their contribution helped to paint a comprehensive picture of the program's effectiveness, and it allowed researchers to identify areas of strength and weakness that could be addressed in future improvements. The students' feedback was valuable in gaining an understanding of how well the program was meeting their needs, and how it was impacting their academic and personal growth. Their contribution provided a fresh perspective on the program and helped to ensure that the evaluations were relevant and meaningful for all stakeholders. By incorporating the students' experiences, the study was able to provide a more accurate and well-rounded evaluation of the program.

The students interviewed all had a positive experience at the parochial school, Arista, which they remembered fondly with words like “community”, “family”, and “relationships”. The students highlighted the unique and supportive learning environment provided by the small class sizes, where teachers could give personal attention to each student and help clear up misconceptions.

When transitioning to college, the students had different experiences with mathematics. Some, like Jennifer, had a smooth transition, crediting the foundation they received in their high school math courses, while others, like April, struggled with the larger class sizes in college. Despite this, all students felt prepared for the rigor and pace of college mathematics to some extent and had to make adjustments to the learning environment, such as self-assessment or seeking additional help through office hours. However, overall the students felt that their experiences at Arista influenced their post-secondary transition and academic performance in mathematics positively.

Content

The first emerging theme revealed that addressing MCR requires determining challenges that exist within the discipline and identifying conceptual deficiencies during the learning process. For instance, Kocher's Misalignment framework (2017) identified curriculum gap as a challenge pertaining to the high school-college juncture. If secondary mathematics content expectations do not match postsecondary content expectations at the time of graduation, students struggle through the transition and need additional effort to meet the expectations of postsecondary mathematics. Thus, understanding characteristic properties of mathematics becomes essential to further develop and refine MCR.

Mathematics is commonly accepted as a discipline requiring students to think abstractly and gradually work towards grounding their ideas formally in the axiomatic system (Putra et al., 2018). According to data, teachers and administrators perceive mathematics as a language. However, a notable distinction that has to be recognized is the difference between mathematics as a language and the language of mathematics. The language of mathematics refers specifically to the terminology (Powell et al., 2019) . On the other hand, perceiving mathematics as a language entails requiring skills such as speaking, listening, writing, and reading, similarly to any other language (ICLS, 2022). In mathematics, administrators and alumni identify word problems as impeding math fluency.

Deciphering word problems exercises skills associated with making meaning of math language and symbols. As a goal, math educators must guide students to a conceptual understanding of the symbolic language rather than procedural fluency. If students do not achieve math fluency for a particular topic, deficiencies begin to form and, in time, widen. Thus, teachers should identify and address mathematical gaps to support students toward achieving MCR.

A deeper elaboration on the nature of mathematics occupied a large portion of the discussions in this study. Teachers and administrators noted that, due to the linearity of topics, students need a cumulative understanding of math concepts. Therefore, a comprehensive mastery of previous topics supplies a solid foundation for students to succeed in math at the postsecondary level. According to the teachers, acquiring mathematical knowledge corresponds to a chain in which each link must have integrity.

Behavior and Expectations

Achieving MCR applies not only to understanding mathematical content but also to student behavior. In support of Conley's (2007) third dimension, key learning skills and techniques, the skills students acquire at the secondary level foster a mindset promoting a general approach to the study of math. For example, organizational skills bolster a student's experience when learning math. To achieve MCR, students paint abstract ideas by organizing such concepts in discernible ways.

Additional student behavioral traits that promote MCR include self-discipline, self-control, and focus. Because of the linear nature of mathematics, students benefit at the postsecondary level if they logically develop arguments and understand sequential steps before proceeding to more difficult concepts. As noted by the teachers, understanding mathematical concepts requires significant attention since topics layer, which requires students to build knowledge from a solid foundation.

Ownership, responsibility, and accountability occupy another subset of student behavioral traits. Teachers guide students in developing these traits through continual discourse and practice, accomplished through moments of presentation, discussion, and reflection. As noted from the observations, students practice these behavioral traits by presenting problem sets, probing their peers, and fostering class discussion.

Essential for learning in all disciplines, communication skills in mathematics involve particular needs, such as understanding and communicating abstract concepts and symbolic representations. Teachers, administrators, and students voiced their belief that learners benefit from exercising all forms of communication skills. For instance, the ability for students to ask questions using appropriate mathematical formalism promotes persistence and boosts confidence in learning the subject matter.

Unlike other academic subjects, mathematics requires a rigorous approach to gain fluency. In everyday life, people practice language in a continuous fashion, which supports fluency. However, they practice mathematics sporadically, lacking an intrinsic mechanism promoting mathematical fluency. Therefore, if they practice mathematics, they do so discretely, making that practice sacred and serious. Deficiency of appropriate behavior skills also amplifies mathematical knowledge gaps. If students achieve fluency and overcome gaps, they transition smoothly into postsecondary math studies.

School Culture

Understanding MCR also applies to the learning environment of a school. A school's culture, beliefs, and values affect its learning environment. Because schools' beliefs and values vary, each school should provide a unique template from which to operate.

Participants attributed the high quality of mathematical learning at Arista to small class sizes, a central fixture in Vygotsky's Sociocultural Theory. Teacher, administrator, and alumni participants highlighted the benefit of students learning math in a small class environment. The sentiment of community in a small class size alleviates students' inhibitions to participate. Furthermore, students acquire problem-solving strategies through a collaborative environment. Community in a class bolsters discussion in which students collectively explore answers, right or wrong. Through these multiple perspectives and approaches, students begin to acquire a holistic approach to learning mathematics. Discussions in a small class also allow students to investigate the "why" or "how" of mathematical concepts.

From discussions students lead, teachers detect deficiencies and misconceptions in real time. With a high level of autonomy granted by an administration, teachers function on an ad hoc basis in the classroom. Teachers benefit from classroom autonomy because teaching becomes their primary focus, notwithstanding administrative constraints. In relation to MCR, when teachers adjust content, pace, and rigor of students' course work, they go on to address deficiencies and misconceptions earlier in the learning cycle. This approach to teaching mathematics helps teachers foster a positive disposition about the subject in students, facilitating their transition to the next level.

