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Students' Perceptions About High School Preparation For Mathematics In Post-Secondary Programs: A Case Study Of One High School

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STUDENTS' PERCEPTIONS ABOUT HIGH SCHOOL PREPARATION FOR MATHEMATICS IN POST-SECONDARY PROGRAMS: A CASE STUDY OF ONE HIGH SCHOOL

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Abstract

This qualitative case study examined how fifteen former high school students from a small, rural high school in central Vermont perceived their preparedness for college level mathematics and identified recommendations for improvement. Student interviews and math assessment data for each participant were analyzed to respond to the research question.

The interview protocol consisted of one-on-one semi-structured phone interviews that were recorded for transcription. Thirteen open-ended questions were developed to answer the research question and sub-questions grounded in the research literature and specific concerns identified by the math teachers defined in the case study.

The conceptual framework for this research study included six areas that influenced student success in preparation for college mathematics: improving communication and aligning standards between high school and college; expectations, confidence, and belief in capabilities; transition programs; assessing readiness; interventions and recommendations for high school programming; and student perception and voice.

Recommendations for action included: offer a statistics course as a senior year elective for those not needing precalculus, increase the pace and rigor of senior classes and require more independent work, remove the test retake opportunities senior year because that approach is not practiced in college, include more preparation in the development of a student's four-year plan,

take a fourth year math class, expose students to dual enrollment programs such as VAST (Vermont Academy of Science and Technology), help prepare students for the possible change in class size and school size from high school to college, and give students exposure to online programs such as MyMathLab.

Based on the literature review, qualitative interviews, and data analysis a deeper understanding of student perceptions of their preparedness for mathematics in higher education was gained. Students generally felt prepared for college mathematics and linked that confidence to the factors identified in the study.

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CHAPTER 1: INTRODUCTION

The purpose of this research is to understand how former high school students perceived their preparedness for college mathematics and to identify their recommendations for improvements. Their experience and insight can help inform improvement of high school math instruction to better prepare students to be successful in college. Research has shown that high school students who have the opportunity to take higher levels of mathematics will not only be better prepared for college but also be eligible for higher-paying jobs (Long, Conger, and Iatarola, 2012; Martin et al., 2009; Maruyama, 2012). This study will add to the literature to inform the ongoing efforts to improve high school mathematics experiences, opportunities, and outcomes for high school students.

Martin et al. (2009) advocated that "a strong preparation in high school mathematics readies students for future success in their jobs, their continued education, their personal lives as citizens, and their social responsibilities in our democratic society" (p. 1). Maruyama (2012) wrote that there is an increase in demand for jobs needing advanced mathematical skills requiring college degrees, which means that a growing number of students need to be educated in post-secondary mathematics education for future economic success. Long, Conger, and Iatarola (2012) showed that high school students who successfully complete advanced mathematics courses are more likely to be proficient in high school achievement, college entrance exams, high school graduation, performance in college including college graduation, and obtain higher employment earnings. To address these ongoing recommendations and implications the National Council of Teachers of Mathematics (NCTM, 2000) identified mathematics standards to guide

K–12 instruction and assessment in order to ensure students are prepared for the rigors of college math. Yet studies indicate that students graduating from high school continue to lack proficient mathematics skills to successfully participate in college level mathematics (Corbishley & Truxaw, 2010; National Center for Educational Statistics [NCES], 1998, 1999, 2001a, 2001b, 2006; National Commission on Mathematics and Science Teaching for the 21st Century, 2000; US Department of Education [USDoE], 1998).

The research studies examining student math proficiency indicated the resolution of the challenge of improving math achievement is complex, requiring improvement in instruction, curriculum, and application of math concepts. In 2008 Stone, Alfeld, and Pearson (2008) concluded that math should be introduced and routinely used as a necessary tool for problem solving and that communicating with students about the math skills that are necessary throughout life will motivate them. Yet in 2012, Richland's research indicated that students are graduating from K–12 mathematics without true conceptual knowledge or flexible reasoning mathematics skills, despite the fact that NCTM Standards call for problem solving and learning the applications by understanding the connection between the mathematics topics and how they are used in real world applications. Burrill (1998) summarized the Third International Mathematics and Science Study (TIMSS) curriculum analysis by stating that the mathematics curriculum in the United States is unclear and redundant across the grade levels. In terms of middle school curriculum, Barnes, Cerrito, and Levi (2004) found that sixth and seventh grades have little new material introduced and too much time is spent reviewing mathematics that should have already been learned. At the high school level, they also identified that teachers often try to cover too much material in a short amount of time without students gaining a deep, conceptual understanding.

To address the concern of improving math achievement, many researchers recommended including student-centered learning that promotes conceptual learning by having teachers pose complex problems that students must grapple with to solve in order to gain a deeper understanding. Student-centered learning gives students a voice in the classroom. Student voice has been shown to increase student engagement by encouraging student inquiry and providing opportunity for productive talk in the classroom (Mitra & Gross, 2009; Michaels & O'Connor, 2012). Student voice can also help define problems and implement change (Mitra & Gross, 2009).

Mitra and Gross (2009) defined three types of student voice: being heard, collaborating with adults, and building capacity for leadership. Collaborating with adults has been occurring most frequently in schools by getting feedback from students after completing an assessment or parts of the course and asking for input in creating the lessons (Mitra & Gross, 2009). This has resulted in improvements in curriculum and instruction as well as classroom practices. Mitra and Gross (2009) explained it is also valuable to hear student reflections after they have experienced post-secondary learning. The research proposed for this study informed by Mitra and Gross (2009) is based on the opportunity to learn from the experiences of post-secondary students who graduated from a small, rural high school in central Vermont. Students were interviewed to understand their experiences and the extent to which they felt prepared for college mathematics as well as their recommendations for improving high school math curricula and instruction.

The high school in which this study took place is part of a Pre-K–12 school in the heart of central Vermont. As of the 2014–2015 academic year, the high school population was eighty-six students. The school profile showed that for the previous two years 35% and 38% of the graduating class went on to higher education. However, only one male student from each of

those classes went on to college, making it more difficult to include male students in this study. Some teachers on staff have asked for student input when creating curricula and to garner feedback from the students to help implement changes to curriculum and instruction. In the 2014–2015 academic year students were asked to complete Personal Learning Plans (PLPs) in all high school math courses. The PLPs were used to inform math instruction and guide each student's learning to help ensure that math instruction is effective and engaging for each individual.

Problem Statement

Success in mathematics is key to student success in the 21st-century economy. Despite movement to advance 21st-century skills in secondary education, student test data indicate Vermont students are not mastering mathematics standards. The New England Common Assessment Program (NECAP) results for Vermont showed only 35% of students statewide are proficient or higher in mathematics (Vermont Agency of Education, 2010–13). NECAPs were administered to students in grades 4, 8, and 11. Because of the small student population at the identified study site, test results can change drastically from year to year. However, ten years of results indicated that the students in this high school were generally near the state average (35%) in math proficiency (Vermont Agency of Education, 2010–13). This shortfall in attaining adequate math skills for such a large population of students placed these young adults at risk for not being prepared for mathematics at the college level (Barnes et al., 2004).

Corbishly and Truxaw (2010) showed a lack of readiness meant many students were taking remedial math courses in college to learn skills that should have been mastered in high school. Students who began college programs often took more than four years to complete their degree if they finished it at all. In 2012, 59% of students who began a 4-year degree in 2006

completed their program that year (National Center for Education Statistics, May 2013a). High school and college educators must respond to the challenge of improving mathematics teaching and learning at the secondary level if our students are going to attain the skills necessary to be successful in college (Schmidt et al., 2005).

The 2013 National Assessment of Educational Progress (NAEP) results showed that only 26% of grade 12 students tested at the proficient level in mathematics (NCES, 2013b). Adding to the complexity of preparing students for college math is the high school mathematics curriculum, which is repetitive and lacks in-depth study of application, leading to students not connecting what they are learning with why they are learning it (Burrill, 1998). The disconnect results in students who lack the ability to understand the application of the skills that many college educators expect. Richland (2012) further made the case of high schools failing to teach the conceptual basis for understanding mathematics that could lead to better college preparedness.

While instructional strategies to encourage students to develop a conceptual understanding of mathematics are evident in some settings, there has been a lack of coherence for mathematics standards and expectations among institutions of higher education (Venezia & Jaegar, 2013). The misalignment of standards among institutions of higher education and high school indicates that communication is lacking (Mangan, 2013). Mangan (2013) noted that there is a missing link between the expectations of college and high school. He further noted that if the standards and expectations are not aligned, the problem of students not being prepared for college mathematics will continue. Venezia and Jaeger (2013) agreed that high school students were not prepared for college due to differences between expectations in high school and college and that working together could help students be more successful in college. Bardach (2012) suggested defining the problem is the first step in solving it and gave a sense of direction for the

evidence-gathering. Educators must listen to the students to understand the many factors that drive success for students in post-secondary education. This information can then be assessed to inform changes in high school mathematics curricula and instruction that will better prepare students for success in college and beyond.

Purpose of Study

The purpose of this study was to gather qualitative data from fifteen college students who graduated from the research site high school to identify their perceptions of preparedness for college mathematics (see Appendix D for the interview questions). Participants' high school transcripts and test data (see Appendix E) were used along with the interview results to identify patterns and trends of course-taking, successful course completion, and student beliefs about their preparation to inform recommendations for improvement in the high school mathematics program.

In the last three years at the research study site, the math scores from mandated state assessments have declined. The Curriculum and Assessment Team at this site included this problem as a topic of focus for many of the school level meetings. In the 2014–2015 academic year the math department implemented three changes with a goal of improving student learning and test scores: more individualized learning through Personal Learning Plans (PLPs), having a math support block where students can come in for extra help, and using a team teaching model for Algebra 1 classes. All of these initiatives were meant to increase the level of individual support and provide more exposure to the mathematics material to ensure more students were being successful. The findings from this study will be used to inform improvements in the math instruction and outcomes at the study site where the researcher was also a member of the Curriculum and Assessment Team.

Research Questions

How prepared are high school students to succeed in college mathematics? The following overarching research question was used to create the thirteen interview questions in Appendix D that were used to gather data.

> How do students from a small, rural high school perceive and characterize their mathematics preparation for college?

Sub-questions included:

> How do students describe their mathematics learning in high school (e.g., course taking, peer study groups, tutoring, and support from outside of school)?
>
> Given their scope of preparation, how do students describe their levels of preparedness for college math?
>
> What was their math coursework experience during the first year of college or beyond?
>
> What do students wish had been done differently at the high school level to prepare them for college math courses?

Conceptual Framework

The conceptual framework for this study was derived from three areas of research.

First, participation in higher level math in high school better prepares students for college math. Research from the literature review suggested that in order for students to be prepared for post-secondary mathematics, students need to have intrinsic motivation, confidence, and give a valiant effort. They must also have had repeated exposure to rigorous course material (Corbishley & Truxaw, 2010; Fuligni & Stevenson, 1995; Bisk, Fowler & Perez, 2013).

Second, student voice can inform curriculum and instruction at the high school level. Mitra and Gross (2009) wrote that “one way in which youth can be involved in the reform

process is by sharing opinions with administrators and faculty" (p. 744). Allowing students to share their voice through interviews could give beneficial information that schools could use to implement change.

Third, transition support has been shown to improve success in college. Moses et al. (2011) suggested that first-year college students enrolled in mathematics courses who successfully complete those courses are more likely to finish their degree program. Many post-secondary institutions offer math transition programs to help students better prepare for that first year. Vermont Technical College offers a free Summer Bridge Program for students whose acceptance requires successful completion of this four-week intensive program focusing on mathematics, language arts, or physics (Vermont Technical College, 2014). Community College of Vermont (CCV) offers a free Introduction to College Studies course to high school sophomores, juniors, and seniors. Upon successful completion of that course students earn a voucher for a free course of their choosing from CCV. These programs and others that are similar throughout the state have allowed students to strengthen their skills and be exposed to college courses prior to beginning their freshman year (Vermont Community Foundation, 2014). Many young Vermont students have participated in these programs and have gone on to graduate with their intended degree.

This conceptual framework provided a lens to examine the literature and analyze the assessment data. Participant interviews gave students a chance to use their voice to effect change to better prepare students for coursework in mathematics.

(See Appendix A for the definitions and summary of the key concepts and terminology used in this study)

Assumptions

High school students have valuable insights that can improve educators' understanding of their transition to college-level mathematics. One assumption was that the students answered the interview questions honestly. To justify that assumption, students were invited to participate in the study. If they chose to participate they were assured anonymity and confidentiality in their responses and given the opportunity to withdraw from the study at any time with no ramifications (see Appendix B for the consent form). There was an assumption that because the researcher had a close connection to the participants they would freely voice experiences from their long tenure at the school (Coughlan & Brannick, 2009; Creswell, 2013). Another assumption concerned student voice. Many students learn a great deal about their metacognitive abilities while they are in college. There was an assumption that students were able to articulate their perspective of what it means to be prepared for college mathematics and how they perceived attaining that readiness.

Significance of Study

This study is of principal importance and relevance to the study site in central Vermont, as the school staff continues work on its school improvement plan. Improving mathematics preparation was a major focus of the school improvement plan, and results from this study could help guide the school's mission by providing valuable insight from the students. Although this study's main purpose was to find out how students describe their mathematics preparation at this particular school, it will be useful to educators in other high schools and post-secondary education institutions. Improving math performance is extremely important for school district leadership because mathematics is assessed in Adequate Yearly Progress (AYP) as part of the No Child Left Behind (NCLB) Act and is used to determine which schools are meeting the

standards. In Vermont, it was announced in the first week of August 2014 that 97% of Vermont schools missed performance goals of NCLB (Walsh, 2014). The 3% of schools who appear to have met the goals only did so because they piloted the new Smarter Balance Assessment that the state administered in the 2014–2015 school year and their results were removed from the AYP findings. The national college dropout rate of 41% is one indication that many students are not properly prepared, and may give up and drop out (Perna & Jones, 2013; NCES, 2013b). Current research on how to better prepare students for mastering the necessary math skills in high school for success in college math courses is lacking, which underscores the timeliness of this study.

The importance of learning mathematics will remain a high priority for all students. This core subject will continue to be a focus in school to prepare students for college, careers, and life. The effort to continuously examine how students learn mathematics is necessary as technology is constantly changing and mandates for education reform are continually required.

Conclusion

This study focused on student perceptions about their high school mathematics experiences and subsequent experiences in college mathematics to contribute to the literature and make recommendations for best practices that can be implemented in a high school mathematics classroom to better prepare students for college. Corbishley and Truxaw (2010) completed a similar mathematics study that focused on faculty perceptions of entering college freshmen and concluded that college freshmen were not generally mathematically prepared.

This study focused instead on student perceptions about how well prepared they were in mathematics. Chapter 2 reviews the current literature that grounded this study. Chapter 3 explains the methodology and details of the site and participants involved, including limitations

to the study. The data collected from the study and the analysis are included in chapter 4 and a conclusion and summary of the study is presented in chapter 5.

Mathematics instruction is an important topic that continually needs to be analyzed to ensure students are learning the required material. The cost of higher education continues to skyrocket and helping students to understand what skills they need to be successful in college mathematics can save them time and money as well as ensure success in college and career. High school teachers continue to be scrutinized as many students do not meet the standards on required assessments. The goal of this study is to collect information from the students' perspectives to improve math learning and teaching at the high school level to better prepare students to be successful at the college level.

CHAPTER 2: A REVIEW OF THE LITERATURE

The need to learn and understand mathematics is imperative to move our nation forward in this global society, yet educators are not providing adequate math instruction (ACSFA, 2012). A literature review of this topic identified six major themes that illuminate areas that inform curricular and instruction improvement for successful mathematics education:

- Communication and Alignment between High School and College
- Expectations, Confidence, Belief
- Transition Programs
- Assessing Readiness
- Interventions and Recommendations for High School Programming
- Student Perception and Voice

As with the entire field of education, there is a great deal of conflicting information about best practices in teaching mathematics. On one hand, policy makers have advised teachers to teach to every student's individual learning approach and not be so concerned with testing (Nichols & Valenzuela, 2013; Ravitch, 2010). These educators have urged teachers to find ways for each student to show mastery by using unique approaches, such as project-based learning that would allow for several methods of instruction and learning. While these suggestions create opportunities for students to experience success, they are not preparing students for rigorous college mathematics as reported by ACT (2005), which noted that only 15% of students who passed the three basic mathematics classes—Algebra 1, Geometry, and Algebra 2—met the ACT's college-readiness benchmark (Zelkowski, 2011). Individualized approaches are not used

in high-stakes math tests that are required by local, state, and federal agencies. Students are required to take identical timed tests in the same setting under very strict guidelines that have very little connection to individualized learning being promoted by Common Core State Standards (CCSS) and Personalized Learning Plans (PLPs). These standardized tests are also used for entrance into the majority of higher education institutions. While some boards and administrations have adopted approaches that focus on individualized learning, others are not prepared to deviate from standardized test preparation because results from those tests are used to publicly grade the school. Au (2007) found that because of the emphasis on high-stakes testing, there is a narrowing of content being taught, and the content is increasingly taught in isolated pieces only in reference to the test. This teaching-to-the-test approach to instruction runs counter to what researchers suggested supports deep and effective learning (Barnes, Cerrito, & Levi, 2004). The editor's choice for the Friday Freakout Blog from the Freidman Foundation (2014) expanded on this dichotomy of meeting individualized needs or teaching to the test by saying:

> Educators are increasingly told by 'experts' that they should be creative and inspire our children to learn and think critically. Yet, in the same breath, teachers are being told their professional survival hinges on whether their students pass tests— when, where, and how government regulations say they should—on curricula teachers have not chosen. No successful industry gets creative solutions and positive results when it puts strait jackets on its employees like that. (para. 4)

That blog posting effectively sums up the mixed message delivered to teachers each year that causes frustration and anxiety.

Many different education reforms have focused on proficiency-based learning, individual learning plans, and implementation of Common Core State Standards. The importance of mathematics is discussed in many articles—given that it is one of the three key building blocks in education of reading, writing, and math—however, there is a great need for updated research in the area of college math preparedness. While most professionals and citizens agree on the importance of mathematics, researchers have generally found that high school students are not prepared for mathematics in higher education (NCES, 2013a). College level mathematics courses put more focus on real-world applications of the skills (Merriam, 2009). McCormick and Lucas (2011) described how understanding mathematics is important because mathematics is connected with all subjects, is crucial as today's society is globalizing, and helps people to problem solve and critically analyze situations in life. Merriam (2009) discussed the detailed process of data analysis as a balancing act between the concrete and the abstract, between inductive and deductive reasoning, between fact and interpretation. Mangan (2013) found that students who take higher level mathematics at the high school level are more successful in college mathematics, and that high schools and colleges need to align standards to bridge the gaps between the two levels.

A review of the literature makes clear that achieving successful mathematics competence is complex and multifaceted. This study will add to the existing literature by examining the challenges and successes experienced by one group of high school students as they transitioned to the college of their choice. The study site, in central Vermont, was in its third year of a school improvement initiative required by the state due to not making adequate yearly progress (AYP), and a primary focus of the Curriculum and Assessment Team (of which the researcher was a member) was to review the mathematics assessment data. Programs implemented in the past year

were reviewed and assessed, with careful analysis of a variety of data, to determine what was working and what was not. The goals of the Curriculum and Assessment Team included ensuring the students met the math standards upon testing (e.g., to have skill mastery, and to be prepared for mathematics in higher education) and were successful in their post-secondary mathematical experiences. The following research was used to inform both the Mathematics Department and to inform the development of this research study. To help facilitate the accomplishment of these goals, this chapter presents the literature about best practices in secondary and post-secondary math instruction. The study then focuses on where students have been successful, what their high school and college programs looked like, and student perceptions about their preparation.

Figure 1 below summarizes the research themes uncovered during the literature review. We will now examine each of these six themes in turn.

Figure 1: Research themes from the literature review

Communication and Alignment of Standards between High School and College

A common theme found in the literature reviewed for this study was a disconnect between what high school math teachers are covering in their classes and the expectations that

college instructors have of student readiness for their classes. Mangan (2013) claimed that currently there is an important missing link between alignment of standards in secondary education and college. McCarthy and Kuh (2006) found that too many college students need remediation and that high school students admit to putting forth a low level of effort to attain relatively good grades, indicating that rigor in high school classes needs to be increased. All stakeholders must set high expectations for teachers, school leaders, parents, communities, and especially students in order to make progress and raise expectations in the mathematics area (Larson, 2011). Improvement in mathematics achievement will need a concerted and consistent effort by all the stakeholders working together.

In working toward the alignment of standards both college and high school groups need to be aware of some glaring differences. Barnes (1999) warned that "university teachers virtually never face an untracked group of students, which is a significant hidden privilege" (p. 293). High school teachers are encouraged to have heterogeneous groups for reasons of equity, modeling, and collaboration. Oakes and Guiton (1995) concluded that high school tracking usually results from hierarchical curriculum structures, school cultures, or political actions. Additionally, college mathematics moves twice as fast as high school, meets less frequently, tests on more material, and requires about two hours of time spent outside of class for every hour in class (Breitsprecher, 2005).

Clearly, there is a need to bridge the gap from high school to college and that responsibility should begin with the instructors. Culpepper et al. (2010) agreed communication is missing between high schools and institutions of higher education. The two levels share the primary focus of education but work in isolation from each other. There is clearly a need to communicate. Collaboration between high school and post-secondary instructors can facilitate

successful transitions from secondary to higher education as well as employment (Bangser, 2008).

Expectations—Confidence—Belief

In schools that have high performance expectations for teachers and where there is a belief that all students can meet the standards of education, more students enrolled in advanced courses (Long, Conger, & Iatarola, 2012). Students who regularly complete their homework assignments have higher levels of student performance in reading and mathematics and are more apt to believe in their capabilities (Harris, 2012). In schools that have high academic expectations for students, the students will be continually challenged (White, Gamoran, Smithson, & Porter, 1996). Low teacher expectations can be detrimental to student learning. White, Gamoran, Smithson, and Porter (1996) concluded that at the high school level only 14.8% of students who started in the general track completed a college preparatory program. The authors further compared this figure with the college prep program completion rate of those who began high school in transition courses (49.8%) and students who entered the college preparatory program in ninth grade (87.8% completed a college preparatory program). Instead of identifying struggling students early in order to provide appropriate instruction and support, struggling students were put in a lower track class and that is where they stayed. They did not improve. They only rose to the standards that were set for them (Huang, 2009; Slavin, 1990).

In a similar vein, Gohm, Humphreys, and Yao (1998) found that students high in spatial ability were not fully utilizing their academic capabilities, had interests that were less compatible with traditional coursework, received less college guidance from school personnel, were less motivated by the education experience, and aspired to and achieved lower levels of academic and occupational success. Barnes, Cerrito and Levi (2004) reasoned that since there are low

expectations in elementary, middle, and secondary education, students are not prepared for more rigorous expectations in higher education. Expectations of class preparation in college math are substantial and understanding those expectations is crucial to being successful.

Another factor impeding student learning at the college level is inadequate time spent on the course. Students need to spend a proper amount of time as required by the college instructor. A study conducted by Barnes, Cerrito and Levi (2004) found that students were unwilling to work for the necessary time, even though it was clearly communicated in the syllabus. They also found that students generally had an inflated sense of their mathematics knowledge, which resulted in students signing up for classes that are too difficult. Combined with an unwillingness to invest an appropriate amount of time, it is a formula for disaster and failure.

While expectations are an important issue for success, other studies showed the important influence of students' confidence levels. Stodolsky, Salk, and Glaessner (1991) found that students who felt they excelled in math were more confident, had positive experiences, and felt successful in their abilities, while students who felt less confident related math as a negative experience. If students were confident in their math abilities they could often work independently and were more successful (Stodolsky, Salk, & Glaessner, 1991). Lack of confidence is a big problem for math students who struggle, resulting in insecurity turning into math anxiety and fear (Quander, 2013). Students who felt insecure and incapable did not feel they could learn new material on their own (Stodolsky, Salk, & Glaessner, 1991). The perception that math is hard to learn often starts at home if students continually hear how bad their parents were at math. Evidence suggested that parents have the greatest positive or negative influence on their children's learning of mathematics (Ing, 2014). Parents may make such statements in front of their children and make excuses for their children's shortcomings in math because they say their

children inherited their own lack of ability to do math. In 2010 Nebesniak and Heaton completed a study of middle school students and found that confident students seek deep understanding, rather than giving a simple answer to the question in order to say they have completed an assignment. Nebesniak and Heaton (2010) reported that confident students are willing to take risks and make mistakes and are also willing to help teach other students. They further noted that confidence is also built up when students clearly understand why they are learning what they are learning. Sodolsky, Salk and Glaesnner (1991) believed that students need to have positive experiences in math to enjoy it and be able to feel successful.

High teacher expectations and a belief that all children can achieve, along with students' sense of self-confidence, (OCED, 2012) are important factors in the overall success a student can have in mathematics. Constant monitoring of students' mathematical abilities will bring awareness to gaps in learning and the need for recourse.

Transition Programs

A significant factor shown to support student learning is the importance of early detection for those individuals who need remediation and also for those who need more of a challenge. Cabrera et al. (2006) suggested that every effort should be made to intervene at the middle school level to help those struggling with poor organizational habits so that they can learn and achieve on a daily basis. Continuing the theme of helping with the transitions through different stages of education, several popular programs have been implemented. Cabrera et al. (2006) studied at-risk middle school students who were participating in Gaining Early Awareness and Readiness for Undergraduate Programs (GEAR UP) as a Comprehensive Intervention Program (CIP). They showed that CIPs may be more effective than traditional approaches in promoting math and reading for low-income students for college preparation. They found that students

participating in GEAR UP increased their math scores from sixth to seventh grade and even more from seventh to eighth grade. CIPs can help students be successful in middle school and prepare them for math all through high school, which then prepares them to be successful in college, as Culpepper et al. (2010) discussed.

Many students find the transition from high school to college challenging for a variety of reasons, but academics is clearly one of the major challenges. Research has shown the best way to keep students in college until successful completion of their degree is for students to successfully complete their first year—including coursework in mathematics (Moses et al., 2011). Unfortunately, research studies have consistently found many students are simply not prepared for college math, and this may lead to attrition rates among freshmen (McCormick & Lucas, 2011; Barnes, Cerrito, & Levi, 2004). Mathematics interventions and transition programs that help students with time management skills in the first year of college may be essential for struggling students to continue in their program. Additionally, studies have shown that students who are successful in high school calculus will be more successful in college mathematics (Culpepper et al., 2010), which suggests that students who will need calculus in college should be required to take it in high school to help with that transition.

One example of an effective transition program is the Mathematics Enrichment Program (MEP) established at Texas A&M International University. This program was designed to support incoming freshmen who signed up to take college algebra. Goonatilake and Chappa (2010) described the program offered as a pre-freshman 30-hour-week camp. Lectures and discussions happened in the morning session, followed by afternoon work in Assessment and LEarning in Knowledge Spaces (ALEKS). The instructors' direct teaching and help combined with self-paced guided follow-up practice examples on the computer prepared the students for

the assessment. The students enthusiastically reported about their learning through the week, and the outcome showed those students were more successful in their college algebra class than those who did not attend the camp. Many colleges require students to do a non-credit brush-up class such as this, depending on an Accuplacer score or other placement test (Norman, Medhanie, Harwell, Anderson, & Post, 2011).

Proper placement into college mathematics courses is an important factor for student success. Accurately assessing student skill level will help determine the need for participating in a transition program. These programs have proven to be helpful in preparing students for the rigors of college mathematics (Vermont Technical College, 2014).

Assessing Readiness

Students will have a better chance of being successful in college if they are accurately placed in courses that do not exceed their capabilities. There is urgency for high-quality formative assessments that evaluate whether students have the proper prerequisite skills to take certain classes (Wiley, Shavelson, & Kurpius, 2014). SATs and ACTs are tests used to help assess readiness of students going to college. Both of these common tests are currently being redesigned. The mathematics portion of the ACT is changing how it reports the scores and is also adding in some probability and statistics items (ACT, 2015). The SAT is changing more significantly by aligning with Common Core State Standards and focusing more on problems grounded in real-world contexts (College Board, 2015). Other predictors of college readiness include High School grade point average (GPA) and what courses a student has taken as well as the extra-curricular activities in which a student has participated.

Wiley, Shavelson, & Kurpuis (2014) conducted research providing solid evidence for the necessity to document high-quality formative measures of student knowledge, allowing

instructors to help students with continued learning and to place them appropriately. If meaningful student feedback that aligns with the expectations of college-level preparedness is not available, failure and dropout rates will remain problematic (Kelly, Lavergne, Boone & Boone, 2012). Students need to participate in the solution, but the structure for helping them do well requires providing early indicators, diagnostic information, and worthwhile feedback (Wiley, Shavelson, & Kurpius, 2014).

Working together to improve strategies of preparing students for higher education is essential. Mathematics teachers cannot battle for improved mathematics curricula alone; they need to be supported by administration in their strategy development and then in promoting implementation. Maruyama (2012) argued that assessments of college readiness should use benchmarks with meaning and consequences for students and that the assessments should employ multiple measures to provide information that is more precise than a threshold score derived from any single assessment. In assessing college readiness, Desjardins and Lindsay (2008) stated that although high school grade point averages and taking rigorous classes are predictors for college success, their research showed that grades and exams vary too greatly in rigor and content covered to conclusively predict success.

STEM (science, technology, engineering and math) programs are being developed to help prepare students for filling positions needed in the workforce. The problem of students' lack of preparation for college is affecting the college graduation rates and the labor pool (Moses et al., 2011). The engineering field is troubled by the lack of preparedness. There are not enough students in the United States graduating with degrees in engineering to keep up with the demand in the workforce. Retention and graduation rates for engineering students are low, especially for women and ethnic minority students (Moses et al., 2011). The authors added that students who

successfully complete higher level mathematics in high school, who have a higher GPA, and who have higher SAT math scores have an increased likelihood of remaining in an engineering program in college. Du Preez, Steyn, and Owen (2008) showed that the mathematical experience in the first year has a definite effect on students' perseverance in engineering studies.