Within the parochial school environment, values and beliefs stem from religion and manifest in different ways in the learning environment. Although all participants did not discuss religion during the observations, it affected the behavioral development of students. After re-examining the results, I noted that religious aspects help students develop a sense of structure and discipline, which is required in the study of mathematics. Specifically, the linearity of the topics requires that learners achieve a level of mastery before progressing to more difficult concepts.

In addition, participants attributed students' level of respect for their teachers and willingness to learn the discipline as a direct result of the environment. According to the teachers, students trusted the teachers' understanding of content. Consequently, teachers and students could explore mathematical concepts at a mature level without having to contend with student behavioral problems.

Evidenced in the narrative and observation data, participants described a learning cycle when thinking about MCR. Conclusively, their ideas surrounded helping students transition to learning mathematics at the postsecondary level. To support this transition, teachers should engage in three phases: (1) exposure to theory in class, (2) application of ideas in homework assignments, and (3) preparation for discussion in the subsequent class meeting. Occurring as an entire class or with individual peers, this discussion should focus on clarifying misconceptions and advancing thoughts that emerged while completing homework. When secondary teachers acclimate students to this mathematical learning rhythm, students should willingly enter postsecondary mathematics, equipped with skills and resources aligned with a mature learning environment. Therefore, teachers should introduce students to increasingly abstract and theoretical ideas at a steady pace to help them achieve MCR. Henceforth, I can now refer to this process as the Math Learning Cycle.

In this mathematical format, MCR is a function of two variables: (1) mathematical content and (2) student behavior and one parameter: (1) school culture. In a non-mathematical sense, MCR is achievable through understanding mathematical content and fostering student behavior conducive to receiving, digesting, and synthesizing abstract concepts. Both variables are directly affected by school culture in that mathematical content is addressed in such a way that teachers are able to address the needs of students organically and student behavior is developed through school values and beliefs.

Chapter 5

Summary, Conclusion, and Recommendations

Chapter Five includes three parts. Part one provides a summary of the study. Part two explores several conclusions and implications from the study. Part three discusses limitations of the study, suggestions for how the study may have been improved, and recommendations for future studies.

In this study, I describe and identify teachers', administrators', and students' perceptions of factors promoting math college readiness (MCR) at a small parochial school. I also explore types of support at a small parochial high school that prepare students for college mathematics and suggest approaches for further research. Through the study, I contribute to the development of a deeper understanding of MCR. The study's findings could serve as foundation for further research in mathematics remediation.

Summary

College readiness is a challenge for numerous college-bound students in the United States. Standardized exams such as the SAT and ACT measure college readiness in reading, writing, and mathematics. Based on established benchmark scores, students evaluate whether they are math college ready. Recently, studies have indicated declines in achievement scores for both SAT and ACT exams, with ACT scores reaching a record low achievement in three decades (Jaschik, 2022). Unfortunately, research has shown as many as one third of students are entering postsecondary institutions underprepared in mathematics, and institutions must remediate many of those students as a result (Bahr et al., 2010; Bonham & Boylan, 2011; Harrington & Rogalski, 2020; Sreenivasan & Woodruff, 2019).

Mathematics remediation courses can bring students' math achievement to an acceptable level for postsecondary education (Arendale, 2002). However, research has not led to agreement on the definition of college readiness, and measurements for MCR vary from high school grades to SAT/ACT scores and placement exams Conley, 2015; Duncheon & Munoz, 2019; Floyd, 2016). Exacerbating the situation, research has also established that mathematics remediation courses often lack success, as students often repeat or exit courses unsuccessfully. (Frost & Dreher, 2017). Benken et al. (2015) alluded to the difference in rigor from secondary to postsecondary mathematics courses as a main reason for high remediation rates. Potentially closing this gap, teachers should scaffold the amount of rigor in their classrooms, emulating the postsecondary environment. This entails that students experience higher level mathematics (O'Brien & Devarics, 2012) at a higher volume and at a faster pace. With an anticipated increase to 17.1 million students enrolled in undergraduate studies in the current decade (NCES, 2022), the need to address MCR has become increasingly necessary.

To develop a comprehensive definition of college readiness, researchers such as Conley established a four-part framework addressing important aspects of college and career readiness. The four parts include (1) key cognitive strategies (i.e. problem formulations, research, interpretation, communication, and precision skills), (2) key content knowledge (i.e. structure and technical knowledge of the discipline), (3) academic behavior (i.e. ownership of learning and learning techniques), and (4) contextual skills and awareness (i.e. college culture, admissions process, financial aid process, and self-advocacy).

Kocher's framework (2017) offered a misalignment perspective suggesting that students' college readiness requires closely examining the intersections of students, high school, and college. The overlapping regions include learning/teaching, social/behavioral, and expectations/curriculum. According to Kocher, closely examining potential overlap in the regions should reveal misalignment and assist in measuring college readiness. Notably, Kocher investigated college readiness as a phenomenon without delineation for each discipline.

Vygotsky's Sociocultural Theory provided a third perspective on students' learning as a function of their learning environment, culture, and norms. For students to have a positive learning experience, social interactions are a necessity. It is through these learning environments that a community is created by teachers and students. According to Vygotsky, knowledge is built through social interactions (Haenen et al., 2007), implying that learning in isolation is insufficient. In essence, mathematics requires skills beyond reading and writing, namely the ability to orally express ideas, argue perspectives, and make meaning of abstractions.

In the study, I planned to identify criteria and components that encourage and bolster MCR in students at the secondary level. Though existing research elaborates on college readiness and suggests larger main ideas, discipline-specific criteria is sparse. Experts in the field have not agreed on a list of conditions supporting MCR.

To investigate and further develop MCR, I chose a qualitative case study for the research design. As part of the investigative process, I selected one parochial school as the epicenter of the study. A parochial school is a type of private school in which school decisions are governed by a religious parish. Through purposeful sampling, the study involved three types of participants: teachers, administrators, and alumni of the school, Arista. I sent an email to all members of the mathematics department and all administrators requesting their participation. Separately, an administrator sent an email on my behalf to the class of 2019 requesting their participation.

Moore's (2020) study served as a template. To address the two research questions, I scheduled and conducted one hour, virtual interviews with each participant, having adapted interview questions from Moore's (2020) study. In addition to the interviews, I engaged in classroom observations to gather data. During the study, I altered the data verification method to member checking instead of triangulation since document review did not reveal meaningful information pertaining to the investigation. After collection, I entered data into a spreadsheet.

Conclusions

For the study, I asked an initial research question: How do teachers, administrators, and alumni perceive math college readiness? Responses during the study indicated that mathematics content and student behavior are necessary components of MCR. Particularly, the linearity of the subject requires a mastery of sequential topics, or gaps in content knowledge grow exponentially in postsecondary mathematics studies. Addressing the gaps early in these studies should help alleviate the need for postsecondary remediation. From question responses, I also recognized mathematics as a language. Similar to learning a new spoken language, learners achieve fluency through practice by speaking, listening, and writing. In mathematical studies, students must connect symbolic understanding with abstract thinking to master the language. When students reach the postsecondary level, they should have achieved a level of proficiency from years of training in the Mathematics Learning Cycle.

The behavior of students also plays a vital role in their MCR achievement. To continue building the chain of mathematical knowledge, students need organizational skills. These skills assist students in developing a mathematical perspective from which they can understand more abstract ideas. Self-discipline and focus occupy another set of behavioral traits promoting MCR. Students must logically develop arguments and understand sequential steps in a timely fashion.

Additionally, the study's participants identified ownership, responsibility, and accountability as a third set of behavioral traits students need to develop to become successful math learners. These traits develop through presentation, discussion, and reflection, reinforcing students' reading, writing, and listening skills in mathematics. A fourth behavioral trait, communication skills, equips students in learning abstract concepts and symbolic representations. As students use appropriate mathematical formalism, they gain confidence in the learning process and achieve fluency in the language of mathematics.

When studying a new spoken language, learners must process letters and phonics. Learners continue by forming words, accumulating vocabulary, and building phrases. They also need to understand parts of speech to construct complete sentences that convey meaning with clear grammar and syntax. Engaging in these steps minimizes the transition time between native to new language while learners simultaneously construct meaning.

Learning mathematics also requires knowledge of symbols, grammar, and analysis to effectively communicate, understand, and advance in the language. A beginner-level mathematics learner encounters arithmetic, which involves the use of commands proposed as symbols invoking operations, comparisons, approximations, and equivalences (King & Purpura, 2021). Similarly, logic acts as grammar. Students must become comfortable oscillating between mathematical symbols and English grammar appropriate to mathematics.

A twofold benefit arises from exercising writing, reading, and speaking skills in mathematics. Articulating understood mathematics and presenting fluid descriptions of theories benefit students, and assessing students' understanding in real time and in multiple formats benefits teachers. The way a student pronounces and enunciates mathematical symbols may be indicative of their misconceptions. For example, if a student reads "$\frac{\Delta y}{\Delta x}$" as "triangle y divided by triangle x” instead of “delta y divided by delta x,” the teacher immediately perceives deficient connections between symbols and interpretation.

A teacher can also benefit by detecting misconceptions in a timely manner. A student may read “ $\sin^{-1}(0.5) = x$ ” as “the reciprocal of the sine of x equals 0.5” or “sine of x to the power of -1 is equal to 0.5.” The teacher would immediately observe a misconception, knowing the proper reading as “the angle whose sine is 0.5.” If teachers rely solely on written exams, they cannot identify all mathematical gaps students experience. However, when teachers employ writing, reading, and speaking skills, they can mitigate knowledge gaps at an early stage and guide students away from “what is the answer” to “what,” “why,” and “how” they obtain the answer.

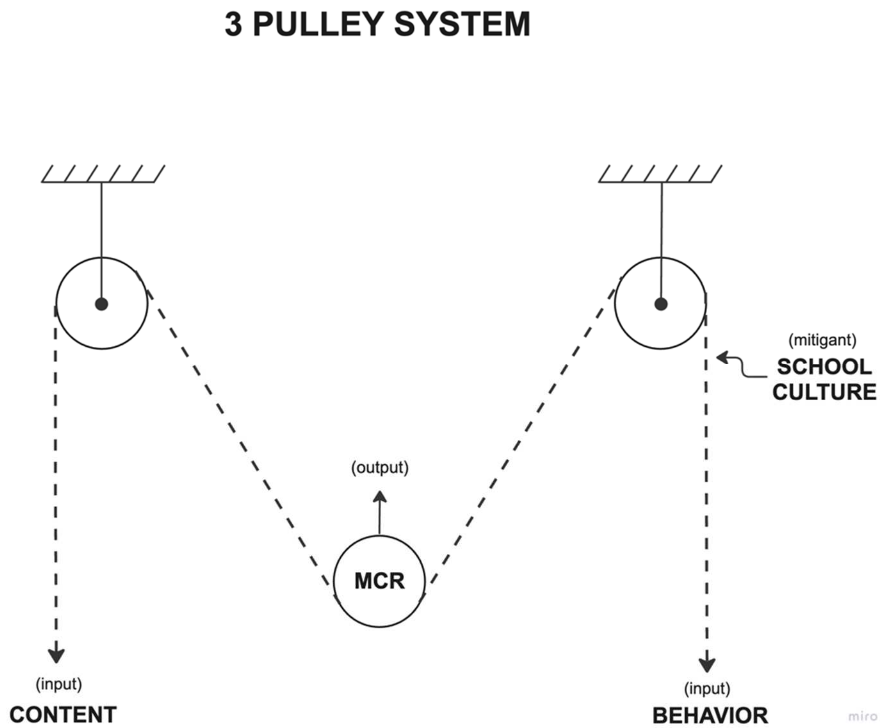
For the study, I also asked a second research question: How do teachers, administrators, and alumni perceive the effect of a learning environment on math college readiness? Participants appreciated characteristics of school culture and learning environment, including small class sizes, teacher autonomy, and religious/cultural practices. Vygotsky’s Sociocultural Theory emphasizes the importance of a learning community as students become aware of their roles as learners. In their responses to the research question, participants observed intersecting characteristics: the beliefs and values of a school guide its culture, and the culture affects the learning environment.