The ability for high school instructors to accurately assess and record skill level is insufficient to determine an individual student's college readiness. There is a need for further research in this area to develop better ways to determine placement for students. However, with the demands of the workforce for more qualified engineers it is crucial to have students properly prepared in mathematics so that they can successfully complete those rigorous programs.

Interventions and Recommendations for High School Programming

There are interventions and recommendations that can be used to support student learning in high school and college. Understanding these interventions can be helpful in revising curricula and instruction and can also provide insights into the levels of support of services that can be employed in both high schools and college campuses to support student success. For example, researchers have found that repeated exposure to mathematical concepts and extra practice will help students become stronger mathematics students (OCED, 2012). Culpepper et al. (2010) and Corbishley and Truxaw (2010) recommended that for students to be successful in college mathematics they should take four years of high school mathematics to achieve repeated exposure to the concepts and so that topics are not rushed through—depth rather than breadth. Barnes, Cerrito, and Levi (2004) confirmed that students should be required to take four years of high school math, and that students must also be willing to put in a serious amount of time and effort outside of the classroom.

Taking four years of high school mathematics is highly recommended for all types of learners who want to continue on to higher education, even those with learning disabilities. Four approaches that improved results of mathematics instruction for students with learning difficulties were: systematic and explicit instruction, self-instruction, peer tutoring, and visual representation (Steedly, Dragoo, Arefeh, & Luke, 2012). These approaches can be used in all four years of high school mathematics classes to support achievement for students with learning difficulties and should help better prepare these students for college mathematics (Corbishley & Truxaw, 2010).

Many researchers have concluded that more time and more effort is necessary in learning mathematics (OCED, 2012; Culpepper et al., 2010; Corbishley & Truxaw, 2010). That effort is not unlike what is needed for many things we want to get better at—playing an instrument, learning a sport, and other skill-based activities. Improvement takes time, practice, training, and commitment. Learning math is really no different than learning other things. Fuligni and Stevenson (1995) conducted a study comparing students in Minneapolis, Taipei (Taiwan), and Sendai (Japan) and found a significant correlation between the amount of time spent studying and scores in mathematics in all three locations—with much more time spent studying in Asia. Verifying that time spent studying will increase student learning, Bisk, Fowler, and Perez (2013) found that a "review-pretest-retest" process helps most of the students demonstrate proficiency and move forward with their mathematics program. Post et al. (2010) said there was no relationship between high school curricula and the number of college mathematics courses completed; however, practice, frequent exposure, and high expectations that are clearly communicated have shown positive associations with student growth.

Class selection and placement are aspects to be considered in terms of how they affect student learning. White, Gamoran, Smithson, and Porter (1996) conducted studies that showed students were most likely to complete the college prep requirements if students started out on that track and least likely if they were on the general track. Culpepper, Basile, Ferguson, Lanning, and Perkins (2010) stated that high school course selection significantly predicted outcomes, which suggested several considerations for policymakers when examining the alignment between state assessments and standards and courses in higher education. This is an area where guidance counselors can play a significant role in helping guide individual students in the best direction.

Scheduling is another variable that changes from student to student. The more academically motivated students tend to prefer block scheduling while those who have a harder time concentrating prefer the shorter classes (Salvaterra, Lare, Gnall, & Adams, 1999). The authors further showed that overall, the students who followed a block schedule perceived their high school education prepared them for their college experiences in math. CER (1996) stated that education reform movements encourage block scheduling because it allows for reflection time, deeper connections, collaborative work, informal presentations, and greater student engagement. Block scheduling is also more consistent with the type of schedule students will face in college or in the workplace.

Curriculum and instruction should frequently be evaluated based on summative and formative assessment data and student feedback to ensure learning achievement and growth. Identifying problems early and implementing strategies to assist students, such as requiring more time spent working with the curriculum (Fuligni and Stevenson, 1995), may help students remain in the college preparatory track. Students can improve their knowledge by practicing math skills

just as athletes learning a sport need to put in a significant amount of practice time. Students' ability to make recommendations about their own learning is a goal of personal learning plans (PLPs) being implemented in Vermont (Vermont Agency of Education, 2015).

Student Perception and Voice

Students who feel they have a voice in their learning are apt to be more involved and engaged throughout the process. Ferreira and Santoso (2008) studied the relationship between students' perceptions and students' performance. They found that positive perceptions about learning had a positive impact on student performance. Conversely they found if students had negative perceptions about learning they experienced more negative outcomes. Entwistle (1998) found students' perception influenced metacognitive skills, which affected how they approached their learning and whether or not they completed a required course successfully. Kelly, Lavergne, Boone, and Boone (2012) studied students' perceptions regarding social factors that impact college retention rates and found that the positive social factors were family encouragement and support, making connections with professors, and successful course experiences. The social factors that had negative impacts on student success and retention rate included burnout from too many school responsibilities, poor time management skills, and inability to handle stress (Kelly, Lavergne, Boone, and Boone, 2012).

By having input into their education and how they learn in and out of the classroom, students will be more engaged and take more ownership, increasing intrinsic motivation and improving academic performance. Mitra and Gross (2009) reported that increasing student voice in the process of math education helps students mature and grow as learners and advocate for their own learning. Mitra and Serriere (2012) emphasized that the way to get students re-engaged

in school is to allow them to use their voice to help make decisions that will affect their learning and school community and that of their peers.

Conceptual Framework

The conceptual framework for this research study was based on the premise that there are six areas that influence student success in preparation for college mathematics: improving communication and aligning standards between high school and college; expectations, confidence, and belief in capabilities; transition programs; assessing readiness; interventions and recommendations for high school programming; and student perception and voice. Improving communication and aligning standards between high school and college helps raise student awareness of how to be successful. Stakeholders should work together to develop common goals that become the collaborative professional priority throughout the school. More insight on preparing high school mathematics students for college math may benefit educators and policymakers with instruction and proposals. Clear and high teacher and parent expectations, self-confidence, and belief in capabilities are important factors in a math student's success. True mathematics comprehension will help build confidence for the student. Additionally, expectations need to be clear with high standards. Research has shown that students will achieve the expectations that are set for them—if they are set low that is what the students will achieve (Burrill, 1998). Early detection of students struggling in mathematics can lead to referrals to helpful transition programs to prevent further delays in learning. It is important to find out early when students are struggling, especially with concepts that are continually referenced and built upon. If those students can get help early on, such as in a comprehensive intervention program, they will have a much better chance of attaining expected achievement goals and not fall behind. Assessing readiness can help students understand their strengths and weaknesses as they prepare

for college allowing students to build on their strengths and work on their weaknesses. If students are struggling with organizational skills, they can get help with those skills before starting college. Awareness of their situation and admitting the need for help allows students to take responsibility for their learning and overcome their academic struggles. Preparing for those possible academic struggles includes interventions and recommendations suggested by high school teachers and counselors. Knowing what supports are available in college and how to access them will help students feel more in control of their success. Realizing their own academic capabilities and potential will help students successfully complete the proper classes and program. Student perception and voice is a method more commonly used in recent educational reforms to try to gain insight from the students for guiding curriculum and instruction for better comprehension of the subject. Building on the data and trends identified in the literature review, I interviewed fifteen former high school students and organized their responses into a case study to see what they think needs to be changed in the high school mathematics program to help students be prepared for college math. This study provided participant interviewees a chance to use their voice to effect change in current practices. Assessment data from high school was also analyzed to look for patterns in determining whether students are ready to be successful in college math.

Conclusion

This literature review identified the practices that are currently used to provide math instruction at the high school level and urged educators to implement them more consistently. Six emergent themes from the literature guided the direction of the research about what students should know and be able to do prior to entering post-secondary education and what is needed to prepare students from the offerings available in high schools. High schools must offer a rigorous

mathematics program that aligns with colleges so students can have consistency in their learning. Accurate methods to assess for readiness help students be placed appropriately and give them more chance for success while at the same time flagging areas of concern that might need remediation or intervention. Allowing students a voice in their learning will help them to feel more active and in control of their own learning.

The study addresses the curriculum, instructional strategies, and classroom practices to improve math instruction at the high school level. The stakeholders who may be interested in this study include educators, students, administrators, policymakers, parents, and community members. Mathematics is one of the most high-stakes subjects, which is why I believe this study will be very useful to others.

CHAPTER 3: METHODOLOGY

Historically only a minority of students has successfully completed preparation for the path of high school mathematics courses to post-secondary and college and STEM majors. This lack of mathematics preparation continues to limit students' options in post-secondary programs. Success can be limited due to both the lack of adequate preparation in high school for the rigor of college mathematics and students' ability to navigate the transition to the expectations associated with college mathematics. This case study of one rural high school math program examined student perceptions of their preparation and subsequent transition into post-secondary math coursework. Yin (2014) recommended using a case study method when trying to understand a specific situation. As such, I selected this method to understand and describe the level of preparedness students who graduated from this study site perceived in relation to their college math experience. Data analysis for this study included an examination of participants' high school math courses, final grades, and standardized test scores to identify any patterns or trends that could lead to predictions of college success rates.

The case study findings will be used to inform decision making about math curriculum, instruction, assessment, and advising within the study site and school district. The goal of the study site is to document students' perceptions of their high school mathematics preparation so curriculum and instruction can be strengthened and so future students are able to successfully demonstrate achievement on state assessments and who are prepared for the rigors of college mathematics.

Research Questions

How prepared are high school students to succeed in college mathematics? The following overarching research question was used to create the thirteen interview questions in Appendix D that were used to gather data.

> How do students from a small, rural high school perceive and characterize their mathematics preparation for college?

Sub-questions included:

> How do students describe their mathematics learning in high school (e.g., course taking, peer study groups, tutoring, and support from outside of school)?
>
> Given their scope of preparation, how do students describe their levels of preparedness for college math?
>
> What was their math coursework experience during the first year of college or beyond?
>
> What do students wish had been done differently at the high school level to prepare them for college math courses?

Overview of Methodology

This qualitative case study of one, rural Vermont high school was informed by interviewing fifteen former students about their perceptions of high school mathematics and the transition to college mathematics. Students who went on to take college mathematics described their experiences as learners in high school mathematics and the transition to college. A series of questions were crafted drawing upon the themes identified in the literature review that could be most helpful in understanding student experience and provide data to inform practice at the study site.

A descriptive feedback methodology was utilized in this study (Rogers, 2006). As Yin (2014) suggested, a case study method was used to garner specific feedback from the participants who attended high school at the study site. Student interviews and math assessment data for each participant along with course taking data both in high school and college were analyzed to respond to the research question and provide recommendations to improve students' preparation for success in college math.

Selection of participants included students who graduated from four years of high school in a rural Vermont high school and who decided to attend college. Students who attended this high school were invited to participate in an interview about their high school and college math experiences to gather first-hand information of what each participant felt helped or hindered success in college math. Assessment data of these students' performance in high school were also collected and analyzed for patterns and trends. Two years of participants' data from the Measures of Academic Progress (MAP) assessment and their NECAP (New England Common Assessment Program) scores if available were analyzed. Both of these assessments break down mathematics scores into categories so weaknesses and strengths in certain standards could be noted. Scores from PSAT, SAT, Accuplacer, math courses at each high school grade level, and final total GPA were also collected and analyzed. Student interviews were analyzed to identify themes, patterns, and recommendations for improvements.

Case Study Site

This study took place in a small, rural school in central Vermont. There were 300 students in grades Pre-K through 12 at the time of the study. This school serves a small town of 2,000 people, reflecting mostly a working class background. About 50% of the students at the time of the study were on free and reduced lunch. The average class size in the high school was

low to mid-teens. Each of these demographics trends have been consistent in the recent history of the school, so no notable changes had occurred in terms of the student or community population just previous to the study. The students followed a block schedule on Tuesday through Friday and attended all eight classes on Monday.

The Mathematics Department at the study site had been in the process of revising the curriculum to align to Common Core State Standards and help students improve mandated math test scores that had recently been decreasing. At the site for the study, information regarding Dennis and O'Hair's (2010) concern about the lack of in-depth study of mathematics application was shared with the math faculty. The Mathematics Department faculty reflected on Burrill's (1998) research and concerns related to low student math scores and the state requirements for implementing the Common Core State Standards (CCSS) to inform some of the following strategies for improving student mathematics academic outcomes.

As a result of the research to date about the lack of in-depth study of application in mathematics, the school recently changed math textbooks to those that are aligned with CCSS. Although the new texts follow a more traditional approach than the integrated program that had been used, there is now an emphasis on projects and real world investigations, and the curriculum allows for differentiation of materials for different kinds of learners as suggested by Barnes, Cerrito, and Levi (2004).

Students were taken out of tracked classes and placed in heterogeneous groups for math classes in grades 7–12. Many studies have been conducted to show that tracking promotes inequality (Gamoran, Porter, Smithson, & White, 1997).

Identifying with Richland's (2012) mission of reasoning through mathematics problems, math teachers have a goal to focus on math reasoning as this was an identified area of weakness

in the school during the last NECAP results. In September 2013 the Curriculum and Assessment Team had its first meeting of that year, and it was agreed that analyzing assessments would be a focus of the team for that school year. A representative from the Agency of Education (AOE) met with the team in October to discuss how to use the assessment data.

The team led several district-wide workshops that year to review strengths and weaknesses in student skills, based on assessment data. The Curriculum and Assessment Team offered a workshop at the December district-wide early release in-service to help teachers understand CCSS. The team chose to look at the math practice standards. The team asked for input from each teacher in mixed groups about how they were teaching those standards in the classroom. It was a very successful workshop, and it helped calm fears that some had about not understanding the math standards or concerns about whether or not they were meeting requirements. Although at first glance the math standards might have sounded confusing, the faculty soon realized that the standards could be broken down and everyone was encouraged to describe how the math standards were being taught in their own classrooms. The Curriculum and Assessment Team modeled this workshop after one they attended at the state level.

Participants

This study incorporated a purposeful sample of students who graduated in the years 2010–2013. However, other than the parameter of graduating from this study site, convenience sampling was used by simply interviewing students who were available and consented to participate (Bernard & Ryan, 2010). Because the school is very small I decided to ask students who graduated from 2010–2013 to ensure enough participants and data. All potential participants were sent a letter of invitation in the mail. Participants included only students who graduated from the site who spent at least one semester at college in the past four years. The following is a

breakdown for the year of graduation and students who attended or planned to attend a post-secondary institution: 2010 – 8, 2011 – 6, 2012 – 14, 2013 – 7.