Small class sizes allow teachers to scaffold the learning process so students are engaged in collaborative and explorative learning. Consequently, teachers can manage learning on an ad hoc basis, leading students to uniform concepts at the end of a learning session. Teacher autonomy also enables teachers to curate mathematical curriculum for each class so mathematical topics progress naturally, building links in the mathematical chain.

Participants also observed the effects of religious and cultural practices in student learning. For example, these practices develop discipline and structure in mathematical learning habits. They also aid students in developing good citizenship in the classroom, attributed to the religious aspect of the school culture. Citizenship qualities include organizational skills, interactive skills, ownership, responsibility, accountability, self-discipline, self-assessment, and self-pace. Together, these skills facilitate the development of a mature and independent learner. If these skills do not surface in mathematics courses, teachers cannot nurture these behavioral traits while teaching mathematical concepts. As a result, teachers may focus on content with the expectation that these traits will develop instinctively.

Investigating the perceptions of MCR through the lenses of teachers, administrators, and alumni revealed three themes as important aspects of MCR: (1) content, (2) behavior, and (3) school culture. I conceptualize MCR as a function of content and behavior with school culture as the parameter as a three pulley system shown in Figure 2. The diagram depicts the elevation of MCR by two forces (content and student behavior). This is accomplished with a 3 pulley system with a non-stretchable rope as a mitigating factor which represents school culture.

Figure 2



Recommendations

For future studies, I propose study adjustments for researchers. First, I conducted this study virtually due to the Covid-19 Pandemic. However, since virtual interviews cannot fully show nonverbal communication, I recommend in-person data collection. Secondly, another form of data collection, such as more quantitative data would be helpful to corroborate narratives from interviews. Introducing a quantitative aspect to the study could provide an alternative perspective for analysis. In addition, since the study focused on perceptions, increasing the number of participants would facilitate generalization in a study's findings. Incorporating participants from different parochial schools would also benefit generalization. Lastly, incorporating alumni from various graduating classes could increase variability in data collection and account for anomalies that may be present during a single academic year.

Because students use writing, reading, and speaking skills in English in a continuous fashion outside of the math classroom, teachers should rely on these skills when guiding students to use mathematical language. Students should not be limited to exercising math skills alone in math classes, so teachers should creatively and efficiently bring writing, reading, and speaking skills to the classroom to maximize the impact on mathematics learning. In addition, reinvestigating the literature on the language of mathematics (Pimm, 1987) could provide a new perspective to mathematics college readiness

To support teacher autonomy, administrators should allow teachers flexibility to shape curriculum based on classroom experiences. This flexibility includes the pace at which teachers deliver curriculum and the level of rigor they deem appropriate for each class. Therefore, through teacher autonomy, students directly benefit from teacher-made decisions during the Math Learning Cycle.

For non-parochial schools, future studies may explore how school culture impacts the development of student citizenship. Investigating alternative vehicles that could help develop this behavior may involve observing students' organizational skills, interactive skills, ownership, responsibility, accountability, self-discipline, self-assessment, and self-pace if these skills result in a similar positive effect on their learning. Future researchers may observe examples such as promoting good sportsmanship, peer mentoring, student-led clubs, or teacher advisories.

In view of similarities between learning English and mathematics, teachers of mathematics can adopt strategies from the teaching of a foreign language to promote a solid foundation in students' minds. Learners achieve language fluency through exercising writing, reading, and speaking skills. Teachers should adapt these concepts to support students as they learn mathematics as a language. Future studies might address methods for such adaptation.

Incorporating perspectives of linguists may also expose pertinent information on best practices for teaching mathematics. A joint research project with a linguist could reveal strategies for adapting teaching methods used in language teaching and learning for mathematics teaching and learning. Moreover, this study only considered English as the language of instruction. Future studies could consider how the learning of mathematics differs (if at all) in another language in which symbols are more extensively used, such as Mandarin, Japanese, and Korean.

Further work may also explore the historical evolution of algebra from rhetorical to syncopated to the modern symbolic appearance. Investigating these transition periods of algebra could reveal methods for incorporating language skills in the teaching of mathematics. Furthermore, the methods students use to achieve a mastery of algebraic symbols could provide more information on addressing ongoing concerns with MCR.

There are several avenues for future research to improve the learning of mathematics, particularly in terms of its language. By incorporating in-person data collection, adding a quantitative aspect, increasing participant diversity, and exploring the perspectives of linguists, future studies can expand on the current findings. Additionally, supporting teacher autonomy and exploring the impact of school culture on student citizenship can further enhance mathematics education. Lastly, adapting strategies from foreign language teaching and investigating the historical evolution of algebra can provide new insights into incorporating language skills in mathematics learning. Overall, these future studies have the potential to improve the Mathematics College Readiness of students.

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Appendix A

Preliminary Interview

1. Are you a certified teacher?

Yes No

2. What is your highest level of education?

Associate Degree Bachelor's Degree Master's Degree 18 or more hours beyond a master's degree

3. How long have you been teaching?

4. Do you believe that you have been fully-trained on math college readiness expectations?

Yes No A little I am not sure I can't remember

5. Where did you first learn about math college readiness?

a) When I was in high school b) When I was in college. c) After completing college

d) I learned it through my own research. e) I learned it at work

6. Within the last 2 years, have you attended a professional development session or event, where college readiness was the main focus?

Yes No I can't remember

7. Have you ever observed other teachers implementing math college readiness strategies in their classrooms, either at your school or at another school? If so, explain.

Yes No I can't remember

8. In your opinion, who should make math college readiness decisions?

Students

Parents

Teachers

Counselors

Administrators

School board

State department

Colleges

Federal government

9. What do you believe is the best way to prepare students for college readiness?

A) ACT/SAT Preparation classes B) Early college/dual enrollment

C) Honors classes D) All of these answers

E) None of these answers

*ACT: American College Testing

10. On a scale from 0 through 10 (0 being no resources at all and 10 being having abundant resources available), do you believe that your school provides you with the necessary resources to prepare your student to be mathematics college-ready?

Appendix B

Teacher Interview Questions

T1. From your professional experience(s), what areas of concern can you identify as challenges for students when transitioning into college mathematics?

T2. What is your experience with math college readiness?

T3. What circumstance(s) have transformed your experience(s) with math college readiness?

T4. How do you prepare your students to be math college-ready? What strategies do you implement in your classroom for mathematics college readiness? Explain.

T5. What mathematical skills do you believe are important in order to be ready for college mathematics?

T6. What behavioral skills do you believe are important in order to be ready for college mathematics?

T7. How early do you think teachers should begin to engage students with skills necessary to be successful in their future college mathematics courses?

T8. What math college readiness programs are available at your school?

T9. Is your school successfully preparing students to become math college-ready? Explain.

T10. Can math college readiness be measured? If so, how might a measuring rubric be developed?

T11. In your opinion, what is the connection between parochial school education/environment with math college readiness?

T12. Absent any constraints, is there anything you recommend be changed as to promote a better understanding of math college readiness?

Appendix C

Student Interview Questions

S1. How long did you attend the selected parochial high school?

S2. How many credits have you earned toward your degree?

S3. What mathematics course are you currently enrolled or have taken at the college level?

S4. How would you describe your transition from high school mathematics to college mathematics?

S5. Did you feel prepared for college rigor, pace, and university level mathematics upon graduation from the selected parochial high school?

S6. In your opinion, what was the most important feature about your high school mathematics courses?

S7. What is/was most challenging for you in your mathematics course in college?

S8. Comment on your high school. How did the overall experience in a parochial school environment influence postsecondary transition and your academic performance in mathematics, if any?

S9. Is there anything that we have not yet discussed that you think may help people understand about parochial schools and help them go on to college? What might you suggest improving the parochial school? Is there anything that is revealing or that stands out that you may want to share?

Appendix D

Administrator Interview Questions

A1. From your professional experience(s), what areas of concern can you identify as challenges for students when transitioning into college mathematics?

A2. What is your experience with math college readiness?

A3. What circumstance(s) have transformed your experience(s) with math college readiness?

A4. What mathematical skills do you believe are important in order to be ready for college mathematics?

A5. What behavioral skills do you believe are important in order to be ready for college mathematics?

A6. How early do you think teachers should begin to engage students with skills necessary to be successful in their future college mathematics courses?

A7. What math college readiness programs are available at your school?

A8. Is your school successfully preparing students to become math college-ready? Explain.

A9. Can math college readiness being measured? If so, how might you develop a rubric?

A10. In your opinion, what is the connection between parochial school education/environment with math college readiness?

A11. What type of support do you provide to your teachers in order to promote math college readiness?

A12. What value does high school mathematics have on students when they graduate onto college mathematics?

A13. What characteristics do you value/search for when hiring a high school math teacher?

A14. Absent any constraints, is there anything you recommend be changed as to promote a better understanding of math college readiness?

Appendix E

Semi Structured Interview Protocol

DATE: TIME & PLACE:

INTERVIEWER: INTERVIEWEE:

OTHER:

Pre-Interview Information & Procedures

Introductions: Researcher introduces herself, reviews process for session, how long interview will last, and general format for questions
Study purpose and application: Researcher reviews study's purpose and uses of the findings, including how the finding will be reported and shared
Consent forms, approvals: Informed consent forms distributed to participants, signatures secured, assurance of privacy/confidentiality/anonymity as appropriate, protection of the participant assurances reviewed, questions answered; note that the interview will be recorded and obtain permission for that, as well
Treatment of data: researcher indicates how data will be managed, secured, and disposed of after a specific time period
Other questions or concerns? Other issues are discussed prior to beginning the interview session

Opening the Interview Session
Introductory questionnaire: Use this questionnaire to introduce topic and to establish a rapport with participant

Key Interview Questions
The central portion of the interview consists of questions directly related to research questions and the elements of the topic to be explored.

Concluding the Interview
Transition to the end of the interview session with the last question that allows the participant a chance to debrief or communicate any final thoughts, clarification, or comments that may need to be shared.

Thank You and Follow-Up Reminder
Thank participants for their time and their insights on math college readiness. Mention a follow-up may take place in a few days for some questions for clarification.
Appendix E Combined Document/Artifact Rubric

Appendix F

Combined Document Rubric

Table 7
Document Rubric

Document	Location/source & author/creator	Original purpose of item	Themes Aligned to Conley, Kocher, and Vygotsky	Other Themes

Appendix G

Observation Rubric for Formal Settings

Table 8
Observation Rubric for Formal Settings

Title of Study:

Data/Time/Day of the Week:

Number of participants:

Setting:

While observing the setting, the researcher will describe activity related to the following categories:

Relates to:	Individual behaviors	Group behaviors	Nonverbal cues	Conversation topics and threads
Participants: Faculty Administrators Students				
Types of ongoing activities				
Demographic details				
Researcher reflections				

Appendix H

Teacher Interview Script

Question #1: From your professional experience(s), what areas of concern can you identify as challenges for students when transitioning into college math?

Amy: "…students severely struggle with abstract concepts…not only going from high school to college math, but also middle to high school math"

Ashley: "Math builds on itself so a lot of times you have students that do not have a strong foundation in algebra. That then carries over into geometry, and then into Algebra 2. The other major issue is just motivation…a lot of students can do it, but they're not motivated and they're so distracted."

Nathan: "… we observe kids with behavior problems, but usually that either corrects itself in their first year of college or they're just not in college anymore because the behavioral problems correct itself when they grow up"

Michael: "…formality and abstraction. The kids can do the math; the biggest issue is breaking down the words and sometimes just reading the problem to them by pausing and demonstrating how to break down the sentence."