The four-year time frame allowed for a broader range of participant experiences. The participants were generally between the ages of 19 and 23. No students were under 18 years old. There were thirty-five potential participants. It was anticipated that no fewer than twelve students would participate in the study. I chose fifteen students out of those willing, based on scheduling requirements and logistical ease. Males and females were both interviewed, but there were more females than males. Less than 5% of the potential interview pool was non-white students. Students who graduated from the site but did not attend a post-secondary institution were excluded from this study because the purpose of the study was to find out how students perceived their levels of preparedness for college after attending high school in this rural community. However, for future further study, I could include those who were less prepared and did not go to college or who did not feel confident in their abilities to be successful in college mathematics. In four years, a new round of interviews could help determine the effectiveness of strategies adopted from this study based on student voice.

Data Collection

The content of the research questions informed the interview questions and guided the data collection process. Sources for gathering the evidence could have included interviews, documents, or observations (Yin, 2014). Because this case study was based on student perceptions, a decision was made to use interviews as the primary source of data collection.

Instrument and Interview Questions

The interview protocol used consisted of one-on-one semi-structured phone interviews that were recorded for transcription. Phone interviews were necessary since the students were in

the middle of their semesters and scattered throughout the northeast part of the country. Although some students were nearby and could be interviewed face-to-face, the benefits of consistency for this first-time researcher were important to maintain. Thirteen open-ended questions were developed to answer the research question and sub-questions grounded in the research literature and specific concerns identified by the math teachers defined in the case study. The questions evolved with input from several cohort members and advisers in my program. Specifically, changes were made to ensure alignment with the literature review and research questions of this dissertation. Final development came after piloting the study with several students that attended a different high school in the same supervisory union. Those who participated in the pilot study gave feedback on the questions, and changes were made based on some redundancy and areas that needed clarification that became apparent after the pilot.

The interview protocol also included the collection of the following demographic information: name, gender, age, college attending(ed) and size, intended major, and whether or not he or she was a first-generation college student. Data was also collected from each participant's high school transcript that included overall GPA, math grades and courses taken, and standardized test scores.

Bernard and Ryan (2010) described a research goal as obtaining good description, which aligns with my research goals of collecting a wide array of data while maintaining Rogers' (2006) method of descriptive feedback. Bernard and Ryan emphasized the need to get as much information from the initial interviews because "you can always generalize from specifics, but you can never go the other way" (Bernard & Ryan, 2010, p. 9). I addressed this goal by carefully incorporating the themes identified in the literature review into my interview questions, piloting

and clarifying these questions, as well as reviewing the data collected through the pilot study to inform revisions.

During the interview process, good listening techniques were imperative to get valid feedback (Rogers, 2006). I carefully incorporated and attended to the research related to conducting sound interviews. Creswell (2013) reminded researchers to use good interview procedures by staying to the questions, being polite and professional, and being a good listener. Merriam (2009) suggested that, after the first few interviews were completed, the researcher would become more confident and comfortable with the process. The interview questions were open-ended, allowing a more natural flow to the interview while still ensuring that all the topics in the interview questions were covered. Conducting the pilot study was important in developing confidence in the interview questions and process.

Roberts (2010) suggested that the qualitative approach allowed participants to express their experiences from their own perspectives. Merriam (2009) claimed that qualitative researchers were interested in how people interpret their experiences and make decisions in their lives based on those experiences. During these interviews I was cognizant to allow the participants to share more personal and in-depth responses about the transition that impacted their learning positively and negatively.

A copy of the student interview questions can be found in Appendix D. The literature themes identified in the literature review guided the development of the interview questions. This alignment ensured that the findings illustrated in the literature review informed the development of the interview questions used in this study. Additionally, writing clear and concise questions for all participants to easily understand led to obtaining the data needed to develop the findings and recommendations. The pilot study revisions helped ensure the questions were clear and led

to the data needed to inform the research questions. Below are two examples, categorized by themes, from the interview questions that were posed to participants as well as the types of follow-up questions and prompts that were used to encourage all the interviewees to address the topics with enough specificity to provide useful information.

Sample Interview Questions

Theme 1: Communication and Alignment between High School and College

Questions:

1. Compare your overall experiences in high school math classes with your first experiences in college math classes.
    1.1 Compare the pacing of a high school math class and a college math class.
    1.2 How did you prepare for each of those classes?
    1.3 What were some differences in the class settings that stood out to you?
    1.4 How did you learn the material for each of those classes? (independently, tutor, online program, a lab, videos, study partner or group)
    1.5 How do your grades compare?

Theme 2: Expectations—Confidence—Belief

Questions:

2. Describe your confidence level as a high school math student.
    2.1 In what ways did you demonstrate to your teachers your confidence or lack of confidence as a math student?

    (Prompts: offering solutions in class, helping explain steps to other students, were you afraid to speak in class—why?)

3. How would you describe your emotions as you approached a math test or exam in high school and then in college?
4. Describe the math courses in high school where you felt challenged.

Additional Data

Scores from high school math assessments, including both criterion and norm referenced tests, were evaluated and included to identify patterns and trends in order to supplement the student responses to the interview questions. This study captured participants' math assessment data from the study site. The first part of my research included evaluating two years of participants' data from the Measures of Academic Progress (MAP) assessment and scores from NECAP, PSAT and SAT, and high school math grades. NECAP tests are criterion referenced, while all the other tests reviewed in this study were norm referenced. I had access to and permission to use participants' data to identify patterns and trends of successful course-taking and successful course completion in order to make recommendations for improvement.

Data Analysis

Merriam (2009) described the detailed process of data analysis as a balancing act between the concrete and the abstract, between inductive and deductive reasoning, between fact and interpretation. The data consisted of transcribed interviews, highlighting certain information and including notes to code the data, such as prior knowledge, readiness, and leadership skills. The codes were reduced to narrow the study to find themes. The data were organized within a spreadsheet and a qualitative data analysis software program, NVIVO, was used after the first two interviews were organized. Merriam (2009) suggested conducting data analysis in conjunction with the data collection. This allowed important changes to take place after reflection time once the first two interviews were analyzed. A constant comparative method of

categorizing information (Creswell, 2013; Merriam, 2009) from the data was used to help the researcher sort through the emerging results from the data. Validity and reliability were secured by allowing the students to read through their interview transcripts. The data were analyzed from a holistic approach to present salient themes and interpretations within the case.

Demographic information was used to analyze the size of colleges attended, intended majors chosen, gender, and age. Transcript data, standardized test scores, and overall GPA were analyzed to look for any patterns of college math success when analyzed in tandem with the interview data. For example, I compared responses of students who had high GPAs and were above average in standardized test scores and also felt that they were prepared for college math and successfully completed college math courses with patterns of math achievement in students who did not perceive they had demonstrated effort in high school and had mediocre grades in high school.

Participants' demographic information showed patterns for comparison with students who took higher levels of mathematics in college. GPA and test scores were analyzed for students who took calculus in college against those who took lower or leveled math classes from high school. Comparisons were made between the two groups of students with some predictors of success becoming apparent.

Student Protection

In order to keep the identities of each participant confidential within the write-up, aliases were used and the researcher needed to develop case studies on individuals based on a composite picture rather than an individual picture (Creswell, 2013). As the data were collected and analyzed, names were removed and changed to protect anonymity. The researcher should not add data based on previous knowledge of the participants (Creswell, 2013; Merriam, 2009).

Participants were asked to participate in a one-to-one interview for approximately forty-five minutes to respond to interview questions about how prepared they felt for college mathematics courses. High school assessment data and transcript information was aligned with student interview results to identify patterns and trends of course-taking and successful course completion. Participation in this study was voluntary. Participants could opt out of the study any time they chose for any reason. They were encouraged to answer all interview questions, but they did not have to answer questions that they did not want to answer. The results from this study were included in this dissertation as a case study with pseudonyms used. Their answers were not connected to their names, which will never be published as any part of this study. There were no known risks in participating in this study. Participation contributed to a study that will bring much needed knowledge to the field of mathematics education.

Limitations

Limitations of this study included the small number of qualified participants and how varied the responses were within a small case study. A study of this scope and size is not intended to be applicable to other settings. The findings were not easily categorized to provide enough information to find out exactly what makes it possible for students to be successful in college mathematics. The sample of students and higher education institutions they attended varied too much to draw concrete conclusions.

My passion for the subject could have swayed the participants if I offered my opinion to any of their comments or feedback. I refrained from giving my opinion at any time during the interviews. It was important to keep any bias out of the results by reporting on the facts from the study and literature review. Since I have a strong connection with the participants, it was important to recognize the influence prior experiences with students might have on my

interviews. Becoming a good listener, rather than adding to the responses given by the participants during the interview helped me limit my biases (Creswell, 2013).

While care was taken to craft the interview questions so that there was little room for misinterpretation of questions, open ended questions allowed for a broad range of responses. Check and Schutt (2012) warned that potential problems of misinterpreting the questions could lead to ambiguous answers resulting from the way questions were written, the characteristics of the respondents who answered the questions, and the way questions were presented in interviews. I conducted a pilot study and used constant analysis to address this concern.

The role duality of being a teacher and researcher within my organization allowed me certain benefits, such as accessibility to information. I was conscientious not to introduce obstacles to gathering the necessary information from the participants and paid attention to bias based on prior knowledge of the students. I believe my pre-understanding of my organization supported my inquiry in many ways. I have worked in the organization for fourteen years and lived in the valley my entire life. I am very familiar with the culture, the employees, and the community. I have seen initiatives change as the administration has changed. I strived to remain unbiased as I conducted insider action research, especially with the level of familiarity I had with the participants. I made a purposeful effort to leave my opinions about the high school out of my research; otherwise it could have biased my findings and report. I used journaling and reflecting during the interview process. Prior to each interview, I wrote a list of warnings to myself, such as making sure I allowed the participants to completely answer the questions even if I thought I knew what would be said. There was a possibility that students could give “incorrect” responses based on poor memory of events because some of the questions may have participants reflecting back four years. I made notes in my journal about any discrepancies from the interviews that

could be potential recall bias. There was potential recall bias, which typically stems from a negative event, so students who felt less prepared may have biased responses. After each interview, I wrote a reflection in my journal. After reading the transcript, I reflected again to see if I felt there was anything I should have changed before the next interview. I also knew I could have asked my cohort from the doctoral program and my colleagues from high school for any help or advice if I had questions or concerns.

Usefulness of Findings

Many students throughout the country are struggling with mathematics and meeting standards on required testing. There is no magic formula in the way to schedule a day or choose the curriculum in order to have guaranteed student success. There are many factors that need to be considered and examined frequently. What worked one year might not work three years from now, depending on shifts in technology, society, and education requirements. The goal of this study was to identify how high school students can be best prepared to be successful in mathematics in higher education. Results will be shared with any interested educators or administrators and other stakeholders to improve student learning in math. Another benefit could be strengthening the collaboration between high school teachers and higher education instructors and professors to align mathematics standards.

Pilot Study

A small pilot study was conducted with former students from a different school in the same supervisory union. Students who participated in the pilot interviews provided insightful information that allowed me to test the questions and analysis protocol prior to beginning the study. Based on feedback from the pilot participants, I revised some questions for clarity. I also removed some questions that produced redundancy in the data.

Conclusion

This study identified changes that need to take place in the mathematics classrooms to better prepare students for college math. The results from this study may provide useful insight to educators who are now divided between those who think high school math should be more rigorous with those who think the process should be slowed down by teaching to each individual student's needs, allowing them as much time as necessary to master the skills (Wormeli, 2010). This study captured student perceptions about how they learned mathematics in high school and whether that learning prepared them for college mathematics. The High School to College Math Study was designed to help educators and policymakers understand what it takes to make great math classrooms where students leave prepared for mathematics in higher education. The goal of this study was to find out how students felt they learned math best and what experiences made them most successful. It is important to find out if the goals of high school teachers are aligned with the prerequisites of colleges. Aligning those goals more clearly and identifying best practices and skills that need to be mastered before leaving high school will help better prepare students for college mathematics.

CHAPTER 4: RESEARCH FINDINGS

The purpose of this case study was to gather feedback from high school graduates from a small, rural high school in Vermont about their perceptions of how prepared they felt for college mathematics. Hearing from former high school students helped provide experiential information to inform possible changes to curriculum and instruction for preparation of future college bound students.

The data collected to inform this study included fifteen student interviews and participant demographic information. High school transcript data for each participant were also collected and examined to find identifying patterns leading to preparedness and success in college math. Interview data were collected through one-on-one interviews lasting from forty-five to seventy minutes with former graduates from the research study site that had gone on to college. This study sought to respond to the following research questions: how prepared are high school students to succeed in college mathematics, and how do students from a small, rural high school perceive and characterize their mathematics preparation for college? Sub-questions included: how do students describe their mathematics learning in high school? Given their scope of preparation, did they feel prepared for college math? What was their math coursework experience during the first year of college or beyond? What do students wish had been done differently at the high school level to prepare them for college math courses?

An extensive analysis of each interview resulted in three thematic topics and nine sub-themes that are described later in this chapter. Each theme was identified as either the students supported or challenged the most current research literature, with supporting evidence

documented from their direct quotes as well as summaries of the participants' experiences. Implications and recommendations from this data are examined in chapter 5.

This qualitative case study was based on information provided by participants who were former students to inform instruction at their former high school. Because of the small size of the school in which the study was conducted it was often necessary to report findings more generally within the case study format to ensure anonymity of the participants. Other times it was crucial to understand the high percentage of certain occurrences, in which case those points were made using individual statistics.

Participants

Criteria for participants were that students had graduated from high school in the years from 2010 to 2013 and had gone on to post-secondary education. Thirty-five students were approached. After ten days, twelve signed participant consent forms were received. There was only one male participant, and it was important to include the male perspective. Therefore two more male students who graduated earlier than the proposed graduation year criteria were solicited to provide a more balanced gender representation. In the end a total of fifteen students agreed to participate, representing a variety of post-secondary education institutions. The most recent high school graduate, who had just finished her first semester at college, provided an additional perspective about the new high school schedule. By expanding the initial participant criteria a richer cross-section of experiences was obtained. Diversity in perspectives was represented by including males and females, students going to a variety of colleges, and students enrolled in a variety of programs requiring different mathematics classes.

Table 1 describes the institutions students are attending or have attended and other demographic information.

Participant	Gender	Yrs in College	College Demographics	In/Out of VT	HS GPA	SAT	1st Gen	Race
1	F	2.5	Small, private	Out	92.21	490	Y	White
2	F	2.5	Small, private	In	88.58	470	Y	White
3	F	3.5	State	In	92.97	410	Y	White
4	F	2.5	Lg, public, research Univ	In	95.28	630	Y	Asian
5	M	4	State	In	91.99	450	Y	White
6	M	3.5	Lg, public, research Univ	Out	90.81	600	N	White
7	F	4	State	In	94.01	570	N	White
8	F	3.5	Small, private	Out	89.14	540	Y	White
9	M	6	State	In	91.70	520	Y	White
10	F	2.5	Lg, public, research Univ	In	93.84	590	Y	White
11	F	2.5	Lg, public, research Univ	In	95.69	490	Y	White
12	F	1.5	State	In	89.07	540	N	White
13	F	0.5	State	In	88.89	480	N	White
14	F	4	Lg, public, research Univ	In	91.44	570	Y	Asian
15	F	1.5	State	In	94.47	550	N	White

Table 1: Student Demographic Information

Analysis Method

Interviews were recorded and notes were taken during the interview to capture additional details and to provide an opportunity to consider additional questions that arose, attend to possible biases as a research practitioner, or capture nuances of the interview that would not be evident in a recording. After the interview, the transcribed notes were compared to the recording in its entirety to ensure transcription errors were caught. The notes were then corrected as necessary. After the first three interviews were completed, the interview questions were revised to eliminate areas of redundancy and allow for more clarity of the original question as well as to avoid possible interviewer bias in suggesting a particular response. The interview transcriptions

were sent to the participants for final approval of the content. The coding of the interviews and the review of the data went through several levels of analysis to identify themes. Saldaña (2013) suggested researchers begin by coding anything and everything. In order to identify emergent themes, it was necessary to pare down the number of codes. Each of the fifteen interviews was about an hour long, which meant a lot of words and data to sift through. All materials were transcribed, although only a percentage of the content is reported here. After I conducted several rounds of manual coding, a second approach was used to identify themes.