Question #2: What is your experience with math college readiness?

Amy: "… I was working at the tutoring center with students that were taking remedial classes…that's where the bulk of my college readiness experience comes from. Seeing students fall into the cycle of having to take the remedial class … failing and retaking."

Ashley: "As a student… I did a lot of that on my own and then as a teacher"

Nathan: "…what I've learned from teaching … over the years and through other teachers"

Michael: "…being an adjunct professor and teaching high school seniors"

Question #3: What circumstance(s) have transformed your experiences with math college readiness?

Michael: Teaching both levels and going back and forth. I have seen both sides of the coin on a somewhat daily basis. Seeing how not college ready some college students aren't.

Question #4: How do you prepare your students to be math college-ready? What strategies do you implement in your classroom for mathematics college readiness? Explain.

Amy: "… I want them to be able to think abstractly, work through problems, and understand the order in which you work through problems. In other words, I want to help students formulate a general approach for the study of mathematics"

Ashley: "…the content is important…and I like to stress the conceptual understanding, not just procedural. I focus a lot on that and less on the memorization of procedures."

Michael: "I believe in teaching the class in front of you, not the curriculum. I mean hopefully they match, but so often nowadays they don't. Curriculum says you're supposed to spend one day on factoring. The kids in front of you can't distribute 3 into x + 4. I have the flexibility to spend a couple of days on something they do not comprehend completely, rather than following the target time as prescribed by the state curriculum."

Nathan: "…it depends on what they're going for. If they're going for something that's not going to need high level math then the skills from algebra and geometry will be just fine… but if you're going for high level stuff, then you should definitely be trying their best in AP calculus."

Question #5: What mathematical skills do you believe are important in order to be ready for college mathematics?

Amy: "…students should have the basics down because there's such a foundational lack. Some students are even lacking in simple operational skills with integers, which is concerning. I also find connecting numerical data with graphing very important… a lot of statistical data arose from the pandemic and they're looking at all these charts and can't make sense of them"

Michael: Solving linear and nonlinear equations, factoring, and understanding y = mx + b. I also think understanding of the relationship symbols and language are very important, such as 'what does Y = 3 X plus 4 mean?' 'How do you interpret the slope of 3?'

Nathan: "I guess it depends on what they're going for. If they're going for something that's not going to need high level, then algebra and geometry suffice…if you're going for high level stuff then they should be trying for AP calculus"

Question #6: What behavioral skills do you believe are important in order to be ready for college mathematics?

Amy: "…one of the things that I hold to a high standard is telling the truth, owning up to your mistakes behaviorally and academically"

Ashley: "…self-motivation and accountability, that's very important because they can do it, it's just whether or not they want to. When you get to college, that is really a big deal because you're paying, and if you don't show up and you don't do well, they don't care, they got your money already… I stress accountability and taking responsibility for your own education."

Michael: "Being able to learn by reading the textbook… being able to look it up instead of needing it to be fully re-taught from scratch"

Nathan: "…focus and self-control...being able to keep clearly focused on the topic because if anything distracts you it's very easy to get jumbled up with math"

Question #7: How early do you think teachers should begin to engage students with skills necessary to be successful in their future college mathematics courses?

Amy: "As early as possible…it's an ongoing chain of understanding and the high school students that are struggling most are the ones that don't have the prior knowledge. It's almost impossible to do any type of math if you don't have the higher tools… in terms of studying skills, that could be as soon as they enter the school setting"

Ashley : "As early as possible"

Michael: "Ideally in middle school …and then I would say 8th-9th grade algebra one is where that should really start"

Nathan: "I think they all deserve a nudge if they're not giving the effort for whatever course they're in, no matter 3rd, 4th, 5th, 6th, 7th grade… I could say as early as 9^{th} grade"

Question #8: What math college readiness programs are available at your school?

Teachers were aware of certain programs that their school offers for preparing students for college mathematics. Three courses that were mentioned are: SAT prep, dual enrollment, and a college math class.

Amy: "Mr. ___ SAT prep course. We've broken up the seniors into three classes, and my particular group of seniors where one class is called college math"

Ashley : "Mr. ___ does SAT Prep. Last year I was also doing something like that"

Michael: "I have SAT prep courses that are broken into two tracks for ability grouping. We also offer dual enrollment college courses: precalculus, calculus, statistics. Ms. _____ is teaching a college prep class, which is going to prepare students for the CLEP exam."

Question #9: Is your school successfully preparing students to become math college-ready? Explain.

Amy: "I think they could do more work with the students at the bottom. I think it is important to have homogeneous classes after a certain grade."

Ashley: "It's kind of strange because in certain classes I will say yes and then other classes, not so much."

Nathan: "Yeah, because there's some great teachers up here, from what I see and hear how they talk about math. Students are getting a lot more work, thus a better academic experience."

Michael: "We follow the curriculum, including word problems. I engage students with methods of questioning in the classroom. I think we do a great job. I don't just focus on answers, but rather the "how" and "why" of the concepts."

Question #10: Can math college readiness be measured? If so, how might a measuring rubric be developed?

Amy: "I don't know if it can be measured in general…maybe it can be measure if we think of specific pathways into college for each individual child"

Ashley: "College readiness level, what does that really mean?...not everybody is going to go to college and do and go into some field that requires math."

Nathan: "I think it's very hard. You can test them for a certain level of mathematics…it depends on what they're going to be going into and how well they do at that level. For college itself, there's just so many different factors, but forget just your subject math, then if they're not ready for those other things, it doesn't matter how good you are at math."

Michael: "Something very goal oriented… 'can they do these five things?', 'can they solve a linear equation?', 'can they solve a quadratic equation?'. Even something like give a problem and attach 5 lessons from the textbook, 'which lesson of the textbook would help you answer that question?', 'why would it help you?'. Or take a topic that the kid hasn't learned, give notes on the topic and assign a problem to see if they can independently reason or solve through it"

Question #11: In your opinion, what is the connection between parochial school education/environment with math college readiness?