The research questions, theoretical framework, and purpose of the study guided the coding process (Auerbach & Silverstein, 2003). The data was entered into a spreadsheet with fifteen rows, one for each participant, and columns indicating demographic information, high school transcript data, assessment scores, and various topics that evolved during several cycles of coding analysis. The first cycle of coding used the program NVIVO 10 to help evaluate and interpret the qualitative data. Nodes were identified based on that list and another query was run using text search, coding all occurrences of those words to pull out potential themes. The second cycle of coding narrowed the list and identified thematic patterns. In Vivo coding was used to honor the participants' voices and to ground the analysis from their perspectives (Saldaña, 2013). Two more rounds of coding were then done for further clarity: Values Coding and Evaluation Coding. Values Coding included a note specific to each participant—suggesting it was either a value, attitude, or belief—and the Evaluation Code added a positive or negative value from the participant. The spreadsheet was analyzed for patterns in the demographic and assessment information. Three themes were identified and direct quotes were cited in the results chapter to demonstrate the thematic topics.

High school GPA did not correlate with what mathematics courses were taken during college. Courses were determined by program requirements. However, the higher high school GPA correlated with the students' high motivation level and work ethic, which they indicated was partly responsible for their overall success in college.

Characteristics of the participants included:

- Twelve females and three males were interviewed
- Three students were advanced by skipping a junior high math class and taking high school math
- Six of the students (three sets) were siblings
    - Two sets went to the same college, one set went to different colleges
- Ten students were first generation college students, while five had at least one parent who holds an undergraduate degree
- Six students (five female and one male) successfully completed their senior year in the dual enrollment program
    - Two of those six took pre-calculus in high school
- Seven students took pre-calculus in high school (a 4th year math elective) and two students took only three years of math
- Students who successfully completed college calculus or beyond had higher SAT scores
- Students with lower SAT scores, but higher GPA chose equivalent math courses from high school to college
- Twelve students stayed in state while three went out of state for college

Beliefs and values shared by participants:

- All fifteen stated they had supportive parents who were very involved in high school, but not overbearing
- All twelve female students said that high grades and making honor roll were very important
    - All three male students wanted good grades, but realized after they were in college that they should have worked harder in high school holding themselves to a higher standard
- All six dual-enrollment students stated that attending that program was the best preparation they had for college
- Six students took the next harder level mathematics from high school to college
    - Nine students took an easier or leveled math class from high school to college all because of program requirements

The fifteen participants openly shared their responses to the interview questions, giving insightful feedback for this study. Gender appeared to be a factor in the area of motivation as the males made a more profound realization in college that they needed to take their studies seriously, rather than the more lackadaisical approach they held in high school. The female participants were more serious in high school and they described it as a more natural progression of working harder each year, rather than having any big epiphany about motivation. There were several similarities in the students: growing up in a small town, knowing they were going to college and working toward that goal, having personal connections with their high school teachers, and having supportive parents that have contributed to their college success. There were also differences in the students: taking different classes, different learning styles, different

backgrounds, and different interests—none of which hampered their ability to be successful in college. After coding and analyzing the data and highlighting the characteristics of the participants, the next step was to develop themes from the data.

Themes

Themes were developed from the coding process. Bernard and Ryan (2010) indicated that the more the same concept occurs in an interview, the more likely it is a theme. Themes can come from repeating ideas, participant terms, metaphors and analogies, transitions in topic, similarities and differences in responses, and even from what is missing in the data (Saldaña, 2013). The theoretical propositions that initially led to the case study were used to identify the themes present in the interviews (Yin, 2014). Table 2 below shows the themes and sub-themes developed during the data analysis process and how those themes aligned to the literature review themes.

Theme	Thematic Patterns	Link to Lit Review Theme
1	**Personal Connections**	Communication and Alignment
1a	Involved Parents	Expectations, Confidence, Belief
1b	Comfort level	Transition Programs
1c	Small Groups	Interventions and Recommendations
2	**Self-Motivation**	Expectations, Confidence, Belief
2a	Grades Matter	Expectations, Confidence, Belief
2b	Confidence Level	Expectations, Confidence, Belief
2c	Learning Methods	Interventions and Recommendations
3	**Rigor**	Assessing Readiness
3a	4-year plans	Transition Programs
3b	Exam Anxiety	Assessing Readiness
3c	Pace	Assessing Readiness

Table 2: Themes Derived From Data Analysis Linked to Literature Review Themes

Coding procedures easily identified similarities in certain topics where there was 100% agreement from the participants, such as the fact that all fifteen participants said they had

supportive parents who encouraged them to go to college. All six students who went to VAST (Vermont Academy of Science and Technology) their senior year said this experience was the most important preparation for them being successful in college.

Coding procedures also indicated that there was divergence among the participants in certain topics. For example, there was no consensus about how each student "learned math best." Some students said they learned best by working in small groups, while others preferred learning math independently. One student loved online learning, while several others disliked it so much they described in detail how online learning did not work for them. One student loved the integrated approach while another only wanted the old school method of professor at the board moving through topics in a particular order and giving a weekly quiz on all material. Individual learning styles varied too much to be able to identify a best approach method for success.

Thematic Patterns Derived from Interviews

Three major themes and their sub-themes emerged from the student interviews:

- Importance of personal connections
    - Supportive parents with high expectations
    - Important to find comfort level academically and socially
    - Small group learning has benefits
- Importance of self-motivation
    - Grades are important
    - Confidence is gained from being advanced, consistently doing well, or teaching others
    - Practice problems (applied or theoretical) are important to learning
- Rigor is the biggest difference between high school and college

- Need to be intimately involved with 4-year plan and beyond
- College exams are the majority of the grade
- The pace in college is much faster than high school

Thematic topic 1: Importance of personal connection with instructor. All fifteen participants discussed the importance of making a personal connection with a teacher. They all had felt a personal connection to their high school teacher and understood the benefits that created and how it helped them succeed in high school and beyond. The one-to-one attention readily available in their small high school classes created a personal connection where they were comfortable asking questions or performing informal presentations to prove their mastery of a skill. Some attributed their experiences working one-to-one in high school classes to their ability to search out the college instructor and ask for help outside of class. Those who did not feel a personal connection with their college math instructor did not feel as comfortable asking for help or participating in class. A lack of personal connection made it harder to get through difficult material. For some the mere size of the class made them feel that personal connection was unattainable. The following quotes exemplified participants' experience with and desire to have a personal connection with a teacher:

- "I'd ask the teacher if I needed help." (participant 3)
- "When I got to college I had no one-to-one contact with the teacher and that was foreign to me." (participant 12)
- "In high school if I didn't know how to do something I would go to the teacher, but in college it was different because the teacher is extremely busy with over 200 students so I had to turn to my online program MyMathLab for help." (participant 10)

- "In high school the classes were small and the teacher would make sure that we got everything." (participant 5)
- "High school math classes were much more personal with the teacher and getting help." (participant 2)
- "My college math class was much less personal because the classes were so big and that was intimidating." (participant 11)
- "I loved my high school instructor. I liked the personalness of the class that was always upbeat, and we had a great time while we learned." (participant 6)

Sub-Theme 1a: Supportive parents with high expectations are key to success. All of the participants spoke about their parents being very involved in their high school experience with genuine appreciation. None of them felt their parents were overbearing. Their parents did not sit down and work with them on particular assignments. Instead they reported that the parents' support was displayed more in terms of questioning them about what was going on and how things were going. These participants reported that their parents had high expectations for their learning and that getting good grades and preparing for college were also important. Some of their remarks follow:

- "When my parents were involved in high school it usually meant I was doing well." (participant 5)
- "In helping me to figure out a direction to take in college and for a career, I sat down with my parents and talked about where I wanted to live, what I wanted to do, thinking about where I could make money, and if the economy crashes how does that affect my job and career." (participant 6)

- "My parents were really involved because like I said they always expected me to get good grades and then to do my best no matter what. They had really high standards and still do. But I think that really helped me to also set high standards for myself and expect to do well." (participant 2)
- "My parents were very involved and were always asking about my grades and wanted to know what was going on. They always went to parent teacher conferences even when they didn't need to anymore." (participant 14)

Sub-Theme 1b: Important to find comfort level academically and socially. One interview question asked participants how socially prepared they felt to go to college. Although many stated the presence of fear and trepidations they all soon realized they would be okay. They talked about their realization that the sooner they made social connections the sooner they would feel comfortable in their new surroundings, which would help ease them into their academics and new life. Below were some statements made by the participants about social preparation:

- "Socially I was definitely prepared for college—after arriving on my first day I was on a mission to go introduce myself and talk to people—and I have to say I had a great time and I loved it, which made me feel that I was in the right place and doing the right thing for me." (participant 8)
- "It was the first time being away from my parents and I didn't struggle, but I definitely thought a lot about am I safe? Is this what Mom would say? Is this okay? I questioned myself a lot." (participant 6)

- "Part way through the first semester I started to figure things out, got a routine, made friends, and had people I could rely on to feel comfortable around, and then by the end of the first semester it was just a huge sigh of relief to say 'I made it!'" (participant 1)
- "I was really scared to go to college because I could not remember how to make friends, but it worked out fine after a couple of weeks. After that I made friends, and I realized I could do this and I was going to be okay. Orientation was extremely helpful, especially because I was so shy and quiet." (participant 10)
- "I was scared because I was so used to being in a small classroom setting, but I was excited to meet new people." (participant 11)
- "Socially I was definitely nervous just because our school is so small and our town is so small. I had known all my friends since elementary school so I hadn't really met many new people in a while." (participant 13)

Sub-Theme 1c: Small group learning has benefits. Although there was not consensus in this theme, the majority of students felt there was a huge benefit to small group learning. The math program in the high school emphasized collaborative grouping where students were expected to practice over and over until using a math concept became a familiar and comfortable experience. This testimony from students emphasized the importance of carrying on the work in small groups and presenting material. Students had this to say:

- "Study groups have been the best learning tools for me. Nothing is better than sitting down with a group of friends and just trying to figure it out and learning from each other." (participant 6)
- "In all my college math courses we have had smaller groups that are required to meet outside of our class where we work together on weekly projects and a final project. It

helps because it makes you have to study outside of class on other things besides homework—bringing together the theoretical and applied learning." (participant 2)

- "In college I would meet up with friends and do homework together or if there was an exam we should study together and that really helped me because in high school we learned in groups too." (participant 5)
- "I like the high school setup better because you are in smaller groups and all facing each other versus just in rows facing the instructor. It feels more welcoming." (participant 14)
- "I especially like small group learning, where if I didn't understand something it was easy to ask for help and have it explained and then I could do the same for others." (participant 15)
- "College really changed me as a person because I was kind of a shy kid in high school who got really good grades and college opened me up quite a bit because my major required a lot of presenting in small groups that I think helped me a lot as far as being comfortable around people and showing what I know." (participant 5)

Thematic topic 2: Self-motivation is helpful. The participants all felt that being self-motivated helped in their academic success. Some indicated they were always that way, while others said they learned the usefulness of it as they matured through their academic career. Several students indicated that the key to success in college is being self-motivated because the students are responsible for their own learning. They saw the benefits of being self-motivated in completing assignments, going to class, using their resources, and taking full responsibility for their learning. Here are some quotes that revealed students' realization about self-motivation:

- "I am paying for this class. I need to get the most out of this, whether I enjoy it or not, I need to actually get something out of it." (participant 13)

- "I have always been a self-motivated learner. I didn't need anyone nagging at me to do my work. I enjoy the feeling of completing assignments on time. Plus I know I will be the one benefitting in the end and I want to get the most out of my education, especially with how expensive college is." (participant 8)
- "In college you have to be the most active person in your education. You can't rely on the professor to give it to you and just be able to understand it. You have to work at it to make sure you understand the concepts and how to apply it." (participant 6)
- "It requires taking things in your own hands and making sure that you know things and not expecting the professor to know that you get something or don't get something." (participant 15)

Sub-Theme 2a: Grades are important. All of the participants felt that grades were important, some more than others, and some learned the level of importance after a class was over. However, at the time of the interviews, all fifteen participants strived for high grades and felt that in order to continue to do well in classes and prove mastery in the subject, grades had to be taken seriously. Listed below are a few quotes about student beliefs about grades:

- "In my first two years of high school I wanted to do well enough to make honor roll. After that it became more important because I knew I wanted to go into engineering in college and how important those math grades would be." (participant 6)
- "I wanted to make sure I got at least a B or a B+." (participant 2)
- "I knew I wanted to major in chemistry so I knew I had to take several advanced calculus courses. I wanted a good foundation for that and I wanted good grades to be able to get into that competitive program." (participant 4)

- "I definitely pushed to have high grades all the time, except for my senior year when I got senioritis. When my grades dropped it was a wake-up call and so I began to push myself again and my parents did too." (participant 7)
- "I wanted to make high honors to get a free ski pass, please my parents, and in college I wanted to maintain my scholarship." (participant 3)
- "I need to get a B or better to remain in the college I'm in." (participant 4)

Sub-Theme 2b: Confidence is gained from being advanced, consistently doing well, or teaching others. Self-confidence was determined by the participants as an important consideration in mathematics success. The information gathered from the participants in this study showed a clear realization that students who excelled in mathematics were more confident than students who considered themselves mediocre at best. Quotes follow regarding confidence level:

- "I skipped junior high math so that gave me a lot of confidence in my ability to do math." (participant 1)
- "It was not really until I taught something to somebody else that I felt confident in it." (participant 3)
- "Doing little presentations helped demonstrate everyone's abilities well and raised confidence." (participant 12)
- "I was bumped up for math so I was with the older kids, which made me confident. I really enjoyed math, and I liked being in a high school class when I was in junior high." (participant 7)
- "I realized when I was doing well consistently that it meant I understood the material and that helped my confidence." (participant 9)

- "One of my best friends was a better math student than I was. I was always so excited when I could teach her how to do a problem, and that really helped my confidence level." (participant 2)

Sub-Theme 2c: Building on the concepts and practice problems (applied or theoretical) are important to learning math. When asked how they best learn math material the majority of the participants said they needed to learn by building a strong foundation of concepts and then practicing those problems. Most said they learned by doing all the homework and then some needed to do even more extra practice problems. There was discrepancy in preference of theoretical versus applied learning. This is what students had to say about how they learn best:

- "I learn best independently and doing all the homework. I actually like doing worksheets and practicing all the steps over and over until I know I have it down." (participant 15)
- "To learn the material, I ask questions and do my homework and make sure I look over every homework problem knowing that I got it right and the steps I took to get there." (participant 1)
- "I learn best by doing all the homework problems, and I remember I did extra problems to help me practice. I remember that was a big part of it because some things I just don't get and the only way is doing more and more problems." (participant 14)
- "I would do all the homework problems and check all of my answers to make sure I had done them right and if I couldn't get the correct answer I would ask to go over it the next class." (participant 11)

Thematic topic 3: Need more consistent rigor in K–12. Participants mentioned that in some cases they felt they did not get a solid background of math concepts in elementary school, while several other participants mentioned one teacher in particular who had a solid reputation of

letting all students work at a different pace while always pushing them to their full potential. Those recollections were followed by junior high experiences where several students mentioned feeling stalled in their learning. The majority of the participants felt challenged in high school math courses, especially in their junior and senior years. Here is what the students had to say about rigor:

- "I wasn't as challenged in junior high and felt that I lost some skills during that time and had to catch up when I first got into high school." (participant 1)
- I attribute my confident math skills to a teacher in elementary school who pushed me and I was able to excel in math and then skip a grade in junior high. But I feel that I really stalled in 7th grade math because the teacher did not really know how to teach me at a different level than others in the class. So I was sent to the library to work on my own." (participant 4)
- "I was not challenged in 7th grade math. So I talked to the teacher after 7th grade math and the teacher did try to give me some other work to do. I was bored and most of my time was spent helping the other kids, which didn't really help me to progress in one of my favorite subjects." (participant 7)
- "College Prep Math III and Precal were definitely challenging. I wish that it was more consistent all the way through because I don't think I learned much in junior high." (participant 3)

Sub-Theme 3a: Need to be intimately involved with 4-year plan and beyond. One male participant said that each student should be intimately involved with his or her own 4-year high school and college plans. Many other participants discussed the importance of knowing about available opportunities given the academic direction one chooses. The participants suggested that

students should look at several scenarios of different course requirements that allow entrance into certain colleges or programs. The participants also emphasized that the plan should constantly be monitored as goals change or are achieved throughout high school and college.

- "It wasn't until my junior year when I started thinking about engineering and knew I needed to work a little harder in math because I knew I would be using math and science for the rest of my life." (participant 6)
- "It would have helped me more if I took math every year in high school because I did not take it my senior year." (participant 2)
- "In college if you don't understand the material then it's your fault—professors don't hunt you down to make sure you are getting it. You need to understand the importance of passing classes in order to take the next required class. You can easily add required semesters in college if you fail one class and that gets very expensive." (participant 12)
- "I wish I would have gotten help at school to understand what classes and degrees were required for different careers. I felt like I learned a lot while I was in the middle of my program and if I had to do it all over again now I would definitely have done things differently." (participant 9)

Sub-Theme 3b: College exams are the majority of the grade. Many students said they experienced test anxiety, and this is certainly heightened when the importance of the exam was emphasized by making it worth the majority of the grade. Below are student quotes around test anxiety:

- "I had some big time stress in college as I prepared for an exam that was worth 30% of my grade." (participant 8)

- “High school exams are only worth 10% of the grade. College exams are very stressful for me because they are worth so much more and sometimes there are just 3 to 4 grades all semester.” (participant 10)
- “In college it was more difficult and definitely more stressful at exam time because they were worth so much of your grade. I stayed up really late the night before exams, and I woke up early that morning to study some more because I never felt like I had everything done.” (participant 4)

Sub-Theme 3c: Pace of learning is the biggest difference. Participants who took an equally difficult or more difficult level math in college than in high school all said that college math was faster paced. This was a recurring topic when asked what students wished they knew in high school about college math. Many students said they wished they had known about and were prepared for that fast pace. There were some discrepancies in data collected about the topic of pace, because participants who took an easier math course in college felt that the pace was slower in college. Students offered the following on this topic:

- “College is paced much faster, much faster; new material every day.” (participant 6)
- “I was definitely not ready for the pace of the [college] math class.” (participant 5)
- “I felt prepared for my college math classes, but it was presented faster.” (participant 7)
- “I would definitely say that the pacing in a college class was a lot faster; we were covering a new subject each week.” (participant 1)
- “College math classes were definitely much faster and I went to tutoring to help me with that.” (participant 9)

- "My program only required 1 statistics class math course, which I found easier than my high school math classes, and they seemed to go at the same pace or even a little more slowly." (participant 13)

Divergent Themes

There were a few responses that did not reflect the majority of the participants' beliefs. Participants 7 and 14 said they felt the pace in high school was faster than college. They also took lower level math classes in college due to program requirements. They both took pre-calculus in high school. While many felt anxiety during exams, participant 8 said she liked testing when she knew she was prepared. She looked forward to proving her abilities.

Most of the students said grades were very important. Participant 1 said she wished that she hadn't put so much emphasis on grades in high school and made it more about whether or not she learned the material. Participant 2 said she was less concerned about what grade she got, but rather did she "learn" her money's worth?

Summary

The purpose of this study was to document students' perceptions about preparation for college mathematics. Interviews were analyzed along with student assessment data and demographic information to identify themes and patterns. This chapter described in detail the participants interviewed and how those interviews and other pertinent data were analyzed. The thematic topics that evolved from the extensive and all-inclusive review of each interview were broken down and detailed. Three key factors identified by participants were: Connections, self-motivation, and rigor.

Connections—the importance of making a personal connection with the instructor. Students recounted how they learned the importance of personal connections after leaving the small school they grew up in. After arriving at their new school where they did not know anyone they realized the importance of being able to go to the teacher for help when they did not understand a new topic, how to apply a formula, or how to do specific steps in a process. Participant 10 realized when she arrived at college that she took for granted the logistical ease of working with her teacher and found that she had to wait for office hours, which did not always coincide with her free time and could be a mile away from where she otherwise needed to be. Still, participant 2 understood the importance of getting to know her instructor so that she felt comfortable going to ask for help when she needed it. She understood that based on her experience from high school.

Self-Motivation. Self-motivation is an important factor in being successful in school. The data suggested that the females were more self-motivated in high school, and the males realized the need for this toward the end of high school or when they arrived at college. However, at the time of the interviews all fifteen participants stated they took most or all of the responsibility in their learning and understood that was a crucial factor to their success in college. Participant 11 stated that she takes a high level of responsibility by attending all the lectures, completing all the assignments on time, and making sure she understands how to apply the problems.

Rigor. Students said that college math classes were more rigorous—noting the difference between the increased amount of material to get through and the faster pace to learn it. Many commented on their desire to have classes in their senior year of high school more closely resemble college by going faster, requiring more independent work, and holding the student fully

accountable with their grades by not allowing a lot of extra credit opportunity or retakes as those opportunities are not readily offered in college.

The majority of the participants agreed on the following sub-themes: supportive parents with high expectations are key to success; it's important to find a comfort level academically and socially as soon as possible after arriving at college; there are benefits to small group learning; realizing that grades are important; confidence is gained when a student learns and masters the skills; understanding how each individual learns best and then practicing those methods is important; knowing the 4-year plan and beyond will help keep students focused on their goals; college exams are the majority of the grade; there needs to be better preparation for the fast pace that students will be exposed to in college.

The patterns and trends that emerged from the student transcript data indicated that all fifteen students were successful in high school with a GPA of As and Bs. GPA did not correlate with SAT scores, but students with higher SAT scores generally went into college degree programs requiring higher level mathematics. Ten of the participants were first-generation college students, but all fifteen students said they had supportive parents who were critical to their college success. Participants indicated that even parents who did not go to college were crucially important to their success in college by being supportive and involved all through high school, setting high expectations that were clearly communicated, and caring about what was going on at school. A detailed account of the thematic patterns linked to the literature review along with recommendations and implications follows in chapter 5.

CHAPTER 5: CONCLUSION

The purpose of this qualitative case study was to find out how students from a small, rural high school perceived and characterized their mathematics preparation for college. A review of the literature led to the development of the six research themes that guided the study interviews. Research themes were: improving communication and aligning standards between high school and college; expectations, confidence, and belief; transition programs; assessing readiness; interventions and recommendations for high school programming; student perception and voice.

Lacking in the research cited was a focus on what styles and approaches to learning produced students who consistently felt prepared. For example, some educators suggested that students should be allowed to take a test as many times as they want (Wormeli, R., 2010). Students from this study vehemently disagreed with that approach because they did not feel it prepared them for college or for the working world since in their experiences they were not offered opportunities to re-take exams.

The responses from participants were aligned with the literature research conclusions. This chapter concludes with recommendations for different stakeholder groups that could help direct instruction and course offerings to better prepare students for mathematics in college.

Review of the Study

Interview responses were analyzed for patterns of students' perceptions about their preparation for and their level of success in college mathematics. Several strong conclusions were made by the consensus of responses to certain interview questions. A few questions led to

split responses, where conclusions were drawn based on several other factors, such as gender, course preparation, maturity level as reported on by the individual participant, and time and effort. Other questions produced data that provided no common conclusions based on the varying responses and discrepancies in the answers.

Findings

The three themes derived from the data analysis included: personal connections, self-motivation, and rigor. Participants described how each of these themes affected their preparedness as a learner. Other topics analyzed when making recommendations included: years of high school math, working with peers, study habits, course-taking patterns in college, and transcript data.

All of the themes and sub-themes linked back to the literature review (see Table 3). The majority of the students in this case study said they felt prepared for college mathematics and they attributed this to having successfully completed certain high school math classes or having mastered a particular style of learning that was more conducive to the way they learn best. The majority of the participants had mostly all As and Bs for their high school math classes and high overall grade point averages (GPAs). The majority stated and the demographic data correlated that their college math grades were similar to their high school math grades, indicating that the strategies and skills they had learned and used to be successful in high school mathematics classes were carried over to college where they continued their success.

Students who were able to take higher level mathematics, such as calculus and beyond had higher SAT scores. Other claims of success came from nine participants who took precalculus, the highest math class offered at the participating school, and four who took math at the local college while completing a year of dual enrollment of high school and college. These

opportunities were important for students to be able to choose from in order to help them prepare for mathematics in a post-secondary school.

Personal Connections

Students felt they could be more successful when they made personal connections with their instructors. All participants appreciated their supportive parents and connected those relationships with their success. Relationships were mentioned over and over again during the interviews, as these students who lived and grew up in a small town going to a small school realized their importance. Students could see that personal connections with instructors can help with learning in many ways—being comfortable to learn without fear, knowing help is always available, understanding that the goal is for learning and a teacher is willing to offer help outside of class, and knowing that someone cares (Eley, Charles & Leeks, 2013).

The majority found working in small groups very helpful. Many mentioned that once they were able to teach a math problem or concept to another student they really knew they understood it themselves. Working with (and teaching) other students was a skill that helped them to meet new people and make new friends because they would set up study groups to do homework together and study for tests. This skill directly related to the integrated curriculum they used in high school that focused on a collaborative group effort. Some students preferred to work independently, especially those who were required to use the online MyMathLab program, which offers step-by-step solutions that the students could walk through in order to learn the material (Pearson Education, 2015).

Self-Motivation

The students stated that their success in college mathematics was dependent on their level of self-motivation. The participants made recommendations to better prepare current high school

students, including emphasizing self-motivation, by adding a statistics course as an elective, and making sure the pace and rigor matched that of a college math course. When asked to elaborate on self-motivation, students spoke about the maturing process. The males in the group said they were not as self-motivated in high school because they did not really need to be. They did a minimal amount of work to do well in their classes and did not really understand self-motivation until they got into college where they needed to work much harder to get the equivalent grades they were used to receiving in high school. Three of the females followed the same pattern as the males—learning about self-motivation once they got to college. Nine of the females felt they were very self-motivated in high school, setting high achievement goals and working hard to reach those goals. They felt their self-motivation was a contributing factor to their success in high school and college (participants 1–15, personal communication, February, 2015).

All participants who took four years of high school mathematics attributed their later success in college mathematics to their successful completion of those high school courses. Male students admittedly felt they could have put more time and effort in during high school to help better prepare for the rigors of college mathematics. Students who took three years of high school mathematics wish they had taken four years because they felt they lost too much during the gap year. It also made them more nervous going into their first college math class being uncertain what to expect because of that break. Students varied as they described their mathematics learning in high school.

Many students suggested that going through the examples, doing the homework and practice problems, were key elements to their success. Fuligni and Stevenson (1995) agree that repetition is required for mastery. A couple of students who were required to take calculus in

college tried to stay ahead of the material by previewing the material before class, an approach also recommended by Bisk, Fowler, and Perez (2013).

During the first year of college the students took a variety of math courses, including finite math, business math, pharmacy math, accounting, statistics, tech math, precalculus, and calculus. Although many students felt prepared, they also felt nervous going into the class. The unknown of a new school, a new instructor, and new living quarters can all be overwhelming. This group of students overcame those nerves and settled in as quickly as possible, finding their way socially and academically. Their reports of that first semester experience, however, were varied. Some students realized that after their first few grades were in that they were doing well and would be just fine. A smaller group did not do so well on the first exam and that became a quick wake-up call for them. By their own admission they matured a lot in that time in their lives and soon became very self-motivated and involved in their own learning. Several students took an easier math class in college than they had taken in high school and became comfortable in class very quickly when they found they already knew the topics being covered. When asked why they took that particular math they unanimously answered that it was what was required. This finding indicates students do not feel comfortable advocating to take a more challenging class outside of their program requirements. One of these students who had already graduated said she knew the course would be an easy A and that was fine with her. Students should be more informed of different options when classes that are too easy are required for them so that they can get value out of the class for which they are paying.

Rigor

The students commented on an increased need for independent learning to get through the required material. There was an apparent difference from high school where all of the new

topics were learned in the classroom, and those skills were then practiced and extended for homework. In college, many of the new topics had to be learned independently outside of the classroom, while continuing to practice and extend the previously learned skills, requiring more topics to be mastered in between classes. The pace of their college mathematics class was surprisingly faster to many participants and something they wished they had been better prepared for. Achieving the right pace in high school classes can be difficult, especially with heterogeneous groups. As noted in the literature review, Barnes (1999) warned that "university teachers virtually never face an untracked group of students, which is a significant hidden privilege" (p. 293). High school teachers are encouraged to have heterogeneous groups for reasons of equity, modeling, and collaboration. Individualized learning at one's own pace is a focus of Proficiency Based Learning (PBL) requirements being mandated for high schools in the new education reform by the year 2020. Until then, the pacing of and differentiation within high school courses will continue to be an important topic in education.

Summary of Student Perceptions

In general students felt they were prepared for mathematics in higher education. Only one student had failed one math course and was retaking it at the time of the interview. All other students had successfully completed their college mathematics classes on their first attempt.