Amy: "We teach them how to be independent in the sense of how they act towards their teachers….and [teachers] are regarded in a similar way as professors. Students respect the teacher as understanding their content…and hold teachers in that high regard."

Ashley : "They're extremely mature, polite and respectful, and I think a lot of that does come from the[cultural] and the religious aspect of it. Even the students that can't handle the content have a good attitude about it. They understand what they need to do. I think the idea of structure and engaging in the rituals is something that benefits students… going to church regularly. We have a tight-knit family here, so that helps [us] out. At any moment I feel like I can speak with any of the administrators, and I can follow up with the parents of any of the students. It's also a fairly small school, so that helps out."

Nathan: "… it's definitely more traditional and I knew that I was going to be free to do the things [teaching strategies and pace] that I wanted to do because I knew they worked.

It is not so liberal where you have to be doing the new trends all the time. Also, they expect kids to be a certain way around adults, to be respectful."

Michael: "Since it's so small here, its not as easy to slip through the cracks here. You're not going to get a 90 here knowing nothing."

Question #12: Absent any constraints, is there anything you recommend be changed as to promote a better understanding of math college readiness?

Amy: "…the biggest issue is that students don't know how to seek out resources properly and when left on their own and they are struggling; they don't know what to do on their own to remedy that"

Ashley : "Improve our tracking because some of them have gaps. So, we can try to improve on that, maybe refine the math tracks further"

Michael: "What is college readiness? I mean any attempts to do it, it oversimplifies. Maybe for college readiness, there's an actual checklist of skills we can assess."

Nathan: "…most people aren't thinking about that. If you want to narrow it down for people who are really focused on jobs or they're going to need it. Maybe they should promote it more like certain jobs where there's more of a direct connection with career paths."

Appendix I

Administrator Interview Script

Question #1: From your professional experience(s), what areas of concern can you identify as challenges for students when transitioning into college mathematics?

Administrators believed that language and the application of higher order thinking skills were areas of concern when considering math college readiness. It was said that students need to learn how to analyze, dissect, and understand various math problems.

> Heather: "… the verbiage and the word problems. I think that the analysis of math is probably where I would see them struggling, how to analyze, and break down math problems."
>
> Jack: "Higher order thinking skills, solving complex and multi-step equations and the transfer of knowledge and skills of what students should know, understand, and do. What is the difference between expressions and equations?".

Question #2: What is your experience with math college readiness?

> Heather: "… workshops that I've attended through College Board and ACT…and any observations I've done with the teachers."
>
> Jack: "… observing teachers and observing lessons; when I observe I try to become a part of the lesson to get the same experience as the kids"

Question #3: What circumstance(s) have transformed your experience(s) with math college readiness?

> Heather: "… before I started the college advisement, I didn't pay as much attention to college readiness in math."

Question #4: What mathematical skills do you believe are important in order to be ready for college mathematics?

Heather: "… basic algebraic skills. At a minimum, they should have Pre-algebra and algebra 1, but they should go all the way through geometry and algebra 2."

Jack: "Problem solving and a deep understanding of number sense...beyond just the answer, I think when you are math college ready, you're not just getting the right answer, but it's how you are getting to the answer"

Question #5: What behavioral skills do you believe are important in order to be ready for college mathematics?

Heather: "If you're not organized, I don't think you can be math ready...they will have an easier time mastering math…in order to follow a chain of events with math…you miss out on a link with the math, you broke the chain. You're never going to go back."

Jack: "Self-discipline…pacing yourself and putting forth the correct amount of effort required to transfer knowledge, knowing when to speak and when to listen, a lot of students you know are so quick to want to give the right answer"

Question #6: How early do you think teachers should begin to engage students with skills necessary to be successful in their future college mathematics courses?

Both administrators expressed the importance of starting students with math skills for college as early as Pre-School. One administrator noted that building a solid foundation of math skills and behavior skills towards the learning of math can benefit students in the future.

Heather: "Elementary school"

Jack: “Kindergarten… even in Pre-K we can introduce a set of skills and behaviors that kids can profit from in the long run. There are a lot of “why” questions being asked in our preschool classes and kindergarten classes that were never asked in the past.”

Question #7: What math college readiness programs are available at your school?

Heather: “…our prep courses for the SAT & ACT…and the books we're using now are very good”

Question #8: Is your school successfully preparing students to become math college-ready? Explain.

Heather: “Depending on the group and on the year …I can't just give one uniform answer for it. … it also depends on how seriously they're taking it…the ones that know from a from a younger grade, from 8th or 9th grade their school goals like where they want to study are the ones who are ready”

Jack: “The teachers we have make the difference here”

Question #9: Can math college readiness being measured? If so, how might you develop a rubric?

Heather: “It’s measured through the assessments that are being done with the PSAT, ACT, SAT standardized assessment and from classroom assessments”

Jack: “I think it can be measured absolutely and I think an all-encompassing rubric that focuses on skills, behaviors and attitudes, then I think you can assess your current program.

Question #10: In your opinion, what is the connection between parochial school education/environment with math college readiness?

Jack: “I think the connection is we have smaller class sizes.”

Heather: "The smaller the class, I think the more ready they are. I think small class size is very important in preparing them for college. Individualized attention is very, very important for their mathematical development and therefore readiness for college math."

Question #11: What type of support do you provide to your teachers in order to promote math college readiness?

Heather: "We provide them with the resources to attend workshops that focus on math college readiness and also the freedom to make decisions in their classrooms, such as how fast they choose to cover the curriculum or choosing their own textbooks"

Jack: "We provide teachers consistency and continuity. As their administrator I take a lot of obstacles out of their way by letting them focus on teaching."

Question #12: What value does high school mathematics have on students when they graduate onto college mathematics?

Heather: "…it provides students with a foundation upon which they can learn to assess, plan, organize, and provide problem solving heuristics."

Jack: "I think math is the subject and I think everything, no matter what, whether it's finance or whatever a student is doing, math is going to play a role. The math always has a hand in the students' college education"

Question #13: What characteristics do you value/search for when hiring a high school math teacher?

Heather: "…a secondary school teacher who has a diverse background not necessarily just in one math area…with a diverse background… who's taught 6th grade math and 11th grade"

Jack: Someone who can take theory into practice. Someone who can take the most difficult concept and make it applicable in a real-world situation, someone who has a deep understanding of math as a language so kids understand.

Question #14: Absent any constraints, is there anything you recommend be changed to promote a better understanding of math college readiness?

Heather: "I would like to see I think an extra period of math across the board, starting in 7th grade"

Jack: "I think professional development that is geared strictly towards mathematics as opposed to just general PD"

Appendix J Student Interview Script

Question #1: How long did you attend the selected parochial school?

Ally: Since Pre-K

Jennifer: 9th grade

Ella: 7th grade, 6 years

April: I have been there since 6th grade, so 7 years.

Questions #3: What mathematics course are you currently enrolled in or had to take in college?

Ally: "I was placed in mathematics remediation, which included college algebra. I then had to take a math education course because of my degree."

Jennifer: "I got credit for Pre-Calculus and Calculus I from Arista. So, I went straight into Statistics 101 & 102."

Ella: "I had to take Calculus II and Statistics I."

April: “My college placed me into Calculus II. I am now doing Bio Statistics for my Masters.”

Question #4: How would you describe your transition from high school to college mathematics?

Ally: “I had to adjust a bit. Since I was placed into math remediation, I had thought I was behind course wise. But when I realized how well I was performing in my remediation course, I quickly saw that I was misplaced”

Jennifer: “I had a smooth transition. The material I learned in my math courses at Arista gave me a good foundation for college math. I felt I had experienced the gist of college math”

Ella: “I really benefited from the small size of math classes at Arista, so when deciding on which college to attend, I looked for similar characteristics. I thrived in that environment.

April: “I feel that I had to adjust to the college math environment, the bigger class sizes for math was a little different than my experience at Arista”

Questions #5: Did you feel prepared for college rigor, pace, and university level mathematics upon graduation from Arista?

Ally: “At first I didn’t, but I quickly realized what was necessary to keep up with my math classes in college”

Jennifer: “I felt prepared for college rigor, pace, and the content because I was placed in the higher tracked math course at Arista. It was a little hard to make friends in college and find people to work with, but that would be across the board.”

Ella: “I definitely had to adjust to the volume of work that my math professor expected us to cover in one class meeting, but once I did it went smoothly”

April: “I felt prepared for college math after having taken the dual enrollment courses at Arista. I think that really prepared me for college math expectations”

Question #6: In your opinion, what was the most important feature about your high school mathematics courses?

Ally: “The small class size. I felt like we were learning collectively not in isolation.”

Jennifer: “I felt like being in such a small class at Arista, there were 7 people, that the teachers really understood how to push us individually to our full potential. I felt challenged, and where the material was harder in college; I was able to take it on.”

Ella: “Definitely the small classes because the math teachers always gave us personal attention and helped clear up any misconceptions. I developed a close relationship with my math teachers which also enabled me to talk about my math progress”

April: “The small class sizes I had for math classes. I feel like the teacher was able to focus more individually on students.”

Question #7: What is/was most challenging for you in your college mathematics courses?

Ally: “I had to learn how to self-assess in the sense that I had to learn on my own how to identify where I needed help with the subject. In contrast to Arista, my teachers were familiar with my learning style and where I would make silly mistakes, so they anticipated that”

Jennifer: “By the time I took statistics in college, I had not taken math in a year after I graduated from Arista. I would say that the one year gap made it a bit challenging to re-adjust to the discipline.”

Ella: “Making friends with my peers in math classes. My professors really stressed collaborative learning, so suddenly I had to communicate and work with people in my math classes who I didn’t know for years. I also struggled with word problems.”

April: “I really struggled with the class sizes. I was so used to 10 kids in math classes at Arista. I had to get used to the professor not being able to provide individual attention. I had to prepare before going to lecture so that I could ask the professor questions in the classroom. If I needed more help, I went to office hours”

Question #8: Comment on your experience at Arista. How did the over experience influence your postsecondary transition and your academic performance in mathematics, if any?

A common thread amongst all alumni was the sentiment of support. Words like “community”, “family”, and “relationships” were used to describe their experiences at Arista. All seemed to have reminisced about their experiences of learning with a positive lens, highlighting the uniqueness of their educational upbringings.

Ally: “I think I benefited from the small class size but had that expectation going into my math class in college.”

Jennifer: “It was a tight-knit family; everyone was so close, the teachers, the students, and even the administration. I always remember everyone had an open-door policy, which is not the same in other schools. As a result, I struggled with finding colleagues in my college math courses, but I eventually got the hang of it.”

Ella: “The close relationships with my math teachers, administrators, and classmates gave me support while learning at Arista. I always felt confident that I would be able to achieve even difficult math concepts”

April: “It would have to be the small class size. The individual attention I received was like no other. Also, there was a sense of camaraderie with my classmates in math.”

Question #9: Is there anything that we have not yet discussed that you think may help people understand math college readiness? What might you suggest that could be improved based on your experiences? Is there anything that is revealing or stands out that you may want to share?

Responses were diverse. Participants discussed the impact of math college readiness in high school on postsecondary studies. One participant noted that although she did not recall her teacher at Arista directly mentioning math college readiness, it was inherently embedded in her student habits and led to an ability to adapt in a changing environment.

Ally: “I think that everyone will experience a difference in college…addressing college readiness in high school eases the transition, especially for a difficult subject like math”

Jennifer: “I attribute my success in postsecondary math because I was tracked higher. I wish there was more diversity in my math class, like connections to everyday things, taxes for example.”

Ella: “I think the teachers did not directly address how to be college ready for math, but I was college without explicitly being aware of it”

April: “Although I was placed in a higher math tracked class, I think the rest of my classmates in the other two tracks also benefited from the small classes.