When asked what students wish had been done differently at the high school level to prepare them for college math classes there was once again a variety of responses. Those responses included taking four years of math and not taking a year off of math in their senior year, offering a statistics class senior year so that there is a choice between that and pre-calculus, making the senior year math just like college freshman math with a fast pace, independent learning, grading tests only, and not offering retake tests.

The students' insightful responses informed recommendations from this study. Student perspectives and voice can be so powerful and provide educators with great insight, especially after a developmental growth period at the end of their teen years and into their twenties.

Interpretations of Findings

Many of the students develop their metacognitive skills as they begin their higher education. During their secondary education, they are usually told what they have to do, how they have to do it, and when it should be done. They do not have to think about how to learn. Once students get into college they realize that so much of their learning needs to be done independently. Some students are ready for that and others have to spend some initial amount of time learning how to learn. Personal Learning Plans and Proficiency Based Graduation Requirements should encourage metacognition at a much earlier age. This will take training and it will be a new concept for students in high school. Linking the thematic topics from the interviews with the research themes (see Table 3) from the literature review helps reveal opportunities for change and improvement.

Theme	Thematic Patterns	Link to Lit Review Theme
1	**Personal Connections**	Communication and Alignment
1a	Involved Parents	Expectations, Confidence, Belief
1b	Comfort level	Transition Programs
1c	Small Groups	Interventions and Recommendations
2	**Self-Motivation**	Expectations, Confidence, Belief
2a	Grades Matter	Expectations, Confidence, Belief
2b	Confidence Level	Expectations, Confidence, Belief
2c	Learning Methods	Interventions and Recommendations
3	**Rigor**	Assessing Readiness
3a	4-year plans	Transition Programs
3b	Exam Anxiety	Assessing Readiness
3c	Pace	Assessing Readiness

Table 3: Connecting the Data Analysis Themes with the Literature Review Themes

Communication and alignment of standards between high school and college

Initiatives need to begin in Vermont to align high school and college curricula and standards, especially as changes happen during the 2015–2016 academic year. Communication around alignment of standards is imperative to student preparation and success in college. As Mangan (2013) noted, this communication is missing in the current push of education reform. Students realize the importance of personal connections. They have close personal connections with their high school teachers and many of them can have that same type of connection with their college instructors, which will help them understand the standards they are to meet in college.

Expectations—Confidence—Belief

The majority of the participants said they felt they took full responsibility for their learning. One felt more could have been taken in high school, while others felt that as they matured they understood that it was really up to them to take charge of their learning. The students discovered that is such an important step in success in mathematics—to understand metacognitive abilities and how to get the most out of every learning situation. Corroborated by Barnes, Cerrito, and Levi (2004), many of these participants found their success can hinge on the amount of time and effort they put into a math class, and that they are the only ones that can really make that happen. While many of the participants had different learning styles that worked or did not work, understanding that achieving their learning is their own responsibility was crucial to their success.

Some students find that they work better with more structure—strict deadlines and grades for every piece of work. However, many college courses do not function that way so it is

important for students to either learn how to adjust, or be creative and come up with their own structure to help with that particular learning style.

All of the participants spoke with the utmost respect about their parents and that relationship. All of the parents were very involved in their children's high school education, but interestingly none of the parents were involved in course selection once they got to college. From the students' perspectives they were there for them all during high school and taught them how to advocate for themselves and the importance of knowing how to continually be looking ahead and at the big picture of all four years to ensure getting in the right classes at the right time.

Transition programs

Students often do not see the value of something until afterward. One participant who was required to complete a summer bridge program found it very difficult to give up his entire summer. As described by Goonatilake and Chappa (2010), after it was over and he realized how much the bridge course prepared him for required classes for his college program, he understood how important it was. We need to educate students about their options or required tasks to help them see that value before it is over so that they can understand why they are doing what they are doing and can then get the most out of the experience.

Assessing readiness

Students who took pre-calculus at the study site and went on to take calculus in college all responded that this was good preparation because the pace was fast, homework was not graded, the majority of the grades were quizzes, tests, and exams, and that this was the best preparation for college calculus. A rigorous high school curriculum and Advanced Placement courses have been connected to college-readiness (Combs et al., 2009) and the study participants agreed. They all prepared for college by taking college prep math courses. Some chose to go to

Vermont Academy of Science and Technology (VAST) as a dual enrollment program during their senior year, which is becoming more common, especially because those credits transfer more consistently than credits from AP classes.

Interventions and recommendations

Culpepper et al. (2010) and Corbishley and Truxaw (2010) agreed with the study participant students that in order to be successful in college mathematics it is helpful to take four years of high school mathematics. The vast majority of the study participant students also think that small group learning is beneficial in many ways. Small group learning helps the student to discover where there are gaps or missing steps, and when a student can successfully teach a concept to another student in a group is when mastery of the skill has been proven. Students also recommend doing practice problems until the concept has been mastered.

Student perception and voice

Students want to be prepared, not scared. They can handle being nervous, as anyone is when they start something new, but a couple of students felt scare tactics were used in trying to prepare them for life after high school. Instead of preparing them, they felt this caused undue anxiety. Students made recommendations in this study on how to help future students be better prepared for college mathematics. Their ideas can also help educators, administrators, and school board members as they begin to rework action plans and goals for the upcoming year. Stakeholders should remember to listen to students and use their insights to help increase learning and level of preparedness. As Mitra and Serriere (2012) emphasized, the way to get students re-engaged in school is to allow them to use their voice to help to make decisions that will affect their learning and school community and that of their peers. The students who

participated in these interviews were completely engaged and excited to share their perceptions. They appreciated the chance to have their voices heard and to try to help others.

Recommendations for Action

The following recommendations are suggested for the study site organization, based on the results of this research. If these suggestions are implemented, it is important that they be tracked to provide future data of the usefulness of these changes. Along with tracking these changes, it will be imperative to also track future changes in education that are likewise being mandated, such as Personal Learning Plans and Proficiency Based Graduation Requirements. All stakeholders can benefit from the information in this study, especially at a time when reforming the way we teach and learn is in the headlines daily. It is important to remember to listen to the students' voices. Too often we hear from people who claim to be experts or who have a lot of power and are instrumental in making change but who have little teaching experience in the classroom and know little about today's students. This study provides stakeholders with current information from the extensive literature review and through review of student interviews—the best way to include student voice.

The recommendations that follow were suggested from the students based on their perceptions and experiences. My own recommendations follow the bulleted list under each theme. My recommendations are based on fourteen years of experience as a high school mathematics teacher and the insights I gleaned from this study. While these ideas are strongly suggested, it is with the understanding that it will be impossible to immediately implement all changes in this small school.

Personal connections

- The importance of personal connections between teachers and students is essential and was discussed at length during the interviews. Focusing on these connections will help students know there are adults they can go to for help and advice. Teachers who have personal connections with students and have developed a trusting relationship can also help with exposure and awareness of outside programs that will help better prepare them for college.
- Students need more preparation for their four-year plan in high school and time to go over different requirements for various college programs, especially if they know in which field they want to major. Even if they do not know, they could go through a course catalog and pick three different majors to see what the requirements and prerequisites are so they can understand how the process works. The course selection process is very foreign to students coming from a small school where there is very little choice about what classes they can take because there are so few electives offered. Students need more experience in this process before going to college, when it can be overwhelming.
- Students need more preparation for the possible change in class size and school size. The majority of students in this study attend the largest university in Vermont and that is a huge adjustment for them—going from a senior math class of 6–10 to 200. Getting students to sit in on a college class or encouraging summer programs that would allow exposure to working in bigger groups would be helpful.
- Some colleges use the online program MyMathLab and it would be helpful to give students some exposure to this type of learning while still in high school because it is so different. Programs used will vary greatly among various colleges.

Researcher recommendation: I believe personal connections are an extremely important factor of the learning process in school. As we implement the teacher advisory (TA) system next year this personal connection will become more evident. Each teacher will have approximately ten students they are responsible for in their advisory. This will allow time for those connections to develop while teachers have important conversations with students about their learning preferences, staying on track in their classes, discovering personal interests and passions, exposing them to outside opportunities, and encouraging them to apply for programs that will help them prepare for life outside of their school. As students develop their PLPs and continue to update them, the school guidance counselor should offer personality and career tests that could help guide students by matching their passions and preferences with degree programs and jobs. Educating these students early in their high school years could help inform important decisions about what direction to take for coursework and program planning.

Self-motivation

- A statistics course should be offered as a senior year elective for those not needing pre-calculus. The majority of the participants had statistics as a requirement in their college programs. They all stated it would have been helpful to have exposure to introductory statistics.
- Students should understand the importance of taking a fourth year math class if they are going on to college. They will most likely have some kind of math requirement and those who did not take math in their senior year struggled with that amount of time lapse in their learning and really wished they had taken math all four years.

Researcher recommendation: I would like to see statistics offered as an alternative senior year math course and strongly recommend statistics or pre-calculus for any senior going on to

college. Currently, pre-calculus is the only fourth year math class offered at the study site high school. Students going on to college with majors not requiring higher level mathematics might be better suited for statistics and feel that it is more relevant to their upcoming majors while still keeping them active and progressing in mathematics.

Rigor

- By the time students are seniors, their classes should be much faster paced and require more independent work. Students suggested doing away with retake tests to improve their grades in their senior year because that approach is not practiced in college. Occasionally there might be a chance to redo an assignment, but it is uncommon. It is a good lesson to learn about perseverance and to accept the grade and move on. Learning that perhaps it is necessary to put more time and effort in the next time. If, in high school, students always get the chance to take something over, especially in order to always get that A, then that is not truly preparing them for what will happen in college. According to the students, allowing unlimited time for tests and exams is another way that high school instructors are failing to prepare students for college exams.
- Dual enrollment or early college programs should be supported and encouraged for those who are ready to begin college in their senior year. It is obvious from this study how beneficial VAST was to all those who participated.

Researcher recommendation: The pre-calculus class offered should be examined to ensure rigorous and fast-paced learning, requiring independent work to successfully complete the course. Continued grading of quizzes, tests, and exams with few opportunities of retake tests puts the majority of the grading emphasis on the assessments, similar to the approach used in most college mathematics courses. Other teachers who are teaching senior level courses should be

encouraged to use a similar and consistent approach. I believe in offering retake tests, especially in the earlier high school years when it is as important to teach how to study as it is what to study. However, it is also important for students to learn the necessity of putting in the time and effort to learn the skills and to properly prepare for tests. A reasonable compromise would be to have fewer retake opportunities during senior math classes to help students better prepare for testing procedures in college math.

Students could definitely benefit from an introductory statistics course. A budget to introduce this new course should be presented to the administration to gain appropriate support and approval. There have been discussions about offering dual enrollment courses in our school and this would be an excellent class to begin with. This could benefit the students by exposing them to a college level course that they could take in the comfort of their own high school. It could also begin important discussions between high school teachers and college instructors in aligning courses.

Teachers should be encouraged to learn about dual enrollment programs and how they have helped students, rather than discourage students from participating based on prejudged notions about the program or their belief that students are not ready or do not “deserve” to go. One of the participants who went to VAST is now crediting that program for the desire and motivation to one day obtain her Ph.D. This was a student who proved several teachers wrong when they verbalized she should not be allowed to go because she was not ready academically or based on her maturity.

Recommendations for Further Study

Future studies should include research from students who have met Common Core State Standards and taken the new and revised tests (SBAC, SAT, ACT) to see how change in

emphasis on applied learning has affected preparedness for college. Developing a system for continuous follow-up with high school graduates who have gone on to college will ensure students have a voice in what made a difference in their learning. An important study could look at how high school math teachers could increase the rigorous nature of the work while attending to best teaching practices. Another useful study would be to hear from students who chose to go directly to the career sector to see how prepared they were for that industry and to gather data about why they chose that route instead of college. Finally, another study that could be specifically useful for the field of mathematics is looking at students who went to schools focused on STEM learning and to do a comparison of how successful they were compared to students who went to traditional public school to see if there was proof of benefits of one type of school versus the other.

There are a lot of changes happening in education that will require future studies regarding mathematics preparation. The implementation of Personal Learning Plans and Proficiency Based Graduation Requirements will change how education looks on the Pre-K–12 level. It is unclear at this time how or if post-secondary programs plan to align to these new approaches. High school and post-secondary assessment alignment will need to be addressed by elected officials to ensure that students can be properly prepared to be successful. This should be done in conjunction with efforts to improve funding in higher education so that it becomes more accessible to all students.

Conclusion

In summary, the literature review, qualitative interviews, and data analysis provided a deeper understanding of student perceptions of their preparedness for mathematics in higher education. Students generally felt prepared and linked that feeling to many important factors.

Results from this study can be shared at a faculty meeting and school board meeting. Copies of the dissertation can be kept on file at the school library for anyone to read. Action items could be discussed with administration to see if any or all of the recommendations could be implemented.

Fifteen students willingly participated in this study and offered insightful perspectives of their high school and college years, specifically focusing on what makes them prepared for mathematics. There were a couple of instances where incorrect information was given, due to incorrect recall, in which case that information was disregarded.

People will always learn differently, and it is impossible to find one style that is best for everyone. In fact, we are moving further from that notion of one style of teaching for all leaning through the creation and use of personal learning plans. It is not clear if colleges will be adjusting their curricula or methods to align more with the reforms currently happening around primary and secondary education. However, there were some patterns discovered in this research, and if the proposed changes were implemented they could help students feel even more prepared for college mathematics.

The students in this study came from a small, rural school where students do not slip through the cracks. The individual attention and help students receive is an important part of their success. They have gained confidence from growing up in this comfortable and caring environment and that has helped shape them into the young adults they are as they prepare to become totally independent. Learning about relationships and how to advocate for themselves are factors to be considered. The students are serious about their studies, although that level of seriousness varies, and they are all still in school and on track to finish their degrees if they haven't already. Participants from this study believed that students from a small school can be

prepared and successful in college mathematics. Continuous adjustments to curriculum and instruction need to be evaluated while consistently studying available data. Being prepared for college is not a linear process that is one change and done. Educators must constantly be looking for changes in society and technology to consider ways students can learn best. This is an exciting time to be in education, but also an unsettling time with so many changes in the pipeline. This study provides student perspectives about learning and could be helpful to everyone within the study site organization and in similar settings elsewhere.

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APPENDIX A: Definition of Key Terms

College Readiness—A combination of academic skills and soft skills, knowledge, work habits and motivation necessary to take college courses for successful completion in a degree program. Reschke (2005) defines college readiness as "the degree to which a child is predicted to succeed in the school environment" (p. 1).

Common Core State Standards (CCSS)—The Common Core State Standards provide a detailed description of what all students in K–12 are expected to learn in English and mathematics. This state led initiative is voluntarily joined as a way for teachers and parents to help make sure students are meeting all the requirements. Having clear standards such as Common Core State Standards is helpful in developing curriculum mapping and lesson plans. Forty-five states, the District of Columbia, four territories, and the Department of Defense Education Activity have adopted the Common Core State Standards (National Governors Association, 2010). Assessments called SBAC (Smarter Balanced Assessment Consortium) will be available in the 2014–2015 school year to see whether students are achieving the educational standards of CCSS.

Confidence—How well the students think they know their subject. Students need to feel that they have the ability to be successful in math. Once they feel that they can do it they will want to work harder and the will be more intrinsically motivated. Nebesniak & Heaton (2010) observed that students who were confident would ask questions, be willing to try approaches, make mistakes, and learn from those mistakes. They found that confident students resulted in increased conceptual understanding, which is what so many researchers and educators say is imperative in the foundations of their learning (NCTM, 2000; McCormick & Lucas, 2011).

Exposure and Effort—More practice on applications and giving a valiant effort are seen as ways to help improve overall learning in mathematics. In the literature review authors discuss how to help high school math students become more proficient; often that comes down to more exposure and more effort (Fuligni & Stevenson, 1995; Bisk, Fowler & Perez, 2013). This is likened to learning an instrument or playing a sport—the more effort a student puts in along with more time, the better he or she will get.

Math Preparedness—The concept of mathematics students leaving high school with the necessary skills mastered to begin taking and being successful in math in higher education. Corbishley & Truxaw (2010) found that math preparedness is too often only in the eye of the instructors and not the students. This study will investigate student perceptions of math preparedness.

Rigor and Expectations—The importance of an appropriately challenging curriculum. Students should understand they are going to need to work at learning the new topics and material. In this literature review authors discuss the need for high school math teachers to have challenging classes and set high goals for students to work on in order to properly prepare them for the next level. Without rigor aligned to standards and high expectations, student proficiency will be lower than expected as a foundation for success in college mathematics courses. Corbishley & Truxaw (2010) found that instructors' perceptions of students who were prepared for college mathematics included students who took rigorous math courses including a senior math.

Soft Skills—These are skills often related to EQ (emotional intelligence) that show how a person can work efficiently and effectively by using broad skills such as attitude, coach-ability, collaboration, communication, initiative, persistence, problem solving, professionalism, self-discipline, teamwork, time management, and work ethic (Casner-Lotto & Barrington, 2006).

Experts say that too many young people are leaving high school and going on to postsecondary education or the workforce without these essential skills to become well-balanced leaders and to participate long-term in the national, state, and local economies (Gaines & Mohammed, 2013). Some schools are now adding this list of skills to be mastered along with other standards prior to graduating, while realizing that for it to be effective, it needs to be done Pre-K–12, not just in the four high school years. For example, one teacher might assess a student's willingness to help another student who is struggling on a particular concept. Another teacher might analyze different roles in groups where they are always changing those roles, such as scriber, reader, and presenter. This is part of the mixed messages educators receive—the need to teach more soft skills, while pressure continues to be placed on the results of standardized testing.

Student Perceptions—Studies involving what students think about their learning and its effect on the outcome in education have been around for years (Ramsden, 1997; Prosser and Trigwell, 1997; Entwistle, 1998). Ferreira & Santoso (2008) focused their research on accounting students and found that positive perceptions about their learning had a positive impact on their performance and the inverse was true as well. Student perceptions can be a crucial component in academic success and I have not found many studies focusing on students' perception regarding mathematics, which is what this study will focus on.

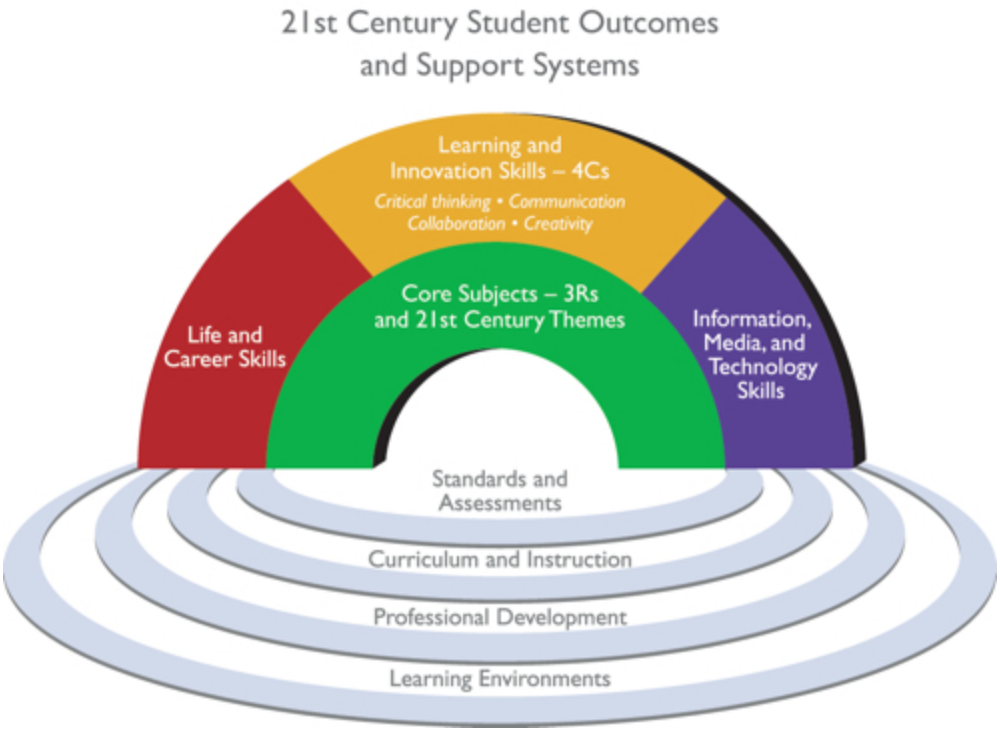

Figure 2: Outcomes and support systems. *Partnership for 21st century skills* (2014, January).

Twenty-First Century Learning Skills—These are the skills necessary for a student to be prepared for the twenty-first century and beyond. All skills are interconnected and should be worked on together and mastered in order to be prepared with the expectations of employers, instructors, local and national officials and politicians, and to become a conscientious and contributing citizen. The graphic in Figure 2 from the 21st Century Skills website (January 2014) represents both twenty-first century student outcomes (as represented by the arches of the rainbow) and twenty-first century learning support systems (as represented by the pools at the bottom).

APPENDIX B: Participant Outreach Letter

High School to College Math Study

Participant Outreach Letter

My name is Wendy Pratt. I have been teaching high school mathematics for thirteen years. I am enrolled at University of New England in a Doctoral Program in Educational Leadership (Ed.D.). As part of my dissertation I will be conducting a study to analyze student math achievement data and to interview former high school math students about their math preparedness for post-secondary courses.

The High School to College Math Study is designed to help educators and policymakers understand what it takes to make great math classrooms where students leave prepared for mathematics in higher education. The study includes 12–15 college students who graduated from a Vermont high school. The purpose of the study is to share best practices and describe what students think is most important for being prepared for college mathematics.

Participation in the Study

You are being asked to participate in a one-to-one interview for approximately forty-five minutes, conducted by myself, for data collection about how prepared you felt for college mathematics courses. Your high school assessment data and transcript information will be merged with your interview results to identify patterns and trends of course-taking and successful course completion that may indicate some best practices that could be used for all students to feel prepared. Participation in this study is voluntary. You may opt out of the study any time you choose for any reason. I encourage you to answer all interview questions, but you do not have to answer questions that you do not want to answer. The report from this study will be included in my dissertation as case studies with pseudonyms used. Your answers will **not** be connected to your name which will never be published as any part of this study.

Risks and Benefits

There are no known risks in participating in this survey. Your participation will contribute to a study which will bring much needed knowledge to the field of mathematics education.

Contact Information

If you have any questions or concerns about this study or your rights as a participant, please do not hesitate to contact me at wpratt@une.edu or by phone 802-767-4968.

APPENDIX C: Participant Consent Form

CONSENT FOR PARTICIPATION IN RESEARCH

Project Title: Students' Perceptions about High School Preparation for Mathematics in Post-Secondary Programs

Principal Investigator(s):
Wendy L. Pratt, M.Ed.
University of New England
Doctoral Student, Ed.D.

Advisor(s): Dr. Michelle Collay, Dr. Pamela Flood

You have been invited to participate in a study that documents student perceptions of their preparedness for mathematics in college. You will be asked interview questions over the phone that will give information about how well prepared you were and how successful you felt you were in mathematics. The interview will take approximately forty-five minutes. Approximately twelve students will participate in this study.

The goal of this study is to find out how students feel they learn math best and what experiences have made them most successful. It is important to find out if the goals of high school teachers are aligned with the prerequisites of colleges. Aligning those goals more clearly and identifying best practices and skills that need to be mastered before leaving high school will help better prepare students for college mathematics.

The purpose of the phone interview is to gather information about your experiences and math skill mastery in high school, college, and general education.

Please read this form. You may also request that the form be read to you. The purpose of this form is to provide you with information about this research study, and if you choose to participate, document your decision. You are encouraged to ask any questions that you may have about this study, now, during, or after the project is complete by speaking with the principal investigator, Wendy L. Pratt (wpratt@une.edu, 802-767-4968).

As I prepare to set up the phone interview, please be advised of the following:

- You can decide whether or not you want to participate; kindly make your decision within a week of receipt of this invitation.
- Your participation is voluntary, and your responses are confidential.
- Your decision to participate will have no impact on your current or future relations with the University of New England or your employer.

- If you choose not to participate there is no penalty to you and you will not lose any benefits that you are otherwise entitled to receive.

- You are free to withdraw from this research study at any time, for any reason.

- If you choose to withdraw from the research there will be no penalty to you and you will not lose any benefits that you are otherwise entitled to receive.

- During our time together, you will be asked a series of questions about your experiences as a student. You may decide to withdraw your participation at any time, and you are not obligated to answer any question that you are not comfortable with.

- Your name, institution's name, and all identifying information will be removed, in accordance with Federal Laws surrounding student records. No individually identifiable information will be published.

- The phone interview will be recorded. The recordings will be transcribed as part of the data analysis. Notes may also be taken during the interviews. The recordings, transcriptions, and any notes taken from that interview will be securely locked and only accessible to the researcher and the transcription company hired, if one is used. Once the data is merged into the study and all names removed, the notes will be shredded and destroyed.
    - Please note that the IRB at the University of New England may request to review research materials.

- There are no foreseeable risks or hazards to your participation in this study.

- You may choose the location that you participate in the phone interview that assures a level of privacy.

- At the conclusion of the study, you will receive a small gift card; there are no other financial benefits to your participation in this research. Your participation will, however, indirectly inform the independent education community of important practices.

- The results of this research will be used for a doctoral research study at the University of New England. It may be submitted for further publication as a journal article or as a presentation.

A copy of your signed consent form will be maintained by the principal investigator for at least three years after the project is complete before it is destroyed. The consent forms will be stored in a secure location off school property that only the principal investigator will have access to and will not be affiliated with any data obtained during the project.

If you would like a copy of the completed research project, you may contact the principal researcher directly.

If you have any questions or concerns about your rights as a research subject, you may call:

Olgun Guvench, M.D.
Ph.D., Chair of the UNE Institutional Review
Board at (207) 221-4171 or irb@une.edu

You will be given a copy of this consent form.

Participant's Statement

I understand the above description of this research and the risks and benefits associated with my participation as a research subject. I agree to take part in the research and do so voluntarily.

_____

Participant's signature/Legally authorized representative Date

_____

Printed name

Researcher's Statement
The participant named above had sufficient time to consider the information, had an opportunity to ask questions, and voluntarily agreed to be in this study.

_____

Researcher's signature Date

_____

Printed name

APPENDIX D: Student Interview Questions

STUDENT INTERVIEW QUESTIONS

Date:

Time of Interview:

Name:

Gender:

Age:

College attending(ed):

Intended major:

First generation college student?:

Communication and Alignment between high school and college

1. Compare your overall experiences in high school math classes with your first experiences in college math classes.
    1.1 Compare the pacing of a high school math class and a college math class.
    1.2 How did you prepare for each of those classes?
    1.3 What were some differences in the class settings that stood out to you?
    1.4 How did you learn the material for each of those classes? (independently, tutor, online program, a lab, videos, study partner or group)
    1.5 How do your grades compare?

Expectations—Confidence—Belief

2. Describe your confidence level as a high school math student.
    2.1 In what ways did you demonstrate to your teachers your confidence or lack of confidence as a math student?

(Prompts: offering solutions in class, helping explain steps to other students, were you afraid to speak in class—why?)

3. How would you describe your emotions as you approached a math test or exam in high school and then in college?
4. Describe the math courses in high school where you felt challenged.

   (If applicable, prompt: How did taking a high school math class as an 8th grade student affect your learning?)

   4.1 What was it about the instruction or expectations of the more challenging course(s) that made you feel academically challenged?

   4.2 How were these academic challenges the same and/or different from those you experienced in your college math courses?
5. What strategies did you use to keep yourself focused or motivated in math courses in which you didn't feel challenged?

   5.1 In what ways did you communicate with your teacher about not feeling challenged?

   5.2 What was your teacher's response to your communications?
6. What goals did you set for yourself as a high school math student?

   (Prompts: Certain grade, certain amount of time spent, pleasing parents, getting through the class, getting to calculus or fourth-year math class?)

Transition Programs

7. Describe how you chose your first math class in college.

   7.1 Was it a general requirement for graduation or your major?

   7.2 Did your adviser help you in choosing this class?

7.3 Were you placed into the class based on a placement test? Did you agree with that placement?

7.4 Describe the details if you needed to take any kind of brush up or non-credit course or summer program.

7.5 How did that first class go?

Assessing Readiness

8. How would you describe how prepared you felt to take your first math class in college?

8.1 Did your perception of your level of preparedness change after the first half of the semester?

8.2 Do you attribute taking certain high school math classes to that level of preparation?

9. Describe any differences in your approach to college math coursework compared to high school.

9.1 How much time do you spend outside of class on your college math work compared to how much time you spent in high school?

9.2 What level of responsibility did you take in learning the material?

9.3 What math goals did you set for yourself in college?

Social/emotional preparation and influences outside of classwork

10. Reflect back to the end of your senior year and describe how prepared you felt emotionally and socially to go to college.

10.1 How would you describe the differences between what you felt then and how you felt during the first semester, and at the end of that first semester?

10.2 How would you describe your parents' involvement in your academics in high school?

10.3 Describe the ways your parents' involvement influenced your decision-making about what courses to take in college.

Interventions and Recommendations

11. What do you wish you knew in high school about college math?
12. As you reflect on all the math courses you have taken in high school and in college, in what ways did the instructor affect your motivation to learn the material?
13. What do you feel could have helped you be better prepared for college level math?

APPENDIX E: Data from High School Transcripts

HIGH SCHOOL DATA TO EXAMINE

Student Rank:

Final Overall GPA:

High School Math Exams scores:

Final math grade in 9th grade:

Final math grade in 10th grade:

Final math grade in 11th grade:

Final math grade in 12th grade:

PSAT scores:

SAT scores:

NECAP scores:

NWEA Fall 10th grade scores:

NWEA Spring 10th grade scores:

College placement test scores:

High School classes taken:

Honors/AP/Dual Enrollment courses taken: