The Forgotten Population: Honors Math Students At A Vocational High School

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THE FORGOTTEN POPULATION: HONORS MATH STUDENTS
AT A VOCATIONAL HIGH SCHOOL

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THE FORGOTTEN POPULATION: HONORS MATH STUDENTS AT A VOCATIONAL HIGH SCHOOL

Abstract

The purpose of this mixed methods individual case study was to investigate why honors math students at a regional vocational high school felt that their mathematical ability decreased over their enrollment at the site under study from the levels they experienced in middle school. This study specifically focused on long term retention of material and motivational forces that can influence the perceptions of honors students’ ability in mathematics.

The participants for this study were 23 students who had been in honors math for all four years at this school. A records review was conducted for the 23 participants, which yielded both quantitative and qualitative data. Themes that developed through the records review were expanded through interviews with nine randomly selected members of the sample.

Quantitative data compared student semester averages over the four years of enrollment with their corresponding comprehensive semester exam averages. Standardized exam scores from a ninth grade placement test, the tenth grade Massachusetts benchmark exam in math, and the math SAT were also compared. Finally, interviews captured the student voice and expanded upon the themes and data collected through the records review.

Four major categories that influenced students’ perceptions of their mathematical ability developed through the data analysis are: 1) personal history/background, 2) retention problems, 3) motivational influences, and 4) suggestions for the future. Through these categories it was found that long term retention of mathematical concepts is difficult for students at this site. This
was evidenced by lower comprehensive exam scores compared with semester averages and their own personal narratives shared through the interviews.

Participants suggested a handful of strategies the school could implement to help curb this phenomenon. Among those could be a daily/weekly schedule change, the continuation of a math lab course for exam preparation into the eleventh and twelfth grades, and shop week homework that was meaningful. Finally, participants felt that motivation and perception of their ability in mathematics is influenced by the teachers themselves, class structure, and future plans of the students. It was found that teachers who employed hands-on, project-based lessons created atmospheres that increased student engagement. Finally, what a student planned to do in the future had a significant impact on their motivation to do well in school.
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CHAPTER ONE
INTRODUCTION

Vocational education has historically been an option for many students in the United States who do not necessarily want to follow the traditional pathway to college after high school. However, today attending college is an option available to students who graduate from vocational high schools, which was not always the case (Stone & Lewis, 2012). Traditionally, students went from vocational and technical high schools directly to work in industry. These students were typically not very academically inclined, but were better suited for working in skilled labor positions (Dupoux, 2008). This is no longer the case.

Students of today not only can go on to college from vocational high schools, but they can thrive in college (Dare, 2006; Stone & Lewis, 2012). These students are making the best of their education because they are not only graduating able to attend college, but they also have skills for a career in industry as well. Vocational schools of today are no longer the least favorable option for students and parents. Students enjoy their time learning academics in preparation for college and learning a skill that they can use in the world upon graduation, unlike their counterparts at traditional academic high schools (Dare, 2006; Stone & Lewis, 2012).

The tide has turned with the new focus on College and Career Readiness from the Common Core State Standards (CCSS). It is much more difficult for the rigor called for in the CCSS to be successfully implemented in vocational schools (Stone & Lewis, 2012). While the opportunity to have two career paths available is enticing to students looking to enroll in vocational education, it is not without its inherent challenges.

Students in vocational education have to split their time between their vocational major and their academics. This leads to problems with achievement and retention of content in both
sectors of the curriculum (Bozick & Dalton, 2013a). This study was built on the problem of retention of material and the perception of one’s mathematical ability for honors students at an urban/suburban regional vocational high school.

Honors students at this school historically have shared with the researcher that upon graduation, they feel as if they have become weaker mathematics students during their enrollment than they were when they entered the school in the ninth grade. This study aimed to understand this phenomenon from the student perspective in hopes of combating this loss of students’ confidence in mathematics from occurring. Honors students at this site are usually left to learn with minimal intervention from the school when it comes to their academic performance. The ethical school staff will look at this problem and notice that it is in conflict with employing an ethic of care, which is meant to promote loyalty, trust, and empowerment (Shapiro & Gross, 2013). When a student feels that they are being cared for, they will feel safer and be able to better perform to the best of their ability. The ability of a leader to help make individuals better and place their interests first will help to improve outcomes at the individual, organizational, and societal levels (Northouse, 2013).

The school’s mathematical philosophy is mainly to focus on the weaker academically skilled students in the ninth and tenth grades so that they will perform well on the Massachusetts Comprehensive Assessment System (MCAS). Once a student enters the eleventh grade, the school does not necessarily offer the same interventions that were offered previously. This is because eleventh and twelfth graders are not included in the school’s report card rating, which is shared with parents and is attached to funding (Massachusetts Department of Elementary and Secondary Education, 2016). The honors students are especially left to their own devices, even
though they still need strong academic infusion in mathematics so that they can be successful on
the SAT and other college entrance exams with respect to their math ability and placement.

Statement of the Problem

Vocational schools provide two types of education for high school students in the United
States. Students receive a full academic curriculum along with a career technical curriculum for
the given career path that they choose (Stone & Lewis, 2012). There are inherent achievement
concerns however, since students have to split their time between academic and career technical
content. Students either spend half of their day in their academic classrooms and the other half in
their career technical shops, or they spend one week in academics and the following week in
their shop (Bozick & Dalton, 2013a). Due to the time taken away from the classroom, students
have trouble maintaining high levels of achievement in their studies (Bozick & Dalton, 2013a).
Prevention of this problem has been the topic of various legislative acts that aim to maintain
rigor in vocational education, similar to the rigor expected in traditional comprehensive high

Vocational students of the past attended these schools because they were not going to
continue their studies in college. However, many vocational education students now anticipate
going to college unlike their counterparts of the past (Stone & Lewis, 2012). The problem
addressed in this study is the imperative that vocational schools not only focus on training
students for their careers, but also to provide the same strong academic foundation to make them
successful college-bound students (Anderson, 2008; Morgan, Parr, & Fuhrman, 2011; Pearson, et
al., 2010).
Purpose of the Study

The purpose of this study was to explore why honors students at an urban/suburban regional vocational high school perceived that their academic ability in mathematics decreases during their enrollment. Students historically note upon graduation that they feel their math ability is weaker than it was when they entered high school as ninth graders. This phenomenon was shown by weaker achievement on comprehensive end of semester exams, and the overall self-perceptions of students upon graduation. Now that it can be determined why students feel this is happening to them, strategies can be developed to prevent this from occurring in the future.

Research Questions

The overarching research question guiding this study was: Why do honors math students in the twelfth grade at a regional vocational high school feel as if their mathematical ability has decreased over their four years at the school? Specifically, more detailed research questions include:

- How well do honors students retain mathematical content over a given semester in a vocational school?
- What strategies can be employed to help honors students in a vocational school retain mathematical content taught over a given semester?
- How can the perceptions of honors students’ math achievement in a vocational high school be influenced during the time of their enrollment?

Conceptual Framework

A strong conceptual framework develops out of personal experience, prior empirical findings, and includes the blueprint for how the research study will be conducted (Ravitch &
Riggan, 2012). This particular study was based on a phenomenon that had been observed by the researcher over the past twelve years at the site under study. Almost every June, honors students said that they feel as if they have gotten weaker in math since they entered in the ninth grade. These unsolicited comments come when the students are asked to solve problems which relied on their use of prior knowledge. These are honors students who want to go to college and have historically fought hard to maintain good grades.

Theory is a key component of framing and conducting studies according to Anfara and Mertz (2015). The theoretical framework guiding the study is a synthesis of expectancy theory (Ernst, 2014), expectancy value theory (Clinkenbeard, 2012), and self-determination theory (Brooks & Young, 2011). These theories discuss motivational aspects of students and converge on self-perception and self-efficacy and are based on utilitarianism (Cahn, 2013). This theoretical frame fits nicely because it explains why students see their mathematical ability decrease over time, as motivation tends to decreases over time (Biemans, de Bruijn, den Boer, & Teurlings, 2013; Cleary & Chen, 2009; Rosario, Nunez, Valle, Gonzalez-Pienda, & Lourenco, 2013).

This study was conducted as a mixed methods individual case study (Creswell, 2015). A database of students who had been in the honors math program for all four year was compiled. It was from this group that permission was sought to perform a complete records review. This records review helped to better understand who the participants were as students, and provide the foundation for further interviews (Merriam, 2009). Archival data was used to gauge how participants have done in the past and to note any issues, special notes, or honors. The records review was also able to provide a study of weekly student scores which were compared with end of semester scores, as a way to test long-term retention of material. The records review was an important source in developing interview questions to ask the participants (Merriam, 2009).
Semi-structured interviews were conducted to investigate student experiences over their high school career (Merriam, 2009). This data illustrated why students see this phenomenon happening, and documented first-hand suggestions about how to combat this decline in perception of ability in the future. Students are usually more cooperative in providing detailed information when they feel the reason for their input will produce better results for learning (Searle, 2013). Previous studies have looked at methods to increase student achievement in the career technical content area, but the topic of increasing or maintaining student performance in the mathematics classroom has not been studied with the same voracity, which is why this study was important to conduct.

Assumptions, Limitations, Scope

This study was conducted solely at the vocational school identified as the site. The assumptions mainly dealt with structural complications as they related to the way content is delivered in the classroom. The school calendar is made in such a way that students spend one week in academics, and one week in their career technical field. This means that after a student has had academic coursework for five days, they will not return for another ten days. This gap could be one of the reasons that students do not retain mathematical content. Noddings (2008) found that students who only memorize material without digging down deeply tend to lose their ability to recall that information at a later date. Valentine and Collins (2010) warn that memorizing material prevents students from learning how to think, which is a major goal of education. This lack of retention of material, compounded over four years, may lead students to feel that their mathematical ability has decreased over that time.

Another assumption was that students may perceive a decrease in their mathematical ability because they tend to devalue academics as they progress further into their career technical
Students only spend 70 minutes in an academic classroom, but when they are in their shops for the entire day. It is possible that the more time students spend in the culture of the career technical major, the less importance they place on their academic coursework (Bozick & Dalton, 2013a). The career tech teachers may also lend to this assumption, as most of them are not actively promoting strong academic performance for college. Vocational teachers may spend the majority of time sharpening the students’ skills for work in their field because many of them do not have the mathematic content knowledge to help infuse those concepts into the applied work in the shop setting (Capraro, Capraro, Carter, & Harbaugh, 2015).

The researcher’s reliance on students to be able to effectively diagnose their perceptions of their math education was also seen as a possible limitation (Creswell, 2013). The participants may not have been able to verbalize exactly how they were feeling, or may have felt intimidated to speak as openly about their experiences as they would have liked while they were being interviewed (Creswell, 2015). Documenting student perspectives was the reason this study was conducted, and a student’s thoughts and feelings will naturally reflect their own experiences and perceptions.

A final assumption was the belief in the school’s unwritten rule of not caring too much about students once they become eleventh graders. The focus of the curriculum has historically been on the lower grades and their test preparation for the MCAS exam, with the strongest teachers usually assigned to the lower division of math courses. A former administrator has actually said that he does not care about the juniors or seniors, and that the focus must be on the ninth and tenth grade. It is not known if one administrator’s outlook is transferring down to the student level, and maybe that is a cause of their perceived loss of mathematical ability. The researcher was careful not to assume anything when seeking data from the participants, as these
assumptions presented a potential bias which influence the data collection (Coghlan & Brannick, 2009). The researcher also had to be careful not to monopolize the interview; taking care to only interject sparingly, approximately 20 percent of the time (Brown, 2006).

This study was limited in scope, as it only applied to this one setting and to a subset of the honors students at that site. There is a possibility that lessons learned in this study can be applied to other vocational schools across the country, but the participants were students located at this one site. Another limitation existed in the assumption that the school calendar lends to decreased mathematical ability. This study was not able to examine how a change in schedule would affect the retention rate of students or their perceptions of their ability to perform well in mathematics.

The sample chosen for this study was a possible limitation as well. This study focused on honors students in the twelfth grade who have been in honors math all four years at this site and not the entire twelfth grade population. The reason for this segment of the student population is because this is the group of students who will be most likely to enroll in college upon graduation, while many college prep students choose to go into industry. These are also the students who did not receive extra interventions as ninth and tenth graders in order for them to do well on the MCAS. Although there are non-honors students who will apply and go to college, they were not the focus of this study. Those students however, will benefit from the findings of this work, as any interventions suggested and implemented will ultimately help all students.

**Significance**

The rationale for this study was that it is important for our highest achieving students to feel as if they have the necessary mathematical skills and ability to perform well beyond high school. This has not been occurring at the site under study. Students continually have noted that
they feel as if they have gotten “dumber” in math over their tenure at this school, which is not in agreement with how students should feel if an ethic of care is employed in a school (Shapiro & Gross, 2013). It is not acceptable that honors students who plan to continue their education in college should feel doubtful about their ability.

This case study was significant as a way to understand the origins of the phenomenon at this site. Without understanding why students feel that they have experienced ability loss in mathematics, it cannot be fixed for future students. This study investigated why these students felt this was happening to them (Merriam, 2009). Now that the origin has been discovered, the school faculty can work to prevent this phenomenon from occurring in the future. Faculty cannot help students combat this perception if they do not understand why it is happening. This study can now help the faculty and the administrators at this site understand why students feel this way, which might lead to the implementation of strategies to combat this phenomenon. Students in the honors program may now be be better suited and prepared for college, and might be more successful once in college since this phenomenon was recognized.

**Definition of Terms**

**Career and Technical Education (CTE):** Educational practice including occupational and career training along with a comprehensive academic curriculum. CTE is also referred to as Career Tech Education (Bozick & Dalton, 2013b).

**Shop:** This is the setting when students are in their career technical major. Students work on hands on projects to learn the skills necessary to be successful in the career path (Bozick & Dalton, 2013a).

**Vocational Education:** This is another term for Career and Technical Education, both terms are used interchangeably (Casale-Giannola, 2012).
Conclusion

The benefits of a vocational education have started to align themselves with that of a comprehensive high school (Often, 2011). Historically, vocational students were considered to have had a lesser ability to perform well academically, even though they had a gift for using hands-on skills. Their reason for enrolling in vocational schools was to prepare them for the working world, but to also supply them with the basic academic skills required by law (Stone & Lewis, 2012).

Modern day vocational education is referred to as career and technical education. The shift in name is meant to show that vocational education is not just for the remedial high school student with low academic ability (Stone & Lewis, 2012). In fact, many students now enroll in career and technical education with academic skills that previously have not been seen in a career technical education (CTE) student. With the added emphasis on rigor in the classroom and college and career readiness, vocational schools are transitioning to higher level institutions comparable to their comprehensive counterparts (Dare, 2006; Often, 2011; Stone & Lewis, 2012). With this change in the way career and technical education is viewed, comes a change in the culture of the schools themselves. The change of culture from a one where such programming was limited to students perceived as “low ability” to one where students are recognized as capable of higher-level learning takes time, and may even need explicit attention (Kotter, 2012). Today many career and technical high schools are no longer the dumping ground for skilled students with low academic abilities; there are a range of students in attendance and those students need to be provided the best possible education (Stone & Lewis, 2012).

This study was necessary because it is those honors math students at this particular vocational school that feel as if their academic ability has been hindered throughout their
enrollment. Strong academic students are coming to vocational schools to learn a skill and go to college, and they should be educated in a way that keeps them sharp in both areas (Stone & Lewis, 2012). For many years, honors students at this site have spoken to the researcher about a feeling that they are weaker mathematically than when they entered, and no one has been there to take up their cause. This is not fair to the students who have helped changed the image of vocational education. These students in a school that employs an ethic of care need to feel as if they are continually excelling in their studies and not that this type of school has stagnated their learning (Shapiro & Gross, 2013).

The aim of this study was to determine why students have the perception that their mathematical ability declines over the course of enrollment so that the school can serve the needs of the best and brightest in the future. If this phenomenon can be turned around, not only will high-level learners continue to look to vocational education as a positive option for their future, but they will also feel satisfied that they made the right decision when they graduate. Vocational education is undergoing a transformation, and it takes a transformative approach to leadership to help usher in the new image and effectiveness of education (Shields, 2010). Schools tend to operate under a transactional approach as a way to comply with mandates, but this approach will not take the individual student perspective into account and that is what is necessary to promote the feeling that they are valued by the institutions that are tasked with preparing them for the future (Avci, 2015; Mahdinezhad, Bin Suandi, bin Silong, & Omar, 2013; Smith & Bell, 2011).
CHAPTER TWO

SELECTIVE REVIEW OF THE LITERATURE

Vocational education historically was an option for students more interested in going into the workforce after high school than going to college (Stone & Lewis, 2012). This is no longer the case however, as college-bound students are now attending vocational high schools or vocational programming in comprehensive high schools. Today’s vocational high school has a mix of students who plan to attend college and those who do not. With the increased emphasis on rigor and the demands of college entrance requirements, students in vocational education are held to the same standards as students at comprehensive high schools, whether or not they plan to attend college (Dare, 2006; Often, 2011; Schwartz, 2014).

The dilemma with holding vocational students to the same level of rigor as traditional academic students is that half of their time in school is dedicated to exploring a specific career path (Bozick & Dalton, 2013a). These students split their time between academics and their career tech areas, or shops, and are expected to perform on the same academic level as students whose only focus is academics. As vocational education is undergoing a transformation, the way educators approach vocational schools needs to be reconsidered. A transformational approach to teaching the modern day vocational student is more important than the traditional transactional approach to leadership (Avci, 2015; Mahdinezhad et al., 2013; Shields, 2010; Smith & Bell, 2011). This literature review examines research about career and technical education. The review includes studies that examined the ways students in vocational education could maintain high academic performance, while participating in a career and technical education.
Purpose of the Study

The purpose of this study was to explore why honors students at an urban/suburban regional vocational high school perceived that their academic ability in mathematics decreases during their enrollment. Students often note upon graduation that they feel their math ability is weaker than it was when they entered high school as ninth graders. This phenomenon was shown by weaker achievement on comprehensive end of semester exams, and the overall self-perceptions of students upon graduation. Now that it can be determined why students feel this is happening to them, strategies can be developed to prevent this from occurring in the future.

Objectives

The first objective of this review is to explore the historical development of vocational education in the United States and which programs and legislation have been introduced to ensure adequate learning for vocational students. The second objective of the review is to describe strategies used outside the United States - mainly Europe - to help raise academic achievement levels of students in vocational education. The third objective is to describe strategies that are being used in the United States as ways to determine the best methods for helping students achieve at high levels without losing valuable time in the career tech area. A fourth objective is to study the problem of student perception of their academic abilities in the vocational school setting through the lens of motivation theories. The final objective of the review will be to show the need for this study due to the gap in the literature on the topic of retention of mathematical standards in the math courses offered in a vocational high school.

Literature Collection Procedures

The articles that were collected in this review of literature were gathered using online databases and by snowballing sources from articles that were relevant. The descriptors used to
search the EBSCO and ERIC databases were vocational education, mathematical achievement, student perception, career technical education and achievement, and student motivation. These descriptors were helpful in finding over twenty sources to be reviewed. Some of the sources were over ten years old, so they were not included because this review is based on relevant and recent research. After reading some works, cited authors seemed to have interesting points to add to this review, so the full citation was located in the references section and then searched using a Google search. Books that were cited in articles were considered as a way to include more information about vocational education in modern times and differentiated instruction approaches to education. Also, books on education and leadership were reviewed for the purposes of this literature review.

**History of Vocational Education in the United States**

Vocational education has been a part of the society of the United States since the early colonial times. Many young children grew up working for their families in an apprenticeship model, similar to cooperative education programs today where students go to work for a company and earn money and time toward their certifications instead of being in the shop setting of their high school (Schwartz, 2014; Stone & Lewis, 2012). However, as the educational system grew across the country, rules and regulations were instituted in order to protect the students and make sure they were learning the necessary content.

Initially, legislation ensured that vocational education students were adequately protected for safety purposes (Anderson, 2008; Stone & Lewis, 2012). Eventually money became an issue, and new legislation had to be enacted to ensure this type of education would be operational and accessible for students (Anderson, 2008; Stone & Lewis, 2012). As time passed, students in vocational education needed more safeguards, not necessarily for personal safety or financial
stability anymore, but to meet higher academic standards. This became the case as the standards movement encompassed the United States with various federal education mandates requiring performance benchmarks for all students in the country (Bozick & Dalton, 2013a; Often, 2011).

**Legislative Acts Relative to Vocational Education**

**Early legislation.** Education in the United States has been historically seen as providing for the right of students to attend school, but not necessarily the right for them to learn (DuFour, Dufour, Eaker, & Karhanek, 2010). This assumption and the assumption that only few students can learn at high levels has been prevalent during the history of education in the United States (DuFour et al., 2010). It is out of this tradition that vocational education emerged as a viable option for students who were not adept at traditional academics. Vocational education was first introduced as agricultural education through the Smith-Hughes Act adopted in 1917 (Anderson, 2008; Gentry, Peters, & Mann, 2007; Stone & Lewis 2012). In 1984, Congress passed the Carl D. Perkins Federal Vocational and Technical Education Act as a way to bring more funding to vocational education across the United States (Anderson, 2008; Stone & Lewis, 2012).

According to Anderson (2008), an amendment to the Perkins Act passed in 1990 as a way to bring funds for integrating curriculum between career tech and academic content. This amendment now meant that academics would be infused in the shop setting, and schools were given funds to enact this change.

**Current legislation.** The 1990 amendment to Perkins has become known as Perkins II. That along with Perkins III, which was passed in 1998, brought a framework and funding structure to school districts. This structure was put in place to maintain a strong career and technical education for students according to Bozick and Dalton (2013a). Perkins IV was passed in 2006 as a way to keep rigor in the classrooms of vocational schools, where students are
usually seen as lagging behind their counterparts in traditional high schools (Stone & Lewis, 2012). Along with Perkins III, Perkins IV stresses the need for integration of academics in the career technical classroom as a way to promote rigor and prepare students for the new post-secondary world they will be entering (Bozick & Dalton, 2013a; Dare, 2006). Perkins IV also involves accountability like The No Child Left Behind Act of 2001 (NCLB) and Individuals with Disabilities Education Act (IDEA) for how students are performing in their career tech areas as well as in their academics (Casale-Giannola, 2012; Dupoux, 2008). In order to show that students are proficient and performing at high levels in both academics and vocational content, reports are completed detailing spending and learning outcomes (Often, 2011).

The implementation of the Common Core State Standards (CCSS), the latest legislation to affect education in the United States, has also had an impact on vocational education. The CCSS have placed a heavy burden on school districts because the standards favor mainly academic content. However, with Perkins IV, vocational schools must keep integrating their career and technical content with academics and show student proficiency in both. As Bozick and Dalton (2013a) point out, educators and policy makers developed the CCSS without input from business and industry. This means vocational schools have a harder time keeping up with the rigor of the new standards, as there is the expectation that students also be proficient in their career and technical content (Bozick & Dalton, 2013a). Vocational schools are not unique to the United States. Many countries, especially in Europe, have vocational schools. These schools serve a similar purpose as the ones in the United States, but are designed differently.
Vocational Education in Other Countries

Differences from the United States

Vocational schools in Europe prepare students for work in a certain industry after the completion of primary school. Secondary and post-secondary vocational schools offer options for students to learn trades. Vocational schools around the world set up students to explore pathways to careers at a very early age. This is inherently different from the current system employed in the United States. Schwartz (2014) promotes the pathway system as a way for students to be able to get the rigor of academics with the training for the workplace. This approach is used in apprenticeship countries such as, Austria, Denmark, Finland, Germany, the Netherlands, and Switzerland. Schwartz (2014) notes however, that educational leaders and policy makers in the United States are completely against tracking students from an early age. Therefore, this type of pathway system would be difficult to implement in the United States.

Vocational schools in Turkey operate along similar lines, but they do not necessarily track their students. Instead, students test into either a traditional high school or a vocational school (Ergun, 2012). Turkish students are required to take a high school entrance exam, and if they do not obtain a passing score, they are guided into the vocational school track according to Ergun (2012). These students do have the ability to learn traditional academics through the ninth grade, and then work on career content that interests them along with academics for the tenth through twelfth grades. Yavuz Mumcu and Cansiz Aktas (2015) note that Turkish vocational students are seen as having lower abilities, especially in math, than their counterparts at traditional high schools, which is not necessarily the case for vocational students in other parts of the world.
Vocational schools in Taiwan cater to students at the higher end of the academic spectrum according to Chang, Shu, Liang, Tseng, and Hsu (2015). The vocational students in Taiwan are being prepared for the technology-enriched future of the twenty-first century. A popular career path in vocational education in Taiwan is Electrical Engineering according to Chang, et al. (2015). These students have an extremely high academic achievement level as opposed to students who study vocational education in Turkey.

The vocational system in the United States is a combination of both Turkey and Taiwan, but also follows the European apprenticeship model more closely than those countries. Historically, vocational education in the United States was provided for very low achieving students, but now there are more and more higher academic performing students attending vocational schools (Stone & Lewis, 2012). Both types of students must be prepared by the best education possible (Dare, 2006). In the countries of Europe that use apprenticeship training programs, there are two types of vocational schools that students can attend: secondary vocational school or post-secondary vocational school.

**Secondary vocational education in Europe.** Secondary vocational schools in Europe are organized in different ways depending on the country. The Netherlands utilizes three different pathways for their vocational training, as noted by Biemans, de Bruijn, den Boer, & Teurlings (2013). These include Pre-Vocational Secondary Education, Secondary Vocational Education, and Higher Vocational Education. Students are placed in a pathway after their primary education according to Biemans et al. (2013). Beausaert, Segers, and Wiltink (2013) acknowledge that the track the students are placed in may or may not lead them on to higher education after secondary schooling. Students who go from primary school to pre-vocational secondary education, can either go on to secondary education or vocational secondary education.
(Biemans et al., 2013). Whichever path is chosen, students can still gain access to a higher vocational education where they can end their studies or continue on to the university level.

**Post-secondary vocational education in Europe.** Universities in Turkey offer two-year vocational schools. These are an option for students after high school graduation if they want to continue their studies in their specific fields (Akyuz, 2015). Most of these post-secondary vocational training schools are two-year programs that will admit students with low academic proficiency, sometimes without even having to take an entrance exam (Akyuz, 2015). If a student is part of a low-performing cohort, they are allowed to continue their vocational training at these two-year schools without having to pass an entrance exam. This leaves the higher education institutions at a disadvantage because students with low achievement levels are enrolled without needing to improve their academic performance to pass an exam (Akyuz, 2015).

There are also universities in Europe that offer a four-year bachelor’s program for a vocational specialization, as noted by Baartman and Ruijs (2011). These schools take students through a process of learning classroom-based theory in their first year with a short internship to verify students are truly interested in that field. This work continues through the third year when students mainly do experiential learning at the workplace, similar to the apprenticeship model noted by Schwartz (2014) and Virtenan, Tynjala, and Etelapelto (2014).

The United Kingdom allows students to access higher education when coming from a vocational secondary school, but this is not without its problems. According to Farias and Sevilla (2015), students coming from vocational secondary schools are usually only accepted at colleges that have less rigid standards. This approach to admission requirements is different from students who enter college from non-vocational secondary schools, who have their choice at whichever college they would like to attend.
No matter which country is studied, whether in Europe, Asia, or in the United States, students who are in vocational secondary education need some type of reinforcement in order to gain better academic achievement in their studies, especially mathematics. Although vocational systems vary greatly across Europe and the world, one thing is certain, no one strategy has been discovered that maximizes the achievement level for students in a vocational school, especially in academics. It does not matter if the vocational system is set up for students tracked into the workforce, or if the vocational school is post-secondary, finding methods of increasing achievement for students is always a goal.

**Strategies to Increase Achievement in Vocational Education**

Vocational education in the United States has gone through a transformation over the years due to numerous legislative acts (Anderson, 2008; Bozick & Dalton, 2013a; Stone & Lewis, 2012; Often, 2011). The majority of changes have called for more rigor in the classroom. Finding ways to help vocational students gain proficiency in both academic and career content continues to be a focus of educators. There have been a variety of approaches employed to help solve this dilemma. The most common solution to helping students achieve at high levels is by utilizing an integrated curriculum design structure (Anderson, 2009; Hobley, 2015; Morgan, et al., 2011; Pearson et al., 2010; Sundell, Castellano, Overman, & Aliaga, 2012). A major component of integrated curriculum design is the use of differentiated instruction (Tomlinson, 2014). In order for teachers to be effective at using a differentiated instruction approach and an integrated curriculum, they need professional development (Anderson, 2008; Tomlinson, 2014). Professional development is crucial to implement any changes to instruction. Integrated curriculums and professional development play a part in increasing student achievement, but instructional approaches may not be the only variable. The schedule itself could also play a role...
in how students perform due to the amount of time students spend in and out of academic classrooms (Bozick & Dalton, 2013a).

**Student-Centered Initiatives**

There are many ways that teachers can adapt their curriculums in order to make the material more accessible to students, especially those students in vocational education. Some of those best practices include focusing on designs that put the student at the center of the learning. A couple of the best practices most influential in vocational education is integrated curriculum designs and differentiated instruction.

**Integrated curriculum designs.** The cornerstone of Perkins IV was the use of embedded academics according to Often (2011) and Stone and Lewis (2012). Using embedded academics allows vocational students to gain reinforcement for their academic content without sacrificing time from the career tech content (Noddings, 2008). By teaching academic topics through the career path that students are studying, it is hoped that students will be better invested in learning academic skills (Ergun, 2012). Many students in the United States go to vocational schools to learn a trade, and that leads to the belief that academics are not as important to their learning. Anderson (2008) and Stone and Lewis (2012) point out that by infusing academics into the shop setting, students will be able to see how truly valuable those skills are to their future careers.

Biemans et al. (2013) studied two groups of students in the Netherlands. Educators taught a control group with academics separate from career tech topics while different educators taught an experimental group with a curriculum that was interwoven through academics and shop. It was found that the students with the interwoven curriculum benefited more than their peers in vocational coursework as measured by achievement tests at the end of the school year. Students in the interwoven curriculum had comparable mean scores on the same exam after the first two
years of the program. However, students in the separated curriculum path saw mean scores decline during year two of the study. Morgan, Parr, and Furman (2011) concluded that integration was the best way to ensure that the mathematics students learn in the traditional classroom is transferrable into their career setting.

Pearson et al. (2010) studied integration in the reverse order. They, like Morgan et al. (2011) found that students who were taught through an integrated curriculum were more successful on end of course exams such as the Accuplacer, than their peers who were taught in a segregated manner with vocational topics being treated separately from academic topics. One major finding from this report is that contextual and context-based learning were the most beneficial forms of education. More specifically, Pearson et al. (2010) suggests that students better understood integrated math concepts taught using context-based education. Context-based education shows students how the algebraic procedures they use in math class are used in the context of the career setting, so that students better grasp those topics. Contextualized education conversely takes the current vocational curriculum and finds areas where algebraic topics can be infused, as opposed to fitting vocational topics into the mathematics curriculum (Pearson et al., 2010; Stone & Lewis 2012).

In another study performed by Sundell et al. (2012) it was found that not only was integrating academics with career content effective for students achievement levels, but that project-based integrated curriculums produced the best achievement for students. Project-based learning is a more active form of learning contributing to greater student engagement, which is beneficial for students when it comes to raising achievement levels (Collins & Valentine, 2010; Gregory & Kaufeldt, 2015). In Finland, according to Virtanen et al. (2014) the best type of learning for students is to be in the workplace setting. Schwartz (2014) notes that Finland is an
apprenticeship country, and Virtanen et al. (2014) show that workplace learning is the most
effective way for students to learn. This finding shows students how their academic structures
have to be incorporated in the day-to-day operations of their personal career choice.

Hobley (2015) acknowledges the benefits of integrating academics into the shop area, but
cautions about the ineffectiveness of teaching only the topics that career tech students need in
their specializations. Content should also incorporate the science and math behind what is being
taught according to Hobley (2015). Noddings (2008) adds to this concept by noting that technical
education students may not need to think like mathematicians, but need to understand where the
math they use in class is related to the technical skills they are performing. The concept of fully
understanding the theory behind a certain skill is as important to becoming a true master in that
field and should not be over looked (Hobley, 2015). This is another reason that integrated
academics are important to vocational education. Not only do students need to see math from
academics is important to their shop setting, but to completely understand the processes and
procedures needed to perform jobs, students must understand the mathematical theory behind
them (Hobley, 2015).

Integrated curriculum designs can take two distinct paths. Shop material can be used in
the mathematics classroom, thus making the algebra topics more relatable as noted by Morgan et
al. (2011). The other design brings the math topics into the shop in what is known as contextual
learning, and this has its own set of benefits (Noddings, 2008; Pearson et al., 2010). Although the
idea of integrated curriculum is important, there is no single recommendation about which
curriculum should be integrated into the other (Morgan et al, 2011; Pearson et al., 2010). No
matter which model is used, integration, workplace learning, and theory building are ways to
help students see the benefit of mathematics to their academic careers. In order for this
integration to be successful however, teachers must employ strategies to maximize the effectiveness of the content, and one way of doing this is through differentiated instruction.

**Differentiated instruction.** One of the ways to ensure that all students can benefit from an interwoven vocational and academic curriculum is to teach in ways that benefit all learners. The concept of differentiated instruction, which is described by Tomlinson (2014), includes different approaches to instruction and attention to different levels of student understanding. Using differentiated instruction is an important way to reach all levels of students especially in the vocational setting. The use of differentiation in school can help to hone in on student interests, which can help to increase their engagement with a topic of study (Tomlinson & McTighe, 2006).

Differentiated instruction has been a topic of education since the days of the one room schoolhouse, where a single teacher had to accommodate every student’s needs, even if they were at different levels (Tomlinson, 2014). Tomlinson (2014) points out that even though schools today have individual classes with students of similar ages, ability levels may vary. This is true in vocational education, where a shop could have twenty students, with some having honors ability, some standard level, and many in the middle. A vocational teacher must be able to reach all ability levels everyday in that setting, which is why a differentiated approach is necessary.

The study conducted by Chang et al. (2014) highlights the type of improvement that can be gained by students offered a differentiated approach. This study is important because these students were all very talented in the Electrical Engineering major. The students were separated into a group taught by traditional methods, and another group taught using a blended approach with the incorporation of technology. The study found that although the students who were
taught through the blended approach did not necessarily score better at the end of the five-week experiment, their self-assessment scores were higher than those who did not receive a differentiated approach. Even though the scores were comparable, it was noted that if a student feels better about their ability, they would ultimately be more confident in their studies (Chang et al., 2014).

Beausaert et al. (2013) also studied differentiation in the Netherlands. Students were separated into groups where a teacher used a student-centered approach to learning and one where another teacher used a teacher-centered approach. Because of the range of student abilities, the student-centered approach to teaching incorporated differentiation. This study produced similarities and differences to the Chang et al. (2014) study. Unlike Chang et al. (2014), it was found that these students fared better on achievement tests, but similarly to Chang et al. (2014) they had a higher self confidence in their ability to perform their academics (Beausaert et al., 2013). One reason that students may have fared better on the achievement tests comes from findings by Valentine and Collins (2010), who note that student engagement in learning helps to increase scores on achievement exams.

Integrated curriculum designs and the use of differentiated instruction have been studied widely (Anderson, 2008; Beausaert et al., 2013; Biemans et al., 2013; Chang et al., 2014; Hobley, 2015; Morgan et al., 2011; Pearson et al., 2010; Tomlinson, 2014; Virtanen et al., 2014). The use of both strategies has shown the benefits for the students involved, even though there were different approaches to integration. The use of these strategies is not without its downside. In order for teachers to effectively incorporate a differentiated approach to learning and integrated curriculums, they must have the proper training.
Faculty and Building Initiatives

Student-centered initiatives are not the only way that vocational education can be accessible to students. The best practices mentioned above require advocacy from the teaching staff in order for them to be effective. Teachers need to promote positive attitudes toward school and learning, which require the implementation on teaching strategies that will develop quality environments in the classroom (Abu-Hamour & Al-Hmouz, 2013). In order to ensure students in a vocational school access the best possible curriculums for themselves, there needs to be significant professional development for teachers, and the school schedule itself should be modified to support integration and less time away from the academic classroom.

Professional development. The most common way to help vocational students perform better academically is to infuse academics into the vocational area (Anderson, 2008; Pearson et al., 2010). The problem with this model is that many vocational teachers are masters of their craft, but not in the art of teaching academic subjects, such as math. When teachers are not confident in their material, especially teaching mathematics, they might not take risks that could expose their perceived limitations to their students (Capraro et al., 2015). For vocational teachers to be able to incorporate proper mathematical terminology, and teach concepts systematically as an Algebra teacher would, Anderson (2008) notes they need comprehensive professional development. These teachers need continuous training to make them successful at teaching academics, just as academic teachers would need to proper training to help them teach content through a vocational mindset.

One way to help teachers better learn the art of integrating their curriculums is noted by Morgan et al. (2011), who discuss the creation of a collaborative culture between academic and vocational teachers. By having teachers pair up and spend time discussing their crafts, they can
help each other figure out how reach their students better. Armfield (as cited in Papa, 2011) promotes the idea of individual personal professional development as a way to move an entire school to a new level of understanding. Pearson et al. (2010) found that pairing a vocational and academic teacher and providing constant time for them to collaborate was the only way to make this integration worthwhile for both the students and teachers. Morgan et al. (2011) agrees with the findings of Pearson et al. (2010), but finds the lack of time to be the most difficult hurdle to overcome.

Administrators have to work hard to ensure that collaboration time is constantly available for teachers, and this is not always easy because of the way teachers’ schedules are built. It is imperative that school leaders do not just find time to allow for collaboration, but rather make time for it, and make it a priority (Dufour & Marzano, 2011). A school’s schedule is not etched in stone and should not be seen as an impediment of change, but rather a tool that can be used to benefit students when looked reconsidered (DuFour et al., 2010). Scheduling is always a dilemma, not only for pairing the teachers and giving them professional support, but also for the students. Many studies have been conducted that compare different schedules and how those affect the achievement for students (Anderson, 2008; Bozick & Dalton, 2013a; Gentry et al., 2007; Morgan et al., 2011). Those findings are reviewed in the next section.

**Scheduling differences and achievement.** Vocational schools have difficulty maintaining a balance between career and technical training and academic time that is effective for both content areas at the same time. Schools employ different schedules that try to accommodate both areas equally. Unfortunately, due to the increased emphasis on academics, some schools only offer vocational time for a limited portion of the day. Bozick and Dalton (2013a) studied a school where students only spent one-third of their time in vocational settings.
Gentry, Peters, and Mann (2007) studied students in a school where half the day was spent in academics and the other half of the day was spent in the career tech area. Bozick and Dalton (2013a) found that there was a correlation between the more time students spent in vocational shops, the lower their achievement levels are in traditional academic classes.

The best way to balance a schedule that provides students with the academic rigor that is necessary to be successful in college and prepare them for the workforce is still up for debate in the vocational community. Schwartz (2014) argues that educational leaders in the United States should not be afraid of setting up a pathway system similar to Europe, but notes that politically, this would be an enormous challenge. In his policy brief, Schwartz (2014) suggests that students take full-time academic classes through the tenth grade. Then, starting in the eleventh grade and continuing through community college, students would be taught all aspects of the career path that they are interested in. Schwartz (2014) notes that along with needing to change the structure of the education system, agreements between businesses and community colleges would be necessary in order to implement this transition from school to work.

The debate about the best way to teach or structure our schools to prepare students for post-secondary success will continue since no specific schedule design or educational best practice has been found to be the most effective in spite of all the studies that have been conducted. Scheduling, integrated curriculums, and teaching strategies are not one-stop solutions to help vocational students learn. One of the most effective ways to help students, without having control of those variables, is to be able to motivate the students to always do their best (Brooks & Young, 2011; Clickenbeard, 2012; Ernst, 2014; Gilbert et al., 2014). Motivated students will be successful in spite of scheduling or curricular issues.
Motivational Theories

Theories Associated with Student Motivation

Theory plays an important role in framing and conducting a study according to Anfara and Mertz (2015). Vocational education prepares students for both college and a career, however in order for students to be effective in both paths, they need to have some level of motivation to perform well in both sectors of their education. Some theories that have been studied that can help inform understanding of the phenomenon under study are expectancy theory (Ernst, 2014), expectancy-value theory (Clickenbeard, 2012; Gilbert et al., 2014), and self-determination theory (Brooks & Young, 2011; Clickenbeard, 2012).

**Expectancy theory.** Expectancy theory is presented by Ernst (2014) as being grounded in the work of Vroom in his 1964 book *Work and Motivation*. Vroom (as cited in Ernst, 2014), posits that people will choose an act from a list of other possible acts based on the perceived strongest positive or least negative force associated with choosing that act. Expectancy theory thus states that if the motivational force of each alternative action is known, then the action taken can be predicted based on the values of the forces. This theory can be used as a way to identify outcomes that motivate students to do well in their math classes and to figure out the factors that influence motivation (Ernst, 2014).

**Expectancy-value theory.** Gilbert, et al. (2014) studied expectancy-value theory and found that psychological, social, and cultural influences will affect a student’s expectancy of success and task value. Eccles (as cited in Gilbert et al., 2014) states that expectancies and values can predict achievement related outcomes similar to expectancy theory (Ernst, 2014). Schunk et al. (as cited by Clickenbeard, 2012) defines expectancies as people’s beliefs about successful completion of a task, and their individual values as the reason why one might want to engage in a
task. Motivated behavior thus occurs when someone feels that a task is worthwhile to do, and expects that they can do it. Clickenbeard (2012) points out that a comprehensive expectancy-value theory in education defines expectancies as student beliefs about how well they will perform on certain tasks or in subject-matter areas. The higher the expectancies are for the students, the higher the motivation and thus achievement according to Clickenbeard (2012). One important type of motivation is intrinsic, which comes from within us (Gregory & Kaufeldt, 2015). According to Clickenbeard (2012), that type of motivation is a key part of self-determination theory.

**Self-determination theory.** Self-determination theory is grounded in the work of Deci and Ryan (1985) and suggests people work to continually grow and reach a level of fulfillment. Self-determination theory uses self-autonomy as a key factor (Brooks & Young, 2011). Autonomy is the most influential piece of this theory because people have to feel in control of their own lives according to Clickenbeard (2012). Brooks and Young (2011) note a student’s autonomy is heavily linked to their intrinsic motivation. This is why students may suffer from a low sense of intrinsic motivation in the math classroom since they do not have the power to design how the course will run because that lies in the hands of the teacher (Brooks & Young, 2011). Low intrinsic motivation is problematic because that type of motivation can help to predict mathematics achievement (Abu-Hamour & Al-Hmouz, 2013). Bozick and Dalton (2013a) and Gentry et al. (2007) both found students felt more at ease and interested when they were in the shop as opposed to the classroom. The reason that students felt better about their time in shop because they got to design how their learning would be structured unlike in the academic classes (Bozick & Dalton, 2013a; Gentry et al., 2007). This is in alignment with self-
determination theory, where one way to stimulate that intrinsic motivation is to allow for that increased autonomy in the classroom (Jensen, 2005).

The three theories mentioned above, expectancy theory (Ernst, 2014), expectancy-value theory (Clinkenbeard, 2012), and self-determination theory (Brooks & Young, 2011) all rely at one point or another on self-efficacy and the perception of self. According to Clinkenbeard (2012), students’ perceptions of themselves are in line with the expectancy side of the expectancy-value framework. These perceptions and the value placed on how well a student can expect to perform a task are considered part of a student’s self-efficacy. According to Schunk et al. (as cited in Clinkenbeard, 2012) self-efficacy is a personal evaluation of whether or not they can succeed at a given task. Self-efficacy relates to an individual’s beliefs in their performance instead of their feelings about their personal characteristics (Joo Oh, Jia, Sibuma, Lorentson, & LaBanca, 2013). Students will participate in a task if they feel competent in performing that task (Gregory & Kaufeldt, 2015). This essential piece is needed to motivate our students to do their best work. If a student’s self-efficacy and perception of their ability is high for a subject such as math, they will be motivated to do well. The common connection of these motivational theories relies on students doing what will provide them with the most happiness. This is a utilitarian approach to learning and can be explained by understanding how students actually perceive their own learning (Cahn, 2013).

**Student Perceptions of Learning**

The structural issues that are prevalent in vocational education are not getting resolved in the near future. However, in order to help students gain proficiency in both their career tech areas and their academic courses, interventions could focus on the students themselves. When a student feels invested in the work they are doing, they will be more interested in being
successful, as opposed to if they feel they are just getting through curriculum as a means to graduate. This apathy can create a negative force, which leads to disengagement (Gregory & Kaufeldt, 2015). Baartman and Ruijs (2011), Gentry et al. (2007), Jonasson (2012), and Yavuz Mumcu and Cansiz Aktas (2015) all conducted studies that measured student perceptions of learning in the vocational school. These studies all came to the same conclusion in most cases.

Baartman and Ruijs (2011) studied students in post secondary vocational education and compared their self-efficacy and perceptions of their skills to their competence. They found that students who had a better perception of what their skills were, fared better at performing tasks requiring the newly acquired skills. Gentry et al. (2007) found similar results when they studied students who spent half their day in academics and the other half in their career tech field.

Students felt more comfortable in their career tech setting according to Bozick and Dalton (2013a) and Gentry et al. (2007) and this lead to a better self-image in their ability to perform their vocational skills. Increased autonomy in the career tech area helped students become confident in their abilities, and the students felt that career tech teachers treated them with more respect than the traditional academic teachers according to Gentry et al. (2007). Students did not feel bored when they were in vocational areas as opposed to when they were in academics (Gentry et al., 2007).

The boredom and resentment of being in the academic classroom resulted in lower proficiency for students in that setting than in the vocational setting (Gentry et al., 2007). Collins and Halverson (2009) report that as many as 50% of students are bored and disengaged in their classes. A reason that students are less bored in their shops is because the hands-on training provides more opportunity for student engagement than in a traditional academic classroom. This student engagement and active learning help to produce better achievement results according to
Valentine and Collins (2010). When students are disengaged and bored in class, they do not develop intrinsic motivation to perform well (Collins & Halverson, 2009). Noddings (2008) discusses how important it is for students to help organize and create their learning so that they can make the connections to the different curriculums and to real-life. Giving students a voice in the learning process helps to create better engagement (Gregory & Kaufeldt, 2015). When engagement increases for students, achievement follows (Reeves, 2007). Student voice, autonomy, along with active learning is something that is very important to help improve long term retention and performance according to Casale-Giannola (2012) and Valentine and Collins (2010).

Jonasson (2012) found similar results in her study, which took place in Denmark. Students at the vocational school under study were included in the decision making of how their vocational time would be structured similarly to Gentry et al. (2007). It was found that this autonomy led to increased interest in the career tech topics, which lead to students performing at higher levels. The Gentry et al. (2007) and Jonasson (2012) studies both focused solely on vocational achievement however. In order to grasp how student perceptions of learning affect the academic classroom the Yavuz Mumcu and Cansiz Aktas (2015) study is useful.

Yavuz Mumcu and Cansiz Aktas (2015) studied students in Turkey focusing on their perceptions of their learning compared with their mathematical achievement levels. This study compared students in a traditional high school with students at a vocational high school. It was found that the students in the traditional school had both better self-perceptions of their math ability and performed better. Yavuz Mumcu and Cansiz Aktas (2015) concluded that because students at vocational schools already lag behind their counterparts in the traditional schools academically, their self-perceptions were previously been set low. The authors promote the idea
that to truly help the students in the vocational schools, teachers must turn around the attitudes of students in order to help them raise those achievement levels (Yavuz Mumcu & Cansiz Aktas, 2015).

Gap in the Literature

Vocational education in the United States is under study more than ever before. Many studies have previously been conducted in Europe and across the world (Akyuz, 2015; Baartman & Ruijs, 2011; Beausaert et al., 2013; Biemans et al., 2013; Chang et al., 2014; Ergun, 2012; Jonasson, 2012; Virtanen et al., 2014; Yavuz Mumchu & Cansiz Aktas, 2015) but this has not necessarily been the case in the United States. One oversight is that most of the studies cited do not focus on academic content performance at a vocational school specifically in mathematics. Studies have touched on mathematical issues that students have and how that effects their career tech areas (Anderson, 2008; Baartman & Ruijs, 2011; Biemans et al., 2013; Chang et al., 2014; Hobley, 2015; Pearson et al., 2010; Sundell et al., 2012; Virtanen et al., 2014). Other studies have focused on achievement and perception of learning, but only framed through the shop area and not the mathematics classroom (Baartman & Ruijs, 2011; Gentry et al., 2007; Ingels et al., 2011; Jonasson, 2012). It is for these reasons that a study that focuses on maintaining a strong mathematical achievement level for students while progressing through a four-year vocational school curriculum is necessary.

Basic Mathematical Problems

Studies have focused on vocational students having a less than proficient understanding of mathematics (Akyuz, 2015; Ergun, 2012). In most cases, the students with low math abilities are in vocational education for that very reason. Both Akyuz (2015) and Ergun (2012) note that students enrolled in vocational schools of Turkey have issues with basic mathematical topics
such as numeracy. Students may have trouble recalling information because they suffer from problems with their memory systems (Searle, 2013). They note that in order to help students be successful, remediation is needed for those students. However, because students in vocational education in Turkey are there because of their lowered math abilities, the issue of maintaining a high achievement level is not discussed. Since the United States does not employ a tracking system like in Turkey (Schwartz, 2014), students at the site under study do not necessarily enter the school with a low mathematical ability level. This study aims to understand why students with previously high mathematics ability experience that ability decrease during their enrollment in vocational education.

Studies conducted by Anderson (2008) and Pearson et al. (2010) show the benefit of tying mathematical concepts into the career technical area. Both studies find that this practice is beneficial to help students perform better mathematically. The findings of Pearson et al. (2010) show that this practice can be beneficial for students when taking exams like the Accuplacer, but Anderson’s (2008) results only measure mathematic achievement gains in terms of the shop atmosphere. Success in the math classroom needs to translate into a higher score on a college entrance exam. Although integration helps students understand math from the needs of their career paths, it will not help prepare students for post-secondary mathematical success.

**Vocational support structures.** The literature that covers the topic of achievement in a vocational school is mostly concentrated in the career tech area. A minority of studies look at ways to increase student performance in just the academic setting of a vocational school. In studies conducted by Anderson (2008), Chang et al. (2014), Hobley (2015), and Jonasson (2012) student achievement increases were made through the vocational curriculum only. Mathematics was integrated into the career tech content as a way to help show students that math can be
helpful to them in their careers. Although there were achievement gains, whether or not those translated to success on entrance exams to colleges, or preparedness for college was not studied. In addition, none of these studies focused on how a student’s ability or the perception of that ability in mathematics decreases over time in vocational education, and how to stop that from happening.

**Academic support structures.** Perkins IV has increased the accountability level of vocational education in the United States, and with that, a shift in the literature is starting to develop (Anderson, 2008; Often, 2011; Stone & Lewis, 2012). Where studies used to focus solely on the vocational aspects of education, now academics must be part of the conversation. The first major study that is in the process of being conducted is by Ingels, Holder, Burns, and LoGerfo (2011), in which 20,000 students were studied starting in the ninth grade and will be followed longitudinally through the eleventh grade and two years after graduation. This research not only studies student achievement levels but also involves surveying parents, guidance counselors, teachers, and administrators. Once this study is complete, it will be the first one that truly tracks how our vocational students are performing in the classroom and after graduation.

Morgan et al. (2011) note that although students benefit from the infusion of mathematics in their vocational areas, items on standardized tests do not always transfer from the shop setting. Students may be able to perform better in their math classes by having the material tied to vocational topics, but this is not something that college entrance exams take into consideration when designing their assessments. Bozick and Dalton (2013a) also note that based on their study, academic achievement gains are lost when vocational time is increased. Due to the nature of vocational competencies that must be met, half of a student’s educational time must be spent on
their vocational major. This vocational time on learning takes away from academic time on learning, which adversely affects achievement levels in students (Bozick & Dalton, 2013a).

**Retention and Motivation Loss over Time**

The issue of retention of material is something that requires further study as well. According to Biemans et al., (2013) and Pearson et al., (2010), as noted above, there were decreases in student achievement scores when taught in a non-integrated curriculum. Unfortunately, the current vocational system tries to integrate college level mathematics into the shop area, but this integration does not always occur. Students need specific mathematics proficiencies in order to be prepared for college, and the drop in achievement noted above needs to be combated in some way. However, many view the best way to teach mathematics is through rote memorization, which Glasser (2011) finds to be an unsuccessful endeavor. Rather, exploring, conjecture, and thinking is a better way to provide for a deeper understanding of material (Glasser, 2011).

**The middle school perspective.** While this study focused on a vocational high school, studies have been conducted on the motivation levels of students as they progress through school at the middle school level. Cleary and Chen (2009) found that as students progressed through middle school, their motivation to do well in academics dropped because they failed to see the benefits of what they were learning. Their study was followed by Rosario, Nunez, Valle, Gonzalez-Pienda and Lourenco (2013), who studied students through the ninth grade. They too found that students’ motivation to perform well declined over time. Those two studies are a good precursor to what might be happening at the current site under study. One possibility for further investigation is whether students see academics as less valuable as they advance in their shop. Since these two studies did not follow students through the 12th grade, and were not conducted in
a vocational school, this current study can use those studies as a solid foundation from which to build.

Capraro, Capraro, Carter, and Harbaugh (2015) studied teacher preparedness and ability in a middle school. They found that students fared better in mathematics when they had teachers who encouraged questioning and open discussions. However, they found that teachers who were not confident with their subject matter, taught in a more direct way, so that they could limit being exposed (Capraro et al., 2015). This could explain why vocational teachers are not promoting mathematics in their shop curriculums. Although the school schedule was not discussed by Capraro et al. (2015), the lack of opportunity to dig down deep into lessons, because of the scheduling issues could be a reason why students are not feeling as confident in their abilities as twelfth graders than they did as eighth graders entering the school.

The high school perspective. Bozick and Dalton (2013b) conducted a study of high school students in a school with vocational programs. They found that students who take more vocational classes than academic classes in the final two years of school answered fewer questions correctly on a mathematics assessment, than peers who take only academic courses. They also found that the ability to do multi-step real-life application problems that require advanced critical thinking and problem solving was impeded when vocational classes took up a significant portion of the students’ schedules.

Suggestions for future research. Cleary and Chen (2009) noted that their work was in one setting with fairly high achieving students and was situated in the suburbs. They suggested other studies be done in more urban areas with populations that are more diverse. The site under investigation in this study is extremely diverse and considered urban, middle to lower class, and could help to solidify those findings across a larger student base. Also, Bozick and Dalton’s
(2013b) study illustrated what happens when more vocational classes are taken than academic classes in the final two years of high school. However, they did not study a split schedule, as is the case at the site under study, where a student spends equal time taking academic and career technical courses.

**Conclusion**

This review of pertinent literature has tracked the origins of vocational education in the United States and legislation that has transformed how vocational education has been administered. Through differing legislation, accountability has become a cornerstone of all education including vocational education. This has led to increases in funding to help integrate academic content into vocational curriculums so that students can maintain a level of rigor needed to be college and career ready (Dare, 2006; Often, 2011). The issue with integrating math into a career tech setting is that although it provides reinforcement as to why math is important to a certain career path, this may not translate well into the academic classroom or onto college placement tests (Morgan et al., 2011). Students in vocational education spend up to half of their school time in vocational shops and that time outside of the academic classroom can influence their academic skills negatively, especially in mathematics (Bozick & Dalton, 2013a).

Although studies have been conducted to raise achievement levels in subjects such as math, most of those have been done outside of the United States. Vocational schools in Europe operate differently due to the tracking that is employed (Schwartz, 2014). Most vocational schools take students who have a low achievement level already because they cannot meet the necessary threshold to go to traditional high schools based on entrance exam scores (Ergun, 2012). These students are already at a disadvantage academically.

Student perceptions of their academics have also been studied, and can be tied to
motivation. In those cases it was found that the more involved students are in planning for their education, the better they will perform (Biemans et al., 2013; Gentry et al., 2007; Jonasson, 2012). However, most of those studies have focused on vocational content only. The shop setting is more student-centered which Beausaert et al. (2013) found to be a more effective method to facilitate buy-in which helps to increase the students’ ability levels. While increasing vocational competencies is important, it is not the aim of this study.

This study was necessary because no study was found that tracked how students with strong mathematical abilities can maintain those skills throughout their high school career in vocational education. Studies have focused on middle school, and the transition from middle to high school, but not high school, and specifically, vocational high school (Cleary & Chen, 2009; Rosario et al., 2013). Biemans et al. (2013) found that scores lowered in year two of their study, which aligns with the decrease in motivation found by Cleary and Chen (2009) and Rosario et al. (2013). These two concerns deserve to be studied together with the focus on the math classroom in order to understand why this happens and how to avoid it in the future.

Most students enter vocational high schools in the United States from schools that provide academic instruction five days a week. Once in vocational schools, either half of the day is academics and the other half is shop, or students spend one week in academics and the next week in shop. Either way, half of a student’s time in school over their four years is dedicated to vocational content while the other half is for academics. This time away from the traditional classroom has negative effects on achievement as noted by Bozick and Dalton (2013a). A study is necessary to discover why students who enter vocational education in a diverse urban setting, possessing strong mathematical skills, see those skills diminish by the time they graduate. Once
that can be determined, strategies can be implemented to prevent this loss in achievement and performance from happening in the future.

Many studies have looked at patterns of achievement in vocational schools and these the studies consider the use of integrated curriculums (Anderson, 2008; Beausaert et al., 2013; Biemans et al., 2013; Chang et al., 2014; Ergun, 2012; Hobley, 2015; Morgan et al., 2011; Often, 2011; Pearson et al., 2010; Sundell et al., 2012). However, in order to integrate the curriculum, a lot of time must be dedicated to professional development of the staff. Providing quality time is more and more difficult because of all the other professional development that is needed in a given school year. This study examined how the math teachers can work in their own classrooms, with the schedule that is in place to find ways to help students not suffer a decrease in their skills. If it is found that achievement cannot be maintained at a high level within the current structure of the school schedule, then other studies will have to be conducted which focus on how changes to that schedule can help students with strong skills in mathematics keep those from declining over their four years in high school. Vocational education is in the process of undergoing a transformation from dumping ground to a viable option for a greater number of students. Schools must take a transformational approach, as opposed to the traditional transactional method of instruction to help usher in the new competencies required of students, so that they can be the most prepared as possible for life after high school (Avci, 2015; Mahdinezhad et al., 2013; Shields, 2010; Smith & Bell, 2011).

**Conceptual Framework**

A solid conceptual framework according to Ravitch and Riggan (2012) develops out of the personal interest of the researcher, prior literature on the topic including theories that can frame the current study, and a way of measuring what the study intends to showcase. The
concept of mathematical retention of material and performance for honors students at a vocational school has grown out of an observable phenomenon at the site under study. This vocational school goes by an un-written motto that the focus of curriculum must be on the ninth and tenth-graders for the state assessments, but after that, there is no pressure to help the eleventh and twelfth graders. Honors math students in the twelfth grade consistently state that they feel as if they have gotten weaker in math over their four years at this vocational school. This is something that is not just an occasional occurrence, it is noted year after year, and that is why this topic is important to this setting.

The current study focused on why honors students at a vocational school perceive a loss in their mathematic ability during their time at the school. It was initially unknown as to why this was occurring. A possibility was that students were so absorbed in their shop that they devalued academics as they progressed. It also could have been the schedule, where there is a ten-day gap between when the students leave academics and return. Another concern was possibly the way the material is being taught. Different strategies may have needed to be employed to make content more appealing to students so that it sticks better. Students can effectively “learn” from Monday through Friday and do decently on weekly assessments, but when it comes to a comprehensive exam, like a midterm or a final, they do poorly. The long-term retention of content is not present. This study sought to document students’ perspectives on this phenomenon, so their experiences can inform school leaders and provide ways to improve our programs in the future.

In researching literature, there are no true prominent authors speaking on the topic of mathematical achievement or retention in vocational education. Most studies that were included in the literature review were from Europe, where the vocational system is different than in the
United States (Akyuz, 2015; Baartman & Ruijs, 2011; Beausaert, Segers, & Wiltink, 2013; Biemans, de Bruijn, den Boer, & Teurlings, 2013; Ergun, 2012; Jonasson, 2012; Virtanen, Tynjala, & Etelapelto, 2014; Yavuz Mumcu & Cansiz Aktas, 2015). The studies that were conducted in the United States were from various authors (Anderson, 2008; Dalton, Lauff, Henke, Alt, & Li, 2013; Gentry et al., 2007; Gilbert et al., 2014; Hobley, 2015; Ingels et al., 2011; Morgan et al., 2011; Pearson et al., 2010; Sundell, Castellano, Overman, & Aliaga, 2012), as were the ones in Europe. Vocational schools are starting to receive more attention from families looking to provide a quality education for their children, and more studies will likely be conducted in the future. Currently, no studies were identified that focused on students’ perceptions on mathematics learning in vocational education in the United States that were able to be included in the literature review.

In looking at different theories to frame this study, the best way is through a lens focusing on motivation and student perception of learning (Anfara & Mertz, 2015). A synthesis of three motivational theories will be employed. These theories are Expectancy Theory (Ernst, 2014), Expectancy Value Theory (Clinkenbeard, 2012), and Self-Determination Theory (Brooks & Young, 2011). All of these theories have a basis in utilitarianism and focus on intrinsic motivation, self-perception, and self-efficacy, while also converging on student perceptions of their learning (Beausaert, Segers, & Wiltink, 2013; Cahn, 2013; Gilbert, et al., 2014; Jonasson, 2012; Yavuz Mumcu & Cansiz Aktas, 2015).

This mixed methods case study focused on why honors students at a diverse urban/suburban vocational school feel that their mathematics ability decreases during their time in school. The methodology included both qualitative and quantitative measures (Creswell, 2013). A records review was conducted for those students who have been enrolled in the honors
math program for their entire career at this site. This review helped to provide archival data which helped to understand who the students were academically and where they have been. Any past honors, distinctions, or issues were brought to light through this review (Merriam, 2009; Spillane, 2002). The records review also allowed the researcher to compare weekly test scores against end of semester exam scores, which helped to investigate the retention of content for the students with the use a t-test to test for statistically significant differences (Baartman & Ruijs, 2011; Salkind, 2014). It is through this records review that the researcher was able to better structure the interview questions that were asked. Themes that developed out of the records review were expanded on through the interview process (Merriam, 2009).

Semi-structured interviews with respondents were conducted (Merriam, 2009). Students were prompted to explore why the curriculum was either successful or not for them and to provide ways that would have made their experience more meaningful. Probing questions were asked, and the interviewer was careful not to assume what any of the responses were going to be (Coghlan & Brannick, 2009). The student interviews were used to explain how widespread this phenomenon is for the honors students at the vocational school under study (Spillane, 2002). Through these interviews, the reason for this decrease became better understood. Findings will be documented so school leaders can employ strategies to prevent this phenomenon from happening to students in vocational technical programs moving forward (Gentry et al., 2007; Jonasson, 2012; Spillane, 2002; Yavuz Mumcu & Cansiz Aktas, 2015).
CHAPTER THREE

METHODOLOGY

This study was conducted as a single case study focusing on the students at this particular regional vocational school in Massachusetts (Creswell, 2013; Merriam, 2009). This instrumental case study employed both quantitative and qualitative measures in an attempt to understand why honors mathematics students feel that their mathematical ability decreases over their four years of enrollment (Creswell, 2015). The overarching question guiding this study was: Why do honors math students in the twelfth grade at a regional vocational high school feel as if their mathematical ability has decreased over their four years at the school? Specifically, more detailed research questions included:

- How well do honors students retain mathematical content over a given semester in a vocational school?
- What strategies can be employed to help honors students in a vocational school retain mathematical content taught over a given semester?
- How can the perceptions of honors students’ math achievement in a vocational high school be influenced during the time of their enrollment?

The answers to these questions can help the faculty at this vocational school structure their classrooms in a way that will prevent this phenomenon from occurring in the future. Data collected first explored who these students were academically and how well students retained the information taught over the course of a semester based on a review of their student records (Merriam, 2009). The findings from the records reviews helped inform the questions which were asked in semi-structured interviews (Merriam, 2009). Interview questions focused on the established theoretical framework of motivation to do well in mathematics while enrolled at the
school, as well as probing students on their overall experiences in the honors math program at this site, delving deeper into data compiled in the records review (Creswell, 2015).

**Setting**

This study was conducted at a regional vocational and technical high school outside of Boston, Massachusetts. The district includes twelve cities and towns, with varying levels of income. Some of the communities are considered urban/inner city, while others are affluent, white-collar communities. There is tremendous diversity among the student population, not just in income, but also ethnicity. The school has over a thousand students currently enrolled (Massachusetts Department of Elementary and Secondary Education, 2016).

It is in this setting that students in honors math classes have remarked that they feel as if they have lost mathematical ability since they entered the program as ninth graders. The participants were twelfth grade students enrolled in the honors math program for their entire high school career. The researcher sought volunteers from honors math classes to participate in interviews.

**Participants/Sample**

Participants for this study were chosen using purposeful sampling (Creswell, 2015). A list of students who have been in the honors math program for all four years of high school was generated by the information technology department. These students were offered the opportunity to participate in the study, and were asked to return a parental consent form to allow for a records review and interviews (Creswell, 2015). These participants came from two different honors math classes covering two different courses; one is precalculus and the other calculus. The classes are taught by close colleagues of the researcher, who agreed to allow a presentation about the study to take place one day at the end of their classes to those students on the list
provided from the information technology department. It is students in these honors math classes who have historically stated that they feel as if they have gotten weaker in mathematics during their four years at this school. By choosing students who have been in honors math all four years, the researcher was able to examine if this phenomenon is being experienced currently, and to document student perceptions as to why this happens.

There are approximately 71 students in the honors math classes used to select the sample for this study. Since this study was conducted as an individual case study, the number of participants chosen to interview were selected from those who obtained parental permission for the student records review. Once the students obtained parental permission, or given permission themselves if they are over 18, the researcher planned to interview eight to 12 participants. The students were randomly chosen from each of the two courses, with approximately six to eight coming from precalculus and two to four coming from calculus. There are two sections of precalculus, so there are more honors students taking that course than the one section of calculus. Students from only one section of precalculus was used as a sample however because the other section is taught by the researcher, which posed ethical considerations for collection of data. The sample mirrors the ratio of students in the calculus to precalculus courses.

Students were willing to participate to address and possibly resolve this issue since it is human nature to contribute to helping makes changes for the better. People want to participate in ways that are meaningful to make changes (Wheatley, 2006). The researcher interviewed students from both courses to determine whether they felt the same phenomenon, which Creswell (2013) refers to as purposeful maximal sampling. If students felt differently between the two classes, that divergence was documented as well, based on participant responses.
Data

The data that were collected represents a combination of quantitative and qualitative measures (Creswell, 2015). The use of quantitative data as necessary to help explain what is happening to the grades of the honors math students, while the qualitative data was necessary to explore why math achievement was perceived by students as diminishing over time (Creswell, 2015). The quantitative piece of the study came out of the records review (Merriam, 2009) and was partially able to provide a comparison of weekly exam scores throughout the semester with the scores for the end of semester exam, which tested for long term retention of material (Spillane, 2002). If test data show that scores on weekly tests are better than that of the end of semester exams, this loss in retention compounded over four years could help to lead to this phenomenon where students feel they lose mathematical ability during their enrollment.

The record review was also able to provide the researcher with rich information about students’ academic profile, including any background information which may be helpful to understand who they were academically (Merriam, 2009; Spillane, 2002). Grades in honors math classes was important, however, there was also other important data to be collected, such as honors, distinctions, any disciplinary problems, and standardized exam scores. The record review was important to help develop themes and to provide further questions to ask the students in the interviews (Merriam, 2009; Spillane, 2002).

The qualitative data as collected from interviews (Bloomberg & Volpe, 2012). The semi-structured interviews were designed based on information gleaned out of the records review and provided a firsthand account of this phenomenon from the student perspective (Merriam, 2009). The interviews allowed students to fully paint the picture of how they felt the school has worked for them to be successful over their past four years and expand on information gathered from the
records review (Merriam, 2009; Spillane, 2002). This is a way to help the students make meaning out of their experiences, which is an essential first step in learning (Wheatley, 2006). Asking the students for their input helped to promote the cooperation needed to make the data valid and reliable (Searle, 2013).

Interviewees were encouraged to talk openly and were prompted to answer many questions, were redirected if necessary, and were told not be in fear of answering probing questions (Bardach, 2011). It was important for the researcher not to assume too much about the student’s experience when questioning participants, as assumptions could reflect potential biases, or lead to missed opportunities for gathering rich information (Coghlan & Brannick, 2009). The researcher was a facilitator in the interview, and truly let the participants guide the way (Gallos, 2006), this way both participant and researcher learned from each other, instead of the researcher imposing their viewpoints (Brown, 2006). From these interviews, participants gave their advice on what worked and didn’t work for them, and provided suggestions to counter similar negative perceptions from occurring for future students.

After all interviews were conducted and the information had been coded with themes that developed, the researcher met with the participants to do member checks and to discuss those themes (Creswell, 2015; Merriam, 2009). The researcher wanted to make sure that participants agree that what is included in the study is indeed what they were attempting to convey. These member checks serve as a measure of internal validity for the study (Creswell, 2015; Merriam, 2009).

Analysis

The quantitative data that was collected was analyzed by comparing the average weekly scores on chapter/unit exams with the average scores on end of semester exams to see if those
averages were fairly close, or if there were a difference. A t-test was performed in order to test if the difference in averages is statistically significant (Salkind, 2014). Other quantitative data was compiled and used to help better understand these students’ current academic status, and how they have scored academically over time. The themes developed helped to inform the interview questions (Creswell, 2015).

The qualitative data was coded according to themes that developed out of the records review and interviews (Creswell, 2015; Merriam, 2009). The interviews were recorded and transcribed (Creswell, 2015). Interview notes and transcripts were collected and organized in a case study database (Merriam, 2009). This database was then organized to show the themes which emerged throughout the data collection process.

Once the data had been analyzed, the findings were shared with the respondents in a member check meeting as way to provide internal validity for the study (Merriam, 2009). The researcher wanted to make sure that comments and themes included in the analysis are in line represented the thoughts, feelings, and attitudes conveyed by the participants. The use of a records review, including test data, and interview transcripts, provided different methods of data collection which should be aligned to inform conclusions. These measures provided the triangulation necessary to find the results credible (Creswell, 2015; Merriam, 2009; Sagor, 2000). The use of interviews themselves and the ability of the researcher to record precise words provided by the participants adds to the credibility and validity of the final research report (Sagor, 2000).

Participant Rights

The participants of this study were chosen from two twelfth grade honors math classes. Volunteers who had spent all four years in the honors math program were sought based on the
results of a database search provided by the school information technology department. These students were provided with a brief overview of what the study would entail. The researcher assured all students that participation or non-participation would not affect their academic standing or grades in any way. Informed consent forms were distributed to the students so that their parents or guardians could approve them to be included in the study (Bloomberg & Volpe, 2012; Creswell, 2015; Roberts, 2010). Students who were under the age of 18 needed to have their parents sign the consent forms (Sagor, 2000). A parental letter was sent home with the informed consent form, informing them of the purpose of the study. The forms and parental letter were carefully written as a way to not confuse either the students or their parents (Sagor, 2000).

The parental letter and the consent forms contained a Family Educational Rights and Privacy Act (FERPA) disclosure to inform the participants or their families about their right to deny the researcher access to the personal students’ records that are being sought, or to provide their permission. Only the 23 students returned parental permission forms or their own consent forms if they were over 18 and were included in the records review. From that group, nine students were identified and were randomly chosen for interviews (Merriam, 2009).

This study focused on a small number of the approximately 71 honors math students at this school. Therefore, nonparticipation did not lead to any adverse affects because a larger number of those meeting the criteria agreed to participate. Participants were told ahead of time how the data that they provide would be used in the final research study (Creswell, 2013; Roberts, 2010). Students were told that a summary of findings would be provided to them when the member checks were being conducted (Sagor, 2000). Participants’ rights were fully guaranteed and privacy was protected as a way to prevent any issues for participants due to their contribution to the study (Creswell, 2013; Roberts, 2010). Students of the researcher were not
included in the sample as a way to ensure that no ethical considerations were breeched with coercion or balance of power.

The data from the records review, including student math grades was complied without names or identifiable information attached (Creswell, 2015; Merriam, 2009; Roberts, 2010). All records reviews were conducted in a private locked room with only the researcher present. No identifiable information was taken from the records review. Interviews did not identify the interviewee on the recording. The data provided by the interviews was anonymous, and the tape recordings were deleted after the interviews had been transcribed (Roberts, 2010). Interview transcripts were marked with a student identification number for the purposes of member checks, but was not be attached to any identifiable information. All data including grades, other student record information, and interview transcripts was stored in a locked file cabinet at the home of the researcher to assure the protection of participant rights (Roberts, 2010). Nobody other than the principal researcher was able to see or handle any of the data (Merriam, 2009).

**Potential Limitations**

This study was conducted using a small sample of the honors math students at this regional vocational high school. The use of the small sample of only honors students and the use of the single case study as a methodology leads to findings that are not generalizable (Merriam, 2009). Although non-honors students were not sampled, information gleaned from this study will be able to be employed in other classes within the school, and help the school leaders ensure stronger math performance of all students. These strategies, if effective, can help other schools in the future.

The researcher believed strongly that this problem existed in the school, and wished to find a way to resolve it. This opinion leads to potential bias of the researcher, which was
considered in the data collection and analysis. The researcher strived not to make assumptions to anything that participants may want to offer in the interviews, or that could have limited the amount and effectiveness of the information provided by participants (Coghlan & Brannick, 2009). One way to manage the potential for researcher biases to intrude on the data collection was to make sure that the participants talked for the majority of the time, with the researcher only probing for deeper understanding (Creswell, 2015) and meaning without interjecting their assumptions (Brown, 2006). The researcher was cognizant of the possible influence of personal relationships with participants during the data collection.

Participants were reminded that their answers should be truthful, would not affect their standing in their respective math classes, and that they were free to skip any questions they did not feel comfortable with in the interview. It was emphasized that nonparticipation would not lead to any punishment, as well as inclusion in the study would not lead to any benefit that the nonparticipating students would not receive (Creswell, 2013). The researcher’s familiarity possibly worked in a positive way; insomuch as the participants may have been more willing to be open and honest because they know and trust the researcher (Creswell, 2013, 2015; Merriam 2009).
CHAPTER FOUR

RESULTS

The purpose of this mixed methods case study was to explore why honors students at an urban/suburban regional vocational high school perceived that their academic ability in mathematics decreases during their enrollment. The site for this study was a regional vocational and technical high school located outside of Boston, Massachusetts. The students chosen to be participants came from the 12th grade student population who had been in honors math courses during their entire four years of enrollment at the site. These students are the ones who can honestly gauge the usefulness of the school’s honors math curriculum as they prepare for the next chapter of their lives in college or industry. The overarching research question guiding this study was, Why do honors math students in the twelfth grade at a regional vocational high school feel as if their mathematical ability has decreased over their four years at the school?

This study specifically addressed the following research questions:

- How well do honors students retain mathematical content over a given semester in a vocational school?
- What strategies can be employed to help honors students in a vocational school retain mathematical content taught over a given semester?
- How can the perceptions of honors students’ math achievement in a vocational high school be influenced during the time of their enrollment?

This chapter will present, discuss and synthesize the data collected over the course of this study, including the method for analyzing the data collected, a presentation of the results, and a summary of those findings. The data collected were both quantitative and qualitative. The quantitative data was collected from a student records review and provided student semester
averages over the four years of enrollment and the corresponding midterm or final exam. Those semester exams are comprehensive exams given at the end of each semester to measure retention of material over that given semester. A t-test was performed to test whether or not the differences in average scores were statistically significant. The records review was also able to provide results for the ninth grade placement exam, tenth grade MCAS exam and the SAT in mathematics.

The qualitative data was collected by interviewing nine randomly selected participants. Interviews were semi-structured and questions were developed based on a student records review (Merriam, 2009). The interviews took place after school, as did the member check-in to discuss the themes developed during the interview. All interviews were recorded on an iPad and uploaded to the TranscribeMe app. Once the recordings were uploaded, the application transcribed the interviews and returned a transcript via email, which could then be coded appropriately. The ability to compile themes from a records review and compare those with data collected through interviews and member check-ins provided the needed validity and triangulation necessary to take the findings seriously (Merriam, 2009; Sagor, 2000).

**Analysis Method**

Multiple forms of data were collected during this phase of the study. The first stage in the data collection was the student records review, which was helpful to gather quantitative data on semester and end of semester exam grades. This data was helpful to answer the first research questions regarding retention of mathematical content. The records review was also able to provide data on standardized exams that students have taken: the Stanford 10 placement exam, the tenth grade math MCAS exam, and the SAT, which helps to illuminate retention. These
scores, coupled with the semester and semester exam scores helped to inform the types of follow up questions that were asked of the selected participants in the interviews.

Semi-structured interviews were conducted from a random sample of the group who agreed to participate in the study. There were nine interviews total, with five coming from the traditional honors track, and four coming from the advanced honors track. These interviews lasted approximately 45 minutes to one hour and were recorded using an iPad application, which transcribed the interview as well. Once the transcripts were coded into themes, the transcript and summary sheet of the interview were presented to participants at a member check-in meeting to verify the data collected was accurate.

Participants

The sample selected for this study was students at the school who have been in the honors math program for their entire four year enrollment. There were 46 students total, however 11 were taught by the researcher, so they were not asked to participate in the study due to the potential of coercion and influence of power. The remaining 35 students were offered an opportunity to participate, and of that group, 28 students took consent forms. There were 23 students who returned the signed consent forms, and those students were included in the records review. Of the forms returned, 12 students came from the traditional honors program, and 11 came from the advanced honors track. As the consent forms were coming in, a random sample was chosen for interviews. A total of nine students were interviewed for the study, with five coming from the honors program, and four from the advanced honors program. Table 1 illustrates the distribution of participants for the study.
Table 1

*Distribution of Students Available/Participating*

<table>
<thead>
<tr>
<th>Description of Group</th>
<th>Number available/included</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Honors Math Students</td>
<td>46</td>
</tr>
<tr>
<td>Number of Honors Math Students taught by a teacher other than the researcher</td>
<td>35</td>
</tr>
<tr>
<td>Number of Honors Math Students who took consent forms</td>
<td>28</td>
</tr>
<tr>
<td>Total Number of Participants for Record Review</td>
<td>23</td>
</tr>
<tr>
<td>Participants from Honors Track</td>
<td>12</td>
</tr>
<tr>
<td>Participants from Advanced Honors Track</td>
<td>11</td>
</tr>
<tr>
<td>Total Number of Participants Interviewed</td>
<td>9</td>
</tr>
<tr>
<td>Participants from Honors Track</td>
<td>5</td>
</tr>
<tr>
<td>Participants from Advanced Honors Track</td>
<td>4</td>
</tr>
</tbody>
</table>

**Data Collection Procedure**

**Records review.** A records review was conducted as participants returned their signed consent documents. The records review provided the researcher with an account of each participant’s academic history. An Excel spreadsheet was developed to log each participant’s semester grade and the semester exam grade for nine through twelve grade years. Once the data was entered into the spreadsheet, a t-test for paired samples was conducted using the Microsoft Excel data analysis tool (QI Macros, n.d.). The purpose of this t-test was to compare the means of the semester scores with the means of the end of semester exams and to determine if there was
a different and if that difference was statistically significant, or merely due to chance (Excel Easy, 2016).

The records review also contained information on different benchmark exams that the participants had taken over their enrollment at the school. The Stanford 10 exam was given to all students entering in the ninth grade and is used for placement into math classes. The state mandated MCAS exam is given in the tenth grade, and those scores are contained within the student record. Finally, scores for students who participated in the SAT exam were collected. The ability to track how the participants have fared on these three various standardized exams can help to paint a picture of their abilities in math upon entering the ninth grade, at the end of the tenth grade, and again as they prepare to leave high school for college or a position in their vocational specialization. The records review was also able to provide a great deal of background information on the participants, and pointed to different themes that could be delved into with the interview portion of the data collection.

**Interviews.** Data collected from the records review was able to inform follow up interview questions that accompanied the interview protocol used in the semi-structured interviews (Merriam, 2009). The interviews were conducted after school for the nine participants who were randomly selected. The interview sessions lasted approximately 45 minutes to one hour. During the interviews, participants were asked questions according to the interview protocol, attached as Appendix D with follow up questions being from themes that developed in the records review. All interviews were recorded using an iPad using the TranscribeME app. Once the interview was concluded, the app took the recording and transcribed the interview. Each transcript was returned approximately one day after the interview was conducted.
Interview transcripts were analyzed and responses to questions were typed into an Excel spreadsheet in summary form. This form and the original transcript were presented to each participant at a follow up meeting. This member check-in was conducted to make sure that the data that was collected was a true representation of what the participant had wanted to convey. The ability to perform the member check-in provides the validity or trustworthiness required to take this case study seriously (Roberts, 2010).

**Coding of Data**

Following the member checks of their transcripts, any changes to the summary sheets were made in the corresponding Excel spreadsheet before synthesizing the interview data. Multiple rounds of coding were performed to be able to effectively develop themes and categories which could be tied to the corresponding research questions.

**First round of coding.** The different summary sheets were all copied and pasted into one new spreadsheet, with a break being present between participants in the traditional honors track and the advanced honors track. The break was necessary as a way to keep the data separated in a way that made it easy to analyze, but allowed for a synthesis between the two different programs. This spreadsheet gave the ability to see all responses listed together so that similarities could be spotted easier than going to multiple spreadsheets. Once all data was on one spreadsheet, columns were made for each of the questions provided in the interview protocol. The responses of each participant were placed in the appropriate column so that all responses to the same question could be seen together; again with a space between the two different honors tracks. The responses tied to each question asked on the interview protocol made it easier to group responses that were similar in nature.
Second round of coding. Once all the responses were listed under the individual question, similar responses were highlighted with the same color, as a way to identify the similarities more easily. Common responses were tallied below the description in order to see the dispersion of common responses of the participants. From the second round of coding there were ten common themes that were developed, which had to be synthesized down into categories.

Third round of coding. Once all the common responses were listed on the spreadsheet, there were similarities among the themes which were then grouped into categories. Four categories were developed based on the inspection of common responses provided by the participants during the course of the interviews and member check-in meetings. The four categories which were developed throughout the coding process were: background/personal history, long term retention, motivation, and suggestions for improvement.

Presentation of Results

The results of this study will be presented in both quantitative and qualitative forms. Categories were developed through the coding process and are identified as, background/personal history, long term retention, motivation, and suggestions for improvement. The categories of background/personal history, motivation, and suggestions for improvement produced qualitative data through interviews. The category on long term retention was studied through both quantitative and qualitative data sources.

Category One: Background/Personal History

The site where this study was conducted is a school district which encompasses 12 different communities outside of the city of Boston, Massachusetts. The demographics of the 12 communities are quite diverse, as is the student body at this regional vocational and technical high school. It is through this diversity that participants of the study helped to paint the picture as
to why students, especially high-level learners come to this particular school instead of their local community comprehensive high school. This category also encompasses the mathematical history for these participants, why they are in the honors program, and sought to understand how they felt about their mathematical ability in middle school and upon entrance into this site, continuing through until their senior year in high school. Finally, future plans after graduation were discussed, as a way to understand where participants see themselves post high school.

Reason for coming to this school. The nine participants who were interviewed for this study provided various reasons for coming to this school instead of going to their local comprehensive high school. Four students came to this school because they wanted a trade, and that is something that their local school cannot offer. One participant did not say that they specifically came to this school for a trade, but did say that they were very hands-on, which lends to the same basic premise for coming to this site as the other four participants.

The remaining four participants had varying reasons for coming to this site. Two of the participants chose to come to this school because they did not like the school, or the people at the school in their town. One participant noted that his mother made him come to this site, while the final participant noted that the reason he came here was because he liked the idea of academics every other week. A distribution of this data is shown in table 2.

Table 2

<table>
<thead>
<tr>
<th>Distribution of Reasons Why Students Came to This Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reason for Coming</td>
</tr>
<tr>
<td>Wanted a trade</td>
</tr>
<tr>
<td>Did not like town school system</td>
</tr>
<tr>
<td>Hands-on person</td>
</tr>
<tr>
<td>Parental choice</td>
</tr>
<tr>
<td>Academics every other week</td>
</tr>
</tbody>
</table>
Mathematical Ability Level in Middle School. The participants for this study were placed into an honors track upon entering the ninth grade partly because of their prior ability in middle school and their scores on the Stanford 10 placement exam. All students participating in the study scored a 12.9 on the placement exam, which places them at the 12th grade, ninth month benchmark, which is why they were placed in the honors program.

Interview questions focused on how students felt about their mathematical ability when they were in middle school. Out of the nine students interviewed, seven proclaimed to have been good math students. Various quotes from the participants were:

- It just came easy to me.
- I did very well in math. It came easy to me in eighth grade, seventh grade.
- I was over-average, I was very good at math in eighth grade.
- Math was always my strongest subject, so I think I was pretty good.
- I was really good, I was really advanced in it.
- I was a good student, I was in the lower math class but it was really easy for me.
- I was very good at math in eighth grade.

Two of the participants felt a little differently about their middle school math experience however, as quoted below:

- I wasn’t very strong about it.
- Not good at all.

There was something interesting when looking at the responses in the fact that two students in the advanced honors track felt that they were not very good at math. However, both were placed in the upper math track based on their scores on the placement test and have remained in the
highest track for their entire high school career. With the exception of those two participants it can be concluded that a significant majority of students in the honors track are there not only because they scored well on placement exam, but because they felt confident about their mathematical ability upon entering the ninth grade. The final piece of personal history to help paint the picture of who these participants are as math students lies in their future plans after graduation.

**Future plans beyond high school.** The future plans for the participants are as diverse as the total student population in general. Four of the participants interviewed are planning on entering college to study the major that they are enrolled in at the site. Two of the participants are going to a four year college for something other than the trade that they have been studying, while two others are going directly into the industry. Finally the last participant is going into a hybrid of the previous outcomes. This participant is planning on attending a program through a local community college, which is tied to the field of study in the trade. This participant will spend two years in the classroom, paired with working, and have a job for a local utility company upon completion of that program. Table 3 illustrates the dispersion of post high school plans for the participants.

Table 3

**Distribution of Future Plans Post High School**

<table>
<thead>
<tr>
<th>Plans for post high school</th>
<th>Number of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>College for trade</td>
<td>4</td>
</tr>
<tr>
<td>4 year college not affiliated with trade</td>
<td>2</td>
</tr>
<tr>
<td>Industry</td>
<td>2</td>
</tr>
<tr>
<td>2 year college and work in industry</td>
<td>1</td>
</tr>
</tbody>
</table>

The participants for this study who were interviewed come from various cities and socio-economic backgrounds within the twelve communities that make up the regional vocational and
technical high school district under study. The diversity in their backgrounds lends to diversity in their personal stories leading them to enroll in this high school, and informs their decisions about the future. Although most students acknowledge that they came here to learn a trade, there are other reasons as well. Mostly all participants felt very good about their mathematical ability upon entering the school from eighth grade. When asked about their perception of their ability in the twelfth grade as compared to the eighth grade, seven of the nine interviewed stated that they felt more confident now than in the eighth grade. However, this confidence level was based on the fact that they are doing harder topics now than in the eighth grade. Although seven of the interviewed participants feel they are stronger math students now than in the eighth grade, many voiced a myriad of concerns relating to their current ability levels and their ability to retain mathematical content long term.

Category Two: Long Term Retention

In test whether or not students in the study demonstrate long term retention of material, both quantitative and qualitative methods were employed. Quantitatively, participants’ semester exam scores were recorded for their ninth through eleventh grades, and the first semester of their twelfth grade. The corresponding semester exam (midterm or final) scores were recorded as well. A two-tailed t-test was performed to determine if there was a difference in the averages, and if so, whether the scores’ differences were statistically significant (Salkind, 2014). Interviews focused on the students’ perceptions of their own math content retention ability while the participants have been students at this site. The student’s experience is a significant part of the information gathered to gauge retention of content when that experience is paired with the empirical data coming from achievement scores.
**Total Honors Population.** The two-tailed t-test was performed on the semester and semester exam scores for 23 students (N=161) who have been in the honors program for all four years at this site. It was found that there was a statistically significant difference between the averages for the semester grades (M = 85.16, SD = 7.9) compared to the semester exam grades (M = 78.14, SD = 12.94), t(160) = 8.56, p ≤ .05. Therefore, the null hypothesis that the means are the same is rejected, since the mean semester exam scores are significantly lower than the mean semester scores (Research Rundowns, n.d.). The results are listed below in table 4.

Table 4

*Comparison of Semester Grades and Semester Exam Grades for All Honors Students*

<table>
<thead>
<tr>
<th></th>
<th>Semester Grades</th>
<th>Semester Exam Grades</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Honors Population</strong></td>
<td>85.16149</td>
<td>78.14286</td>
</tr>
<tr>
<td>Mean</td>
<td>7.904034</td>
<td>12.9397</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>62.47376</td>
<td>167.4357</td>
</tr>
<tr>
<td>Observations</td>
<td>161</td>
<td>161</td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>0.594916</td>
<td></td>
</tr>
<tr>
<td>Hypothesized Mean Difference</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>df</td>
<td>160</td>
<td></td>
</tr>
<tr>
<td>t Stat</td>
<td>8.560812</td>
<td></td>
</tr>
<tr>
<td>P(T&lt;=t) two-tail</td>
<td>8.77E-15</td>
<td></td>
</tr>
<tr>
<td>t Critical two-tail</td>
<td>1.974902</td>
<td></td>
</tr>
</tbody>
</table>

The results show that semester grades are higher than end of semester exams by 7.02 points. This difference shows that on average, honors students score approximately seven points lower on their end of semester exams than the grades they get for course itself when taking an exam covering material learned over the course of the semester.

**Traditional Honors Population.** Analysis of retention of math concepts can further be broken down into the two different honors tracks that make up the student population at this site. The differences in semester grades and semester exam grades for traditional honors students (N
out of the 12 participants were found to be statistically significant. The semester grades ($M = 86.76, SD = 5.84$) compared to the semester exam grades ($M = 77.08, SD = 11.07$), $t(83) = 8.58, p \leq .05$, showed that the difference between the averages was statistically significant and not due to chance as shown in table 5 (Research Rundowns, n.d.).

Table 5

*Comparison of Semester Grades and Semester Exam Grades for Traditional Honors Students*

<table>
<thead>
<tr>
<th></th>
<th>Regular Honors Track</th>
<th>Semester Grades</th>
<th>Semester Exam Grades</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>86.7619</td>
<td>77.08333</td>
<td></td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>5.838425</td>
<td>11.07065</td>
<td></td>
</tr>
<tr>
<td>Variance</td>
<td>34.08721</td>
<td>122.5592</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>84</td>
<td>84</td>
<td></td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>0.385792</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypothesized Mean Difference</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>df</td>
<td>83</td>
<td></td>
<td></td>
</tr>
<tr>
<td>t Stat</td>
<td>8.584524</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P(T&lt;=t) two-tail</td>
<td>4.43E-13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>t Critical two-tail</td>
<td>1.98896</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The results show that semester grades for students in the traditional honors track are higher than end of semester exams by 9.68 points, which is a larger discrepancy than the total population which has a difference of 7.02 points. This difference shows that on average, honors students in the traditional track score approximately ten points lower on their end of semester exams than the grades they get for course itself when taking an exam covering material learned over the course of the semester.

**Advanced Honors Population.** The differences in semester grades and semester exam grades for advanced honors students ($N = 77$) out of the 11 participants were found to be
statistically significant as well. The semester grades ($M = 83.42, SD = 9.40$) compared to the semester exam grades ($M = 79.30, SD = 14.70$), $t(76) = 3.71, p \leq .05$, showed that the difference between the averages was statistically significant and not due to chance as shown in table 6 (Research Rundowns, n.d.).

Table 6

*Comparison of Semester scores and Semester Exam Scores for Advanced Honors Students*

<table>
<thead>
<tr>
<th>Advanced Honors Track</th>
<th>Semester Grades</th>
<th>Semester Exam Grades</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>83.41558</td>
<td>79.2987</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>9.400939</td>
<td>14.69879</td>
</tr>
<tr>
<td>Variance</td>
<td>88.37765</td>
<td>216.0543</td>
</tr>
<tr>
<td>Observations</td>
<td>77</td>
<td>77</td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>0.758289</td>
<td></td>
</tr>
<tr>
<td>Hypothesized Mean Difference</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>df</td>
<td>76</td>
<td></td>
</tr>
<tr>
<td>t Stat</td>
<td>3.708981</td>
<td></td>
</tr>
<tr>
<td>P(T&lt;=t) two-tail</td>
<td>0.000394</td>
<td></td>
</tr>
<tr>
<td>t Critical two-tail</td>
<td>1.991673</td>
<td></td>
</tr>
</tbody>
</table>

The results show that semester grades for students in the advanced honors track are higher than end of semester exams by 4.12 points, which is a lower discrepancy than the total population which has a difference of 7.02 points, and the traditional honors track students which has a difference of 9.68 points. This difference shows that on average, honors students in the advanced track score approximately four points lower on their end of semester exams than the grades they get for course itself when taking an exam covering material learned over the course of the semester.
**Standardized Exam Data.** All participants with the exception of one student took the Stanford 10 placement exam when entering the ninth grade. Eight of the nine participants scored the highest they could possibly score, a 12.9, which relates to twelfth year ninth month. These same participants all took the MCAS exam in mathematics at the end of their tenth-grade year. The total honors population scored an average of 262 out of a possible 280, which is considered Advanced. There were 16 individuals who scored Advanced (260 or above) and seven individuals who scored Proficient (240-258). This data can be further broken down to traditional honors and advanced honors.

The traditional honors students had MCAS scores on average of 260, which is considered Advanced. Individually nine students scored Advanced and three scored Proficient. The advanced honors population had an average score of 262, which is also Advanced. The spread among students in this grouping was seven Advanced and four Proficient. This data shows that honors students maintained a high level of achievement through the tenth grade. The data collected from the SAT shows a different picture however.

**SAT exam.** Six students in the sample did not take the SAT. The remaining 17 students saw varying levels of success, but rarely the level of success seen on the MCAS exam. The overall average of honors students on the SAT exam was 530 out of 800, which is in the 53\textsuperscript{th} Percentile (The College Board, n.d.). When separated, the traditional honors students scored on average 490 out of 800, which is in the 40\textsuperscript{th} Percentile, and the advanced honors students scored 570 out of 800, which lies in the 66\textsuperscript{th} Percentile (The College Board, n.d.). These scores and the percentiles cannot be compared with the outcomes of the tenth grade MCAS exam since they measure different benchmarks. However, honors students can perceive a drop in their ability exists because they went from top scores on the MCAS to the middle of the pack on the SAT.
Table 7

*Standardized Exam Scores*

<table>
<thead>
<tr>
<th>Population</th>
<th>Stanford 10</th>
<th>MCAS Exam</th>
<th>SAT Exam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>12.8</td>
<td>262</td>
<td>530</td>
</tr>
<tr>
<td>Traditional Honors</td>
<td>12.7</td>
<td>260</td>
<td>490</td>
</tr>
<tr>
<td>Advanced</td>
<td>490</td>
<td>53rd Percentile</td>
<td></td>
</tr>
<tr>
<td>Advanced Honors</td>
<td>12.9</td>
<td>262</td>
<td>570</td>
</tr>
<tr>
<td></td>
<td>Advanced</td>
<td>66th Percentile</td>
<td></td>
</tr>
</tbody>
</table>

**Analysis of Quantitative Data.** The quantitative data collected through the records review on student grades for the semester and semester exams is useful to answer research question one: How well do honors students retain mathematical content over a given semester in a vocational school? Based on the results of comparing the average grades over a given semester with its corresponding semester exam grade, it was found that grades on the semester exams are approximately 7.02 percentage points lower than that of the regular classroom grade over that same given semester. Those semester grades are calculated at smaller intervals throughout the semester, whereas the semester exam is a comprehensive exam covering all topics taught during that same time period.

When the participant group is separated into two different smaller groups, traditional honors track and advanced honors track, the difference in semester averages as compared to semester exam averages is apparent as well, however one group does slightly better long term than the other. Participants in the traditional honors program saw their semester exam scores approximately 9.68 percentage points lower than their semester averages, whereas advanced honors students saw their semester exam scores approximately 4.12 points lower. This shows that advanced honors students fared better at long term retention of material than the traditional honors students, but that there was still a statistically significant difference in their averages, with
the exam averages being lower than the in-class semester averages. The factors that influence retention of math concepts cannot be understood by quantitative measures alone; the student perspective is included to provide another view about retention issues.

**Analysis of Qualitative Data.** Retention differences as measured by semester scores and comprehensive exams can be illustrated effectively using grades; however, there is more to retention issues than scores alone can show. There are many variables that come into play when looking at semester scores. Each teacher employs different grading schemes, such as tests, quizzes, homework, and participation. Therefore, in order to fully understand if retention of material is an issue, participants were asked for their opinions about their ability.

**Student Voice on Retention.** The nine participants who were interviewed all came to the same conclusion with respect to their ability to retain mathematical content long term. All nine participants, both traditional honors and advanced honors students, said that retaining material was not easy for them. This feeling is illustrated by the following quotes:

- I usually forget about stuff we learned the week before.
- It’s a little difficult to retain from the beginning of the year to the end of the year.
- I mean, I can’t really remember that much about math.
- I feel like it’s a little harder to remember some of the stuff because I’m coming back every other week to learn it. Sometimes weeks because of vacations.
- From September to mid-terms for example, not very great at retaining things.
- I still won’t be able to remember it, but yeah, I just don’t think it’s good, I can’t retain information well.

Some students interviewed said that they struggle with retention for some concepts, but other topics are less challenging to retain:
• It depends on the material; say the quadratic formula, that’s something that is repetitive, so I feel strongly about that, but other stuff, not really.
• Stuff we have done a lot kind of stays with me, but stuff we did last year; I couldn’t remember any of it.

These students all feel that the ability to maintain a high level of achievement is impacted by their ability to retain information on a long-term basis. As a way to delve deeper into why the participants felt this way, questions about the school schedule were asked.

**The school schedule and its impact on retention.** The site of this investigation is a regional vocational and technical high school which structures its schedule in to allow for equal time in academic classrooms and vocational shops. The schedule employed at this site is an alternating week schedule where one week students spend their entire day in shop and the following week students spend their day in academics. When students are in their shop, they spend all day, but when students are in academics they have five classes, each one meets for 70 minutes. The participants interviewed expressed their belief that the schedule does impact their retention. Comments from the participants are noted below:

• Yeah, I think when you take a week off, you’ve just already forgotten about it.
• Yes. Definitely. The week off is a lot because you’re completely doing something different. It is very difficult to learn and retain subjects and all the information, because you just forget about it. It just is out of sight, out of mind.
• If we learn something one week and don’t finish it, and then we’re going to learn it next week after shop, I have no clue what I’m doing and he has to re-teach everything all over. So it kind of hurts the ability because it takes longer to learn stuff.
- A little bit, it’s a little harder to retain the information and remember half of it. But at the same time, we’re learning as much as traditional high school students do in a shorter period of time.
- You would retain it better if you were doing it every single day, if you didn’t have that ten-day gap.
- Yes, because they expect you to learn too much in one week. I don’t think it’s fair that you have to learn twice as much in one week than at a regular traditional high school. On Monday, I’m blank. It takes me Monday and Tuesday to relearn what I learned on the last academic week. Then it takes me Wednesday and Thursday for me to learn the new stuff.

The weekly schedule is not the only factor that students feel impacts their retention abilities. The academic classes are 70 minutes long, which promotes its own set of problems in the eyes of the participants:

- I don’t really mind having – because it’s only five classes, but when you’re sitting there for 70 minutes – especially for me, I can’t focus for that long. The first half I might be taking notes, but then after that, I’m like, “I’m done here.”
- Yes, I think it honestly does play against it [retention] because, I mean, you have 70-minute periods and it’s a lot harder to pay attention for 70 minutes than it would be for say 45.

The participants of this study, whether traditional or advanced honors students, have voiced their concern with their ability to retain content. These observations coupled with the empirical data from their semester and semester exam grades shows that retention is currently a major problem for the students in our honors program.
Category Three: Motivation

In order for students to be able to fight their perceptions about their ability to retain math concepts, they have to be motivated to overcome those obstacles. The third category of this study focuses on the issue of motivation. Interviews pointed to personal motivational influences, the comparison of motivation levels in academics and shop, and how a teacher can influence that motivation.

**Personal motivation influences.** This study not only intended to find out how students characterize their retention of material, but also seeks to better understand what drives the participants to do well academically in the honors program. Participants were asked about their motivation to do well in their math classes. The participants’ views were quite spread out in terms of what personally drives them to do well in their math classes. Two participants said that getting good grades was all that motivated them. Three participants said that motivation was about 50% grades, and 50% gaining true knowledge. Two participants said that they are motivated by the challenge, and overcoming that challenge. Finally, one participant said it feels good to do well, and another participant said that they are motivated because this is information that they will need in the future, whether in college or work after college. Table 8 illustrates the personal motivational forces of the participants.

Table 8

<table>
<thead>
<tr>
<th>Motivation</th>
<th>Number of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>50% grades, 50% gaining knowledge</td>
<td>3</td>
</tr>
<tr>
<td>Grades alone</td>
<td>2</td>
</tr>
<tr>
<td>The challenge</td>
<td>2</td>
</tr>
<tr>
<td>Feels good to do well</td>
<td>1</td>
</tr>
<tr>
<td>Will need content in the future</td>
<td>1</td>
</tr>
</tbody>
</table>
Motivational Comparisons. The students at this site and all participants of the study specifically, have two different environments to learn in while they are enrolled at this school. Since students spend one week in academic classrooms, and another week in shop, the motivational influences on the students to do well in shop needed to be sought out along with the motivational influences with respect to academics. Participants were asked about their personal motivation to do well in shop after they were asked about motivation in math class. Five participants said that they are definitely more motivated to do well in shop than they are in academics. When probed to understand why they feel that way, all responded in one form or another that because that is the field they are going into after high school or college, that is why they are more motivated. One participant said that the content in the shop came easy to them, so that is why they were motivated to do well. Two participants shared that they are actually not motivated in shop because they are not going into that field after graduation, while one participant noted that he used to be motivated in shop until he decided to change his future plans, and now that shop is not part of his future, he is not motivated in there at all. Table 9 displays the motivational forces in the career technical major.

Table 9

Motivational Forces in Career and Technical Shop

<table>
<thead>
<tr>
<th>Motivation in shop</th>
<th>Number of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Going into this field</td>
<td>5</td>
</tr>
<tr>
<td>Tasks come easy to me</td>
<td>1</td>
</tr>
<tr>
<td>No motivation at all</td>
<td>2</td>
</tr>
<tr>
<td>Was motivated until change in plans</td>
<td>1</td>
</tr>
</tbody>
</table>

Participants were asked why they thought that there was more personal motivation to do well in shop as opposed to in academics. Replies to this question focused on the sheer amount of time spent in that setting, and the usefulness of that setting to their future:
• The more time I spend in shop, the more time I dread being back in academics.

• I lost interest after the second year because of my shop and the work that I am going to go into, who needs trigonometry when I want to make money.

• Students honestly check out after two years because of shop. Trying to cram twice the work in half the time is hard. One week is intense and one week is a joke.

The teacher’s role in motivation. Motivation to do well in math and the career and technical shop major can be influenced by other factors than just what drives students inside. Participants were asked about the teachers’ role in promoting a good motivational drive for students. When asked if a teacher can influence personal motivation to do well in a class, all nine participants said yes. Participants felt that if a teacher does not show enthusiasm for their topic, or are not organized, it makes it difficult to want to perform well in their class. The shop teachers are considered more as facilitators in the eyes of the participants, and because of that role they feel a better partnership with the shop teachers than the rigid power imbalance that exists in the academic classroom. This discussion contributed to further understanding about what, beyond organization and enthusiasm, a teacher can do to hook their audience in this school.

Participants felt that since this is a vocational and technical high school, teachers should try to teach their topics through the lens of problems that arise in the industry. Participants felt that this approach could help students remain more interested while learning the intricate math content being presented. Four of the participants noted that since this a vocational school, most kids are hands-on learners. In their estimation, this learning style should be taken into account when planning lesson activities. When asked if they had ever been a part of a project-based curriculum in middle school, most said no. One student did remember a lot of math being presented through the use of toys, and said that definitely helped make the class more enjoyable.
to them. Another participant noted the benefits of a hands-on approach as being tied to the ability to pay attention over a 70-minute class, “You have to make it interesting, here most kids have short attention spans.”

The participants were able to verbalize how they feel their motivation is generated or stifled within the context of the school. Once students were able to discuss how they felt their retention of material was affected, and were able to reflect on their motivational forces, the discussions moved to how to correct any perceived issues the students have. These suggestions make up the final category developed over the study.

**Category Four: Suggestions for Improvement**

There are many change initiatives that can be implemented in schools; however, they are usually implemented without much input from the most important stakeholders, the students. This study, through various methods has shown that students at this school have strong opinions about their time at this particular regional vocational and technical high school. This study was not intended to present only problems however, it was designed to allow for the honors students to share their insights, and give suggestions for what can be done in the future to prevent other students from feeling the same way. The final category of study brings that student voice to the foreground.

**Schedule changes.** The school schedule is set in a way that facilitates equal time for students to spend in their academic classes as their vocational shops. This schedule works in theory to supply students with the required hours of instruction, but the quality of instruction can be compromised because of that design. As one participant noted, “We leave academics and do not come back for at least ten days. Sometimes even longer if a vacation is in there or there are snow days.” It was shown above that students feel this ten or more day gap contributes to a lack
of retention of math concepts. The schedule of one week in one setting and one week in the other is perceived by students to negatively influence their math learning.

All nine of the interviewed participants felt that a schedule change may help them feel as if they can retain information better. One participant mentioned that in other vocational schools, ninth and tenth grade students still receive math and English class every day, and go to shop after those classes. The idea of a Wednesday to Tuesday rotation was also discussed. Participants thought it may be tricky to get used to, but once they were used to it, it could be beneficial. One benefit of this rotation is that a student would leave academics on a Tuesday and go to shop Wednesday to the following Tuesday. That following Wednesday the student would be back in their academic classes, which is only an eight day gap, as opposed to the current ten day gap.

Participants felt that a shop week fully dedicated to CTE skills cannot be avoided however. Two participants felt that splitting the day into half shop and half academics could accomplish the goal of continuity, but the remaining seven participants felt that this was not something that would be effective. One participant was strong in their opposition stating, “Shop week is necessary because that is who we are, it is a vocational school, and when you are in shop, you need to be in shop, not half in and half out.” Since it is a fact that half of the time students spend enrolled at the school is in vocational areas, something has to be done over the break time away from math instruction to try and help the students hold onto the material that has been taught to them. One such method is through shop week homework.

**Shop week homework.** Shop week assignments have been a topic of concern at this regional vocational school for many years. These are packets with problems from the previous week that students are supposed to work on during their shop week and turn in on the following academic Monday. The idea has been implemented, but most participants have voiced their
displeasure with it. Six participants thought that shop week homework was a waste of time, and admitted to not putting any effort into doing it well. Those participants noted that they either rush through it Sunday night, or copy it Monday morning. If shop week assignments are treated with this little regard, it is no wonder that students do not use this method to help maintain a level of math concept retention from their academic classes. One participant noted that the shop week work that they were given this year is designed as an attempt to foreshadow what lies ahead.

When asked if that approach helped to develop interest, the answer was a resounding no. Since the content is something that students have not learned yet, most just do not do it, the student responded. Therefore, school staff needs to know if there is a way to make the practice of take home shop week homework more effective.

Participants were asked if there is a way to make shop week take home work more meaningful and help to maintain the knowledge imparted the previous week. Four participants felt that valuable shop week take home work could help to keep students up to date with topics. The most prevalent suggestion from them is to have an online testing system set up in which they must check in and do a problem or two by a certain time over the shop week, say Tuesday and Thursday at midnight. One participant did voice concern that such an approach to take home work could lead to resentment by students, but also agreed that after a while, students would get used to the practice and start seeing the benefits of it. Another suggestion from the participants was the use of a course that all ninth grade and tenth grade students take, known as Math Lab.

**Use of the Math Lab course.** Ninth and tenth grade students all have a course that meets two days a week in their schedule known as Math Lab. This course is designed as a reinforcement/enrichment course to help students prepare for the MCAS exam which they take at the end of tenth grade. These courses are not offered for students in the eleventh and twelfth
grade, for reasons of scheduling and the fact that the state mandated exams have been completed. One participant actually shared a sense of resentment toward the curriculum once students have completed that MCAS exam. The participant said, “The school shouldn’t just stop pushing us once we finish the MCAS, they should not lay back on us.”

Three participants felt that this type of course would still benefit the students after the tenth grade. One suggestion was to link the course with the same math teacher, as is done with the advanced honors track. This approach may not be possible from a staffing perspective, but the idea of continuing that Math Lab into twelfth grade does have merits. Students at this site struggle on college placement exams like the Accuplacer and SAT. To use a course like the Math Lab to help teach those skills, and tie content from the math course into the SAT format, could improve both retention of the math material and the ability of students to do well on those types of exams. Another suggestion focuses on the way material is presented in the class from the instructor standpoint.

**Suggestions to improve teaching practice.** All participants noted above that a teacher can affect motivation levels of students in a classroom. The question about what strategies are best for the students at this school is a topic that participants were able to address. Two participants felt that inconsistency among teachers’ style and grading procedures causes problems with students as they move from grade to grade. They felt a more streamlined approach to teaching at each grade level in the sequence could help students stay organized and know what the expectations are throughout the four years. Also, they vocalized that although they understand there are multiple ways to solve math problems, learning different ways to do the same problems each year tends to confuse them rather than solidify their knowledge. Since learning styles are so diverse at this school however, participants felt that teachers should instruct
in ways that resonate with how students learn best and through topics that interest them, like those from shop. This type of differentiation could be an effective strategy as well, but some challenges to its implementation might be found in teacher professional development and the time to implement it.

*Linking topics of interest to lessons.* The participants who shared their feelings that teachers should teach their content through the lens of the shop curriculum point to increased interest as a reason for success. One participant noted that, “If the math we learned in class had to do with stuff we do in shop, I would be more interested to pay attention and understanding how to do the problems like that.” This type of integration may be a good practice for helping students do well in the specific math courses, but it is not without its challenges. When participants were asked if teaching in this manner could transfer easily into success on an academic based standardized exam like the Accuplacer or SAT, five participants agreed that transferability could be limited. “It might be hard to go from understanding a concept in terms of shop terms, to being able to do that same problem on a test that is not asked in the same way.” The context in which questions are asked has a huge impact the participants shared. What might be a doable problem when incorporating terms and ideas from their vocational area not solvable when asked as an algebraic-type question with no shop context. Again, participants were not only asked for problems with this type of teaching, but asked to offer solutions.

*Transferring content successfully on standardized exams.* Teaching academic courses with a project based-theme, or at least incorporating topics and terminology from industry may help to raise the motivation level for students, but those students who are going to college need to be able to apply that knowledge in other, non-vocational. The most common suggestion from the participants to resolve strengthening math concept learning that can be applied in multiple
settings brings back the idea of the Math Lab course, noted above. Participants felt that the lab could be the best setting to prepare students for transferring content taught in their math class through a vocational lens to the academic standardized test-type problems that they face on a college entrance or placement exam. Other participants said that if there are not going to be additional math courses offered, the content math teachers could take one day prior to taking the unit or chapter test and show how those concepts worked on previously can be transferred into that academic-type assessment.

**Raising the bar.** One final observation of importance came from a participant who felt that this school allows students, especially in the honors track to be left behind. The suggestion from this participant was to, “Raise the fricken bar.” He noted that, just like a majority of his fellow ninth grade classmates, he took Algebra I in middle school and then was placed in Algebra I again. He took exception with the limitation that only one cohort of students was allowed into the advanced honors track, and did not have to repeat Algebra 1. “Sitting in a course for an entire year that you already took makes you lazy. When you feel lazy in class, then spend a week in shop for an entire year, it makes it hard to fully invest yourself in the following years.”

**Summary**

The purpose of this mixed methods case study was to explore why honors students at an urban/suburban regional vocational high school perceived that their academic ability in mathematics decreases during their enrollment. Through interviews of nine students enrolled in the honors program at this site, a clearer picture of this phenomenon was drawn. The majority of the participants, seven, actually do not feel that they have suffered a loss in math ability during their four years here. However, they have painted the picture of a very difficult time striving to maintain a level of achievement that they had previously enjoyed. Four major categories were
developed though the coding process of the data, including: background/personal history, retention problems, motivation, and finally suggestions for the future.

Findings organized into these four categories can go a long way toward helping vocational school leaders understand what needs to be done to accommodate math learning for both segments of their populations, those students planning on going into industry, and those students planning on furthering their education in college. Reflections about the problem statement of this study and answers to the specific research questions will be fleshed out by delving into each of the four categories discovered in this study.

This mixed methods case study was designed to more fully understand how to make the academic education more engaging for honors students at this regional vocational and technical high school. Although case studies are not usually generalizable (Merriam, 2009), the lessons learned here, and solutions offered from the students themselves can help students at this site who are not in the honors program, as well as those who are. The final chapter will tie these findings to each of the research questions guiding this study through the interpretation of the qualitative and quantitative data collected above.
CHAPTER FIVE

CONCLUSION

The study presented here investigated how honors math students at a regional vocational and technical high school perceived their mathematical ability during their enrollment at the school. In order to determine how students perceive their ability, a records review and interviews were conducted. The records review provided empirical data on student grades over the course of a semester and the corresponding grades on end of semester exams, along with standardized exam scores. This data coupled with data from interviews painted a picture of how students feel about their ability to retain information taught over a given semester. The records review was also able to help inform questions asked through the interviews about themes that developed while reviewing the records of students who participated in the study.

Empirical data, and qualitative data collected through the records review and interviews was able to be grouped into four categories (background/personal history, long term retention, motivation, and suggestions for the future) which provided findings to answer the research questions being investigated in this study. The overarching research question was, Why do honors math students in the twelfth grade at a regional vocational high school feel as if their mathematical ability has decreased over their four years at the school? This study specifically addressed the following research questions:

- How well do honors students retain mathematical content over a given semester in a vocational school?
- What strategies can be employed to help honors students in a vocational school retain mathematical content taught over a given semester?
• How can the perceptions of honors students’ math achievement in a vocational high school be influenced during the time of their enrollment?

The data collected will be presented below to help answer those research questions. The data can also be tied to prior research to solidify the conclusions drawn from the results and corresponding answers to the research questions guiding this study.

**Interpretation of Findings**

The three individual research questions and the overarching research question can be answered based on data collected through the categories developed in this study. Conclusions are informed by both quantitative and qualitative methods. These conclusions can be seen as trustworthy for this case study, as all collected qualitative data was processed through a member check-in meeting to ensure its validity (Roberts, 2010). Although not truly generalizable due to the limitations on size of the sample of this study (Merriam, 2009), the lessons learned can be utilized by this institution and other similar institutions. Each research question will be addressed and answered based on the findings presented.

**RQ One: How well do honors students retain mathematical content over a given semester in a vocational school?**

This research question can be answered by both quantitative and qualitative methods. Quantitatively, semester averages were compared with end of semester comprehensive exam averages. Also, standardized exam scores were compared as well. Students took the Stanford 10 placement exam when entering the school, a math MCAS exam at the end of the tenth grade, and some took the SAT exam prior to gaining entrance into various colleges. The changes in averages, and results on those exams coupled with data collected from interviews informs the
answer to this question. The honors students at this particular vocational school have a very
difficult time with retention of mathematical content over a long period of time.

Lack of retention of mathematical concepts is illustrated by the lowered averages on
cumulative end of semester exams. More telling than empirical data alone however, is how the
students feel about their retention abilities in their own words. It was shown above that all nine
of the participants interviewed said that retention was a major issue for them. Only nine of the 23
participants were interviewed, however, there was a fairly even split between participants in the
traditional honors program and the advanced honors program. All nine, no matter which program
they were enrolled in, concluded retention of math concepts was a challenge to them. Therefore,
the limitation on sample size can be overlooked when responding to this question. It was found
that honors students at this school feel that they do not retain material well long term once it is
taught to them.

RQ Two: What strategies can be employed to help honors students in a vocational school
retain mathematical content taught over a given semester?

Participants were asked about their views on what the school can do to support
improvement of math concepts better for future students. Solutions provided by the students are
quite numerous, each contributing to the purpose of this study. No one solution can fix all that
ails, but some of the student recommendations were quite telling.

Schedule change. One significant response to this question comes in the form of a
schedule change suggestion from the participants. However, what the best schedule is to ensure
balance in delivery of math concepts and students’ ability to retain and apply those concepts
remains to be seen. Most participants felt that having a whole week off, with two weekends, and
possibly a longer gap due to vacations and snow days is not conducive to retaining classroom-
based material long term. As noted in the limitations sections, testing which schedules would produce better retention results is beyond the scope of this particular study. There were other suggestions offered that could help to maintain retention as well.

**Contextual education.** Participants felt that one way to increase retention is to teach through a lens of industry, tying the mathematical content to the shops where the students are enrolled. This is known as contextual learning according to Pearson et al. (2010). There was a worry expressed by the interviewees that transferability could be limited if students learn in class through industry-based problems but then take a standardized exam asked mainly through academic questions. Pearson et al. (2010) found this problem not to be case however, noting that students usually did better on those types of exams when taught through a contextual education frame. Most participants agreed this concern was minor, and one that a teacher could overcome with an expanded use of the Math Lab course.

**Keep the math lab.** The Math Lab is a course that every ninth and tenth grader takes to prepare for the MCAS math exam. Participants felt that one way to help students stay sharp into their last two years at school is to keep those courses in the schedule and use them as an SAT prep-type course. This is where participants felt that the contextual education could be effectively transferred into an academic setting. The continuation of the Math Lab and a form of shop week homework were described as ways to improve retention for students, even if some felt the idea might be unpopular.

**Beneficial shop week work.** Shop week homework has been tried at this school in various forms, but usually students think of it more as a punishment than a benefit. Participants felt that beneficial or meaningful shop week homework could actually help them retain content. The best way to facilitate the integration of math lessons would be to implement a system where
students have to log in by certain dates and complete work. This keeps them engaged with the material while on shop week, and prevents them from just putting it off until Sunday night or Monday morning when it is too late to remember topics from the previous academic week.

**Implementation issues.** The answer to this research question lies in changes to how the school and math department do business. In order to help retention, the participants suggested that there would need to be a significant investment from the school district itself. The schedule would have to change to allow for a smaller gap in time away from the academic classroom. The school would need to move the daily schedule around to facilitate the inclusion of the Math Lab courses as they are offered in the ninth and tenth grades. Finally, in order to make the shop week more meaningful, the school would need to purchase or design an online platform that would allow for a system where students can check in and complete problems by a certain date and time.

RQ Three: How can the perceptions of honors students’ math achievement in a vocational high school be influenced during the time of their enrollment?

The majority of participants of this study feel that in spite of their retention issues at the school, their abilities have not declined, which was an assumption in the guiding question for this study. However, after digging deeper throughout interviews, participants noted various reasons that they may have lost retention abilities, which contradicts their more general belief that they have not gotten weaker in math over their time of enrollment. This contradiction is one of the limitations of this study. Students may not be able to verbalize properly what they are feeling (Creswell, 2013). Most participants felt that they have not gotten weaker in math over their time here, yet stated various reasons why they do not do so well in math, and provided suggestions for improvement. Through examination of this contradiction, the perceptions of students as they
view their math classes and ability can be traced back to their motivation to do well in those classes.

**Perceptions based on motivation.** Motivation plays a large part in how students view their ability to do well in their classes. The theoretical frame for this study is based on student motivation. If a student feels that they will do something well, they will be motivated from the start (Deci & Ryan, 1985). The participants felt that, as they went through their four years at this site, they did experience a change in motivational forces based on what they decided to do in their future.

**Factors determining motivation.** Participants shared their ideas about what motivates them to do well in class and in their career and technical shop. Most participants said that grades were the major motivating force in academics, especially math class. When it comes to shop, students seemed to be more motivated to do well. There are differing reasons why that is however.

As students progress through their four years, they spend more time in shop because they are in that setting for five full days in a row every other week. Bozick and Dalton (2013a) noted that the more time a student spends in the vocational field, the lower their academic achievement becomes. This phenomenon was looked at through this study, and participants agreed with this finding. They felt that the more time they spend in shop, the more immersed they become in that culture, and therefore the more interested they are. This interest in shop is contrasted with academics, which are viewed as the boring or hard week at school. Another reason that participants felt more motivated in shop was because most of them plan to enter this field. Participants felt that their ability to learn their trade so that they can make money and support a family someday outweighs anything they find to be beneficial in math class.
There are a few students who are going to college to learn their trade, and those are the students who feel equally motivated in math class as their shop. However, other students who decided not to go into their shop field found that motivation is lower in shop. The outcome points to the sureness about future plans as a driving force for motivation. The students going into the industry feel more motivated to do well in shop, and those going to college feel more motivated in academics, especially math.

**The Teacher’s Role in Motivation.** All participants shared that they felt their motivation in math class is influenced by the teachers themselves. Participants felt that the more fun a teacher makes coursework, the better the experience is for the students. Project-based lessons using manipulatives or toys can really pique interest, which was also found to be the case by Collins and Valentine (2010). Although most students did not learn through project-based activities in middle school, they are now learning in a vocational school where practically every other week is project-based. The incorporation of this technique could help to increase motivational levels for students with respect to learning mathematics. In order to increase motivation through these processes, intensive teacher preparation and professional development will need to be incorporated, just as Anderson (2008) has advocated. Differentiated instruction and project-based performance assessments would help to create this atmosphere in the math classroom, thus making it more like the shop (Tomlinson & McTighe, 2006). This could help students become and stay as motivated to do well in math class, as they feel in they are in their shop setting.

**Overarching Research Question**

The overarching research question guiding this study asks why honors students at this regional vocational and technical high school perceive their mathematical ability decreases over
their time of enrollment. The answer to this question can be fleshed out through the three specific research questions answered above, but the answer to this general question contradicts the findings of those three other questions. When participants were asked about their math ability in the twelfth grade as compared to the eighth grade, most felt they have gotten better, which would run counter to the overarching research question. However, answers to the specific research questions show that students feel that their retention ability is very low, their motivation decreases due to greater engagement in the shop field, teacher influence, or future plans, and that most opportunities to improve their situations would require significant structural work and investment on the part of the school district. This contradiction is a key finding that can be explained in terms of one of the studies main limitations, which is relying on the understanding and vocalization of the participants (Creswell, 2013).

**Implications**

**Stakeholder Benefits**

**Students.** This study aimed to understand better how the honors math curriculum at this regional vocational and technical high school is working for the students. The findings from this study, however, will not just benefit those individual honors students, but the entire student body on the whole. Lessons learned about how to improve the mathematics curriculum will take effect across the entire school, not just the honors population. Students in the college prep track and even the standard track will see the increased retention benefits of the solutions listed above. Transforming academic classrooms into mini shops, albeit mathematics shops, will allow students to be able to learn through differentiated, hands-on methods which will help pique their interests in mathematics. If honors students can be more interested with more comprehensive
methods of instruction, then students who are not as high-achieving should be even more interested.

**Parents.** Students will not be the only stakeholders benefiting from the lessons of this study. Parents will know that their children do not have to choose between strong academics and a career and technical education. If this study can help to find ways to increase retention and motivation, then students will feel as prepared to leave this school for a collegiate career as they do for a career in industry. Parents will now feel confident that their children are not sacrificing one aspect of education in favor of another, but rather getting the best of both curriculums.

**The community.** This history of vocational education has shown it to be an alternative to a comprehensive academic high school mainly for students who are not going to college (Stone & Lewis, 2012). Some communities have looked down on vocational schools in the past. The findings presented by this study and the solutions to these dilemmas can bring much needed change to vocational schools. When vocational schools are seen as dumping grounds, no one is proud to recognize this type of institution. If it can be shown that not only can vocational education be a viable option for low-level learners, but for high achievers as well, then the reputation of vocational schools will increase. When a community can feel as proud about their local vocational school as their local comprehensive high school, that entire community will benefit.

People will not think twice about sending their children to this type of school in the future, which not only prepares students for college, but provides them with another career path. Vocational schools can be an immense help to the community at large as well. Students do various projects to help communities, whether through repairs, or new construction. When a community can see that a vocational school is more than just a cheap repair service, but rather a
quality institution for learning, the community will not only enjoy the benefits, but can relish in the fact that the vocational school is developing their children into upstanding members of their society just as much as the comprehensive high school.

**The school community.** The lessons learned through this study will not only benefit the students, parents, and community, but the school community itself will feel the impact. Faculty members now will understand what it is that truly makes their students tick. The student voice is often touted, but seldom truly given an opportunity to be heard. This study gives students that voice, and their concerns and recommendations can be discussed by the school community.

**Faculty benefits.** One of the major ways to help students retain information better, as discovered through this study is the use of a different schedule, meaningful shop week work, and increased integration of vocational topics. In order to do this, teachers will have to undergo professional development, which will benefit the staff on the whole. When teachers are allowed to collaborate and have constructive discussions, they will sharpen their practice. When the students they teach are more engaged, teaching the material will be more enjoyable. Seeing students fully understand material that is being taught, and having students perform well on assessments will bring a level of satisfaction to those teachers. Stepping out of one’s comfort zone is never easy, but when it works it is much more satisfying for the teachers (Heifetz, Grashow, & Linsky, 2009). Teachers do not want to feel as if their efforts go unnoticed. When teachers are able to learn how to adapt their instruction in meaningful ways to better help their students, they will feel invigorated to go to work each day. This is something that many teachers need from time to time in the age of standardized testing and the multitude of mandates that are draining energy from quality teachers.
Transformative learning and leading. This school district and other similar districts will also benefit from issues brought to light in the study and the suggestions for improvement provided by the participants. Transformational leadership (Shields, 2010) is grounded with a heavy emphasis on social justice. The best and brightest students at this particular school have helped to illustrate a glaring issue. If this issue is present with the high-level learners, it is also an issue for the students of a lesser academic ability. A school looking to provide a quality education utilizing the ethic of care (Shapiro & Gross, 2013) needs to understand that these issues are occurring and take the necessary steps to correct it.

The changes recommended above will not be easy. However, as vocational education is transforming from dumping ground to viable option for college and careers, so to must the schools themselves change. The transactional leadership approach undertaken by most schools in order to comply with mandates has to be set aside in order to fully change this culture within their walls (Smith & Bell, 2011). A school practicing social justice principles and employing the ethic of care (Shapiro & Gross, 2013) for their students will use a transformational approach to bring these changes to the foreground (Shields, 2010). If a school staff knows there is a problem and the students have voiced their opinions about how to help fix that problem, it is up to the school leadership to act on it. A transformational school district will not just sit back and let their students suffer and feel poorly about their experience at their institution (Shields, 2010).

When a school staff observes their students feeling good about their learning, they will have a happier student body that can help promote the benefits of this school. Future high-level learners will want to come to this school, which will strengthen the student body and portray higher academic performance for state reporting and grading of the school itself. Attracting the best and brightest and being able to keep them at the school will help to bring the new and
improved vision of vocational education to light. The school district will no longer be seen negatively, but rather as an equally viable option for students in the community to attend, and more as a diamond in the rough because of the two types of quality instruction the school provides for its students.

**Link to Previous Literature**

This study has its grounding in themes which were developed from previous literature. The findings here are in line with the literature cited for the most part. Major research themes which were developed in the literature review were, achievement increases when academics are interwoven with the vocational curriculum, motivation is key to improving student achievement, how a student perceives their ability can increase motivation to do well, and professional development is a key component to help retention and motivation efforts.

**Interwoven curriculums.** Previous studies have shown that students will achieve better in academics when that content is interwoven with their shop settings (Anderson, 2008; Biemans et al., 2013; Ergun, 2012; Hobley, 2015; Noddings, 2008; Stone & Lewis, 2012). This study asked questions in the other direction, much like Pearson et al. (2010), about what would happen if vocational topics were taught in the math class through the mathematical content. For the most part, participants agreed that this would be a benefit, even if transferability to a college entrance or placement exam could be difficult. Students felt that added courses like the Math Lab could help to ease that transition.

**Motivation.** In order for students to strive to do well in classes, they must have some form of motivation to do well. The theoretical framework of this study was a synthesis of Expectancy Theory (Ernst, 2014), Expectancy Value Theory (Clinkenbeard, 2012; Gilbert, et al., 2014), and Self-Determination Theory (Deci & Ryan, 1985). These theories all spoke of
increased motivation when the outcomes seem to be the best possible, or most easily doable. Participants of this study echoed those same sentiments. Participants who saw themselves going into their vocational field after high school were more motivated to do well in shop, whereas participants who saw themselves going to college had more motivation to do well in their math classes.

Cleary and Chen (2009) and Rosario et al. (2013) both found that student motivation decreases over time. A loss of motivation was also found in this study, primarily in two ways: that the motivation decreased from classroom based learning by students who got more immersed in their shop or career path. Conversely, if they chose not to proceed in their shop field, but still had to remain in that shop until they graduated, they would lose motivation. Bozick and Dalton (2013a) found that the more time students lose from academics in favor of their shop translates to a lower achievement level in that area. Although achievement was not measured in terms of lost time, motivation in the academic segment of the participants’ schedules decreased as they spent more time in their shop according to the participants. Making use of the academic class time in ways that mirror a shop setting could be beneficial to increasing student motivation, but reframing math learning in the academic setting requires professional development.

Professional development. The final major research theme that developed in the previous literature was the need for comprehensive professional development (Anderson, 2008; Capraro et al., 2015; Morgan et al., 2011). The problem with implementing any changes in a school system is that it takes ample professional development and the time, and follow through. The participants in this study all pointed out that how a teacher approaches their class impacts their motivation to do well in that class. Participants wanted to see a more hands-on project
based-curriculum (Collins & Valentine, 2010; Gregory & Kaufeldt, 2015). In order to do this, teachers need to be taught the tenets of this type of instruction and about differentiated instruction (Tomlinson C. , 2014). Scheduling such professional development time is something that may not be easy, but is imperative according to DuFour and Marzano (2011) in order to make the best possible atmosphere for the students and the teachers at this institution.

**Recommendations for Action**

The participants of this study voiced their concern with their ability to retain mathematical content over the long term. However, instead of just voicing their concerns, they provided suggestions to help improve this situation for future students. These recommendations will not only help future honors students, but all students at this and other vocational schools facing the same daunting issues and dilemmas.

**Teacher Preparation and Presentation**

The first recommendation for action coming from this study is to transform the way the math classes are taught. Participants felt that the more enthusiastic and organized teachers were, the easier it was to get invested in their class. This is more of a personal attribute which is not something easy to manage. However, participants shared that one of the reasons they felt teachers were disorganized was because each teacher teaches in their own way without any common strategies or grading practices. This is something that the math department members could work to fix through a change in their philosophy. The department should work together to develop a common form of practice. Teachers can share best practices for units and determine which methods would be the best to teach across the different classes covering that topic. The department could also determine common grading schemes and structures so that when a student
moves from grade to grade they do not have to adapt to a whole set of classroom procedures and grading schemes as well as learning the new material.

**Lesson presentation.** Lessons should be designed in ways that promote hands-on, project-based methods incorporating topics from the various shops. To do this effectively, continuous professional development should be implemented which pairs math and vocational teachers in ways that can promote this type of knowledge sharing. When teachers come together to share their specific expertise and how apply that in a different atmosphere, not only do the teachers benefit by expanding their practice, but the students will benefit as well (Anderson, 2008).

**Shop week work.** In order to keep students invested and on top of their content, shop week homework has been assigned in the past. However, this type of work is usually resented, and left until the last minute, which makes it somewhat meaningless as a tool to increase retention. Meaningful shop week homework should be assigned, but to make it effective, the school would need to develop or purchase an online medium that would facilitate the ability to take tests online by a certain a date and time. This would force students to log in and perform tasks at reasonable intervals during their week away from academics. This is one way to battle the gap of the time between math classes at the end of one week and the start of another. That gap in time is also something that needs to be looked at in order to increase retention at this and other vocational schools.

**Schedule Changes**

The most important recommendation for action is one that is not as easily implemented as some of the other suggestions. The participants overwhelmingly felt that the school schedule leads to their retention loss. A schedule change is necessary as a way to help increase the ability
for students to retain the material that has been taught to them. Changing the schedule for a school is never an easy job, as it involves a lot of differing variables, but as DuFour et al. (2010) note, resolving schedule conflicts should never stand in the way of making things better for students. A schedule change on two different fronts should be considered as a way to help students retain information.

**Weekly rotation.** The ten day gap between academic weeks is not conducive to helping students remember material that has been taught to them. Implementing a schedule that limits the ten day window is a step in the right direction. Some participants mentioned different schedules that they have heard about; some have worked on a Wednesday to Tuesday week where there is only a one weekend gap between meetings. Some schools have done alternating days between shop and academics, while other schools do half the day shop and the other half the day academics. The type of schedule to be implemented is beyond the scope of this study, but something must be done to this schedule to limit the amount of time off between academic class meetings.

**Daily period length.** The length of the classes is also a concern. A daily schedule change could also benefit students at this particular site. Some participants felt that students at vocational schools have shorter attention spans than students at a traditional high school. With this assumption in mind, they felt that 70-minute periods were too long for them to remain properly engaged. A schedule change limiting the amount of time students spend in individual classes might be one way to increase engagement and should be considered along with a weekly schedule change. At the very least, well designed use of class time in the 70 minute blocks should be a goal of the school math department.
Inclusion of Math Lab. Participants felt that they were better prepared for the MCAS exams than they were for the SAT in part because of the Math Lab courses that are offered in the ninth and tenth grades. Keeping this course in the schedule for junior and senior year would help students retain the information taught in the content class. This type of course also provides the help necessary to prepare students to apply their knowledge in ways that will make them successful on the SAT or other types of college entrance and placement exams.

Recommendations for Further Study

This study is the first step in transforming vocational schools from historically viewed stereotypes into modern day institutions of high achievement. The sample in this study was small because only students who were in the honors program for four consecutive years were asked to participate. Students who moved up levels or transferred into the school were not considered as participants. Future studies could look at a larger sample size, a longer timeframe for collecting data, and branch out to other schools to study issues such as the schedule that is in place.

Sample Size

This study was limited in its scope because the case study was based on one segment of one grade of the students at this particular school. Future studies could investigate the entire twelfth grade population, pulling students who are in different levels of courses such as honors, college prep, and standard. The larger the sample, the easier it is to generalize the findings (Creswell, 2015). Also, including students at all ability levels gives a voice to all students. There are most likely other concerns that students in the college prep or standard tracks would like to see brought to light, but by just interviewing honors students, these issues are not going to be uncovered.
Length of Data Collection

One way to truly gauge how our students view a change in their ability level is to follow the participants through their entire high school career. Having twelfth grade students look back is helpful, but there are issues that could have happened in the past that were no longer fresh in their minds. By tracking a sample through all four grades, and checking in with them along the way, a truly clear picture can be drawn about the success of the mathematics program at this organization.

Multiple Organizations

Finally, a study could be conducted that makes a comparison between differing vocational and even traditional high schools. Different schools have different schedules and procedures. In order to determine which is the best schedule or method of instruction, comparisons from outside organizations can be studied. This way, the impact on variables such as the daily or weekly schedule can be determined.

Conclusion

This study was conducted to understand how the honors population at this vocational and technical high school feels about their preparation for college or their careers in the best possible way when it comes to their mathematics training. The purpose of this study developed from various students of the past making their argument that they felt the school has stifled their ability in math one way or another.

This particular study intended to understand why the best and brightest students at this vocational school perceived they were not making adequate gains in math learning, and to determine how to correct it so that future students do not have to feel as if they are receiving an inferior product as opposed to their peers at traditional high schools. Through empirical data
coming from semester, exam, and standardized exam scores, it can be shown that retention of material may be an issue. Interviews shed a significant light on that very issue and suggestions for improvement were made. Although the participants of this study did not agree with the premise of the guiding question, which was that honors students feel they have gotten weaker during their time here, they did feel their retention ability is significantly lower than it used to be.

This study is significant as a way for this vocational school, and others to understand what the students are feeling and giving them a voice in trying to form a solution to this problem. This school and others like it can take the lessons learned here and work in their own organizations to try and combat these issues moving forward. As vocational schools are being seen more positively today than in the past, the schools themselves have to adapt and transition into their standing in society (Stone & Lewis, 2012). To do this will not be easy. However, now that the most important stakeholders have voiced their concerns and provided possible solutions, it is our job to heed their call and develop policies and procedures that take those suggestions into account. Transforming this school will require work, but the inherent understanding that the work is being done for the benefits of the students because the issues came directly from them, will make that work much more meaningful and satisfying to all involved.
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APPENDIX A
Informed Consent Document
UNIVERSITY OF NEW ENGLAND
CONSENT FOR PARTICIPATION IN RESEARCH

Project Title: *The Forgotten Population: Honors Math Students in a Vocational High School*

Principal Investigator(s): Jarrod Richards, Graduate Student, University of New England, *jrichards7@une.edu*, 781-246-0810 ext. 2887.

Faculty advisor: Ella Benson, Ed.D., Lead Research Advisor, University of New England, *ebenson2@une.edu*, 757-450-3628

Introduction:
- Please read this form, you may also request that the form is 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. You can take as much time as you need to decide whether or not you want to participate. Your participation is voluntary.

Why is this study being done?
- This study is being conducted to try and understand how honors math students in the 12th grade at Northeast view their abilities in their mathematics classes. Experiences from your time at Northeast will help to enhance the mathematics program so that future students can benefit.

Who will be in this study?
- Honors math students in Precalculus and Calculus, who have been in honors math courses for the duration of their enrollment at Northeast will be selected as participants. You, as an honors math student in the 12th grade can best paint a clear picture of how this program has worked for you and identify areas of strength and weakness.
- This study will consist of approximately 12 honors students, six enrolled in Precalculus, and six enrolled in Calculus.

What will I be asked to do?
- You will be asked to allow the researcher to access your student record for the purpose of gathering background academic information including grades, to help inform interview questions and themes. This archival data will help to understand who you are academically, and where you have come from to this point. A full disclosure statement for the use of this archival data is attached at the end of this form.
- You will be interviewed by the researcher for the purpose of sharing your experiences with the honors math program at Northeast over the past four years. The interview will be face-to-face in the classroom of the principal investigator and last approximately one hour. Your interview will be tape-recorded. By
agreeing to participate in this study, you agree to allow the principal investigator
to audio tape your interview.

- The interview is important to understand the full student perspective about your
  experiences with the math department at Northeast. You will be asked questions
  relating to your choice to attend this type of school, how you have performed in
  your math courses in comparison with your vocational shop, your motivation in
  both areas and your perceptions of your abilities in math and your vocational
  areas.
- Member check-ins will occur after the data has been compiled as a way to check
  whether the data I collected is a true representation of what you were trying to
  say in the interview. This will be another face-to-face meeting where I will provide
  you with the interview transcript and a discuss the summary of themes that I
  noticed develop over the course of the interview. This member check-in meeting
  is a requirement for participation in the study, or your data will not be included in
  the study.
- The research project will call for two meetings over a four month period, from
  January to April 2017.  These meetings will be for the purpose of the interview
  and the member check-in explained above, both of which are required for
  participation in the study. There will be an iPad in the room allowing for the
  recording of the interview for the first meeting. There will be no audio recording
  devices in the room for the second member check-in meeting.
- Participants will be randomly chosen to participate from a pool of volunteers if
  there are more volunteers than the study calls for.
- Interviews will be conducted by the principal researcher only.
- No compensation will be offered for participation in the study.

**What are the possible risks of taking part in this study?**

- There are no probable risks associated with participation in this study.

**What are the possible benefits of taking part in this study?**

- None

**What will it cost me?**

- There will be no costs associated with participation in this study.

**How will my privacy be protected?**

- No identifiable information will be included in the interviews. A student
  identification number will appear on the interview transcript for the purpose of me
  being able to use the correct transcript with you at the member check-in session.
  Audio files will be destroyed after transcription has been completed. Once those
  member check-in meetings have concluded, the link sheet with your identification
  number will be shredded.
- The setting for the interviews will be the classroom of the principal researcher.
  Only you and the researcher will be present.
  The data will be unidentifiable. When the results are compiled, they will be
  included in the research report in summary form. The results will be shared with
the Dissertation Committee approving this study as part of my graduation requirement, and the administration and staff at Northeast Metro Tech.

**How will my data be kept confidential?**

- The data collected from this study will only be handled by me. Data from the records review will have no identifiable information attached. The interview transcripts will be coded with a student identification number solely to be used for the member-check in after the interview, once the member check-ins has been completed, the coded link sheets with student identification numbers will be destroyed. Your name will not appear on any piece of data collected.
- Interviews will be conducted on the principal investigator’s private iPad. Only the principal researcher has access to this password protected device. Audio recordings will be shared with a transcription service, which will provide a written account of the interview. Once the principal investigator has returned home, the interview will be sent over a secure home network to the recording application company, which will send the transcripts back over a secure email back to the principal researcher. Once the transcripts have been completed, the audio files will be deleted.
- Electronic data will be stored on a private USB flash drive, a private iPad, and on a secure password protected computer at the house of the principal researcher.
- All physical data, including interview transcripts will be stored in a locked file cabinet at the house of the principal investigator.
- All data will be destroyed after the study has been completed.
- A copy of your signed consent form will be maintained by the principal investigator for at least 3 years after the project is complete before it is destroyed. The consent forms will be stored in a secure location that only the principal researcher will have access to and will not be affiliated with any data obtained during the project.
- This data will not be used for future researcher purposes.
- Please note that regulatory agencies and the Institutional Review Board may review the research records.
- Findings from this study will be shared with the stakeholders of Northeast Metro Tech. As a participant you are entitled to the findings if you would like to request them. Since you will have graduated from Northeast, you can email me (jrichards7@une.edu) and I will send you a copy of the findings.

**What are my rights as a research participant?**

- Your participation is voluntary. Your decision to participate will have no impact on your current or future relations with Northeast Metro Tech. Your decision to participate will not impact your standing as a student in any way.
- You may skip or refuse to answer any question for any reason.
- 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.
What other options do I have?
• You may choose not to participate.

Whom may I contact with questions?
• The researcher conducting this study is Jarrod Richards. For questions or more information concerning this research you may contact him at 781-246-0810 ext 2887 or irichards7@une.edu or his faculty mentor, Ella Benson, Ed.D. at 757-450-3628 or ebenson2@une.edu.

• If you choose to participate in this research study and believe you may have suffered a research related injury, please contact Ella Benson, Ed.D at 757-450-3628 or ebenson2@une.edu.

• 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.

Will I receive a copy of this consent form?
• You will be given a copy of this consent form.

Student Record Disclosure:
• By signing this consent form, you grant the principal investigator permission to view and collect data from your personal student record, which is protected under the Family Educational Rights and Privacy Act (FERPA). The principal investigator will be viewing personally identifiable information including but not limited to, grades, honors, distinctions, and discipline issues. The purpose of this data collection to help inform the interview questions asked of you. No personally identifiable information will be recorded as part of the data collection for this study. The data taken from the viewing of your student record will be anonymous, and only the principal investigator will have access to this record. The principal investigator will record information without your name or any identifiable information attached. This data will in no way be linked to your interview or member check-in.

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 or Date
Legally authorized representative

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

Jarrod J. Richards  
Printed name
APPENDIX B
UNIVERSITY OF NEW ENGLAND
PARENTAL CONSENT FOR PARTICIPATION IN RESEARCH

Project Title: The Forgotten Population: Honors Math Students in a Vocational High School

Principal Investigator(s): Jarrod Richards, Graduate Student, University of New England, jrichards7@une.edu, 781-246-0810 ext. 2887.

Faculty advisor: Ella Benson, Ed.D., Lead Research Advisor, University of New England, ebenson2@une.edu, 757-450-3628

Introduction:
• Please read this form, you may also request that the form is read to you by emailing me and setting up a time for me to contact you. The purpose of this form is to provide you with information about this research study, and if you choose to allow your child 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. You can take as much time as you need to decide whether or not you want your child to participate. Your child’s participation is voluntary.

Why is this study being done?
• This study is being conducted to try and understand how honors math students in the 12th grade view their abilities in their mathematics classes. Experiences from your child’s time at Northeast will help to enhance the mathematics program so that future students can benefit.

Who will be in this study?
• Honors math students in Precalculus and Calculus, who have been in honors math courses for the duration of their enrollment at Northeast will be selected as participants. Your child, as an honors math student in the 12th grade can best paint a clear picture of how this program has worked for them and identify areas of strength and weakness
• This study will consist of approximately 12 honors students, six enrolled in Precalculus, and six enrolled in Calculus

What will my child be asked to do?
• You will be asked to allow the researcher to access your child’s student record for the purpose of gathering background academic information including grades, to help inform interview questions and themes. This archival data will help to understand who your child is academically, and where they have come from to this point. A full disclosure statement for the use of this archival data is attached at the end of this form.
Your child will be interviewed by the researcher for the purpose of sharing their experiences with the honors math program at Northeast over the past four years. The interview will be face-to-face in the classroom of the principal investigator and last approximately one hour. Your child’s interview will be tape-recorded. By agreeing to allow your child to participate in this study, you agree to allow the principal investigator to audio tape your child's interview.

- The interview is important to understand the full student perspective about your child’s experiences with the math department at Northeast. Your child will be asked questions relating to their choice to attend this type of school, how they have performed in their math courses in comparison with their vocational shop, their motivation in both areas and their perceptions of their abilities in math and their vocational areas.
- Member check-ins will occur after the data has been compiled as a way to check whether the data I collected is a true representation of what your child was trying to say in the interview. This will be another face-to-face meeting where I will provide your child with the interview transcript and discuss the summary of themes that I noticed develop over the course of the interview. This meeting is a requirement for your child’s participation in this study or their data will not be included in the study.
- The research project will call for two meetings over a four-month period, from January to April 2017. These meetings will be for the purpose of the interview and the member check-in explained above, both of which are required for participation in the study. There will be an iPad in the room allowing for the recording of the interview for the first meeting. There will be no audio recording devices in the room for the second member check-in meeting.
- Participants will be randomly chosen to participate from a pool of volunteers if there are more volunteers than the study calls for.
- Interviews will be conducted by the principal researcher only.
- No compensation will be offered for participation in the study.

**What are the possible risks of my child taking part in this study?**
- There are no probable risks associated with participation in this study.

**What are the possible benefits of my child taking part in this study?**
- None

**What will it cost me?**
- There will be no costs associated with participation in this study.

**How will my child’s privacy be protected?**
- No identifiable information will be included in the interviews. Audio files will be destroyed after transcription has been completed. A student identification number will appear on the interview transcript for the purpose of me being able to use the correct transcript with them at the member check-in session. Once those member check-in meetings have concluded, the coded link sheets with identification number will be shredded.
• The setting for the interviews will be the classroom of the principal researcher. Only your child and the researcher will be present. The data will be unidentifiable. When the results are compiled, they will be included in the research report in summary form. The results will be shared with the Dissertation Committee approving this study as part of my graduation requirement, and the administration and staff at Northeast Metro Tech.

How will my child’s data be kept confidential?
• The data collected from this study will only be handled by me. Data from the records review will have no identifiable information attached. The interview transcripts will be coded with a student identification number solely to be used for the member-check in after the interview, once the member check-ins have been completed, the coded link sheet with student identification numbers will be destroyed. Your child’s name will not appear on any piece of data collected.
• Interviews will be conducted on the principal investigator’s private iPad. Only the principal researcher has access to this password protected device. Audio recordings will be shared with a transcription service, which will provide a written account of the interview. Once the principal investigator has returned home, the interview will be sent over a secure home network to the recording application company, which will send the transcripts back over a secure email back to the principal researcher. Once the transcripts have been completed, the audio files will be deleted.
• Electronic data will be stored on a private USB flash drive, a private iPad, and on a secure password protected computer at the house of the principal researcher.
• All physical data, including interview transcripts will be stored in a locked file cabinet at the house of the principal investigator.
• All data will be destroyed after the study has been completed.
• A copy of your signed consent form will be maintained by the principal investigator for at least 3 years after the project is complete before it is destroyed. The consent forms will be stored in a secure location that only the principal researcher will have access to and will not be affiliated with any data obtained during the project.
• This data will not be used for future researcher purposes.
• Please note that regulatory agencies and the Institutional Review Board may review the research records.
• Findings from this study will be shared with the stakeholders of Northeast Metro Tech. As a participant’s parent you are entitled to the findings if you would like to request them. Since you will have graduated from Northeast, you can email me (jrichards7@une.edu) and I will send you a copy of the findings.

What are my child’s rights as a research participant?
• Your child’s participation is voluntary. Your decision to allow your child to participate will have no impact on their current or future relations with Northeast Metro Tech. Your decision to allow your child to participate will not impact their standing as a student in any way.
• Your child may skip or refuse to answer any question for any reason.
• If you choose for your child not to participate there is no penalty to them and they will not lose any benefits that they are otherwise entitled to receive. Your child is free to withdraw from this research study at any time, for any reason.

**What other options do I have?**
• You may choose for your child not to participate.

**Whom may I contact with questions?**
• The researcher conducting this study is Jarrod Richards. For questions or more information concerning this research you may contact him at 781-246-0810 ext 2887 or jrichards7@une.edu or his faculty mentor, Ella Benson, Ed.D. at 757-450-3628 or ebenson2@une.edu.

• If you choose to allow your child to participate in this research study and you believe they may have suffered a research related injury, please contact Ella Benson, Ed.D at 757-450-3628 or ebenson2@une.edu.

• If you have any questions or concerns about your child’s 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.

**Will I receive a copy of this consent form?**
• You will be given a copy of this consent form.

**Student Record Disclosure:**
• By signing this consent form, you grant the principal investigator permission to view and collect data from your child’s personal student record, which is protected under the Family Educational Rights and Privacy Act (FERPA). The principal investigator will be viewing personally identifiable information including but not limited to: grades, honors, distinctions, and discipline issues. The purpose of this data collection to help inform the interview questions asked of your child. No personally identifiable information will be recorded as part of the data collection for this study. The data taken from the viewing of your child’s student record will be anonymous, and only the principal investigator will have access to this record. The principal investigator will record information without your child’s name or any identifiable information attached. This data will in no way be linked to your child’s interview or member check-in.
**Participant’s Statement**
I understand the above description of this research and the risks and benefits associated with my child’s participation as a research subject. I agree to allow him/her to take part in the research and do so voluntarily.

Legally authorized representative

Date

Your printed name

Child’s 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

Jarrod J. Richards
Printed name
To Whom It May Concern:

I am writing this letter today to explain the informed consent form that your child is asking you to sign. I am conducting a study for my doctoral dissertation through the University of New England in Biddeford and Portland Maine. This study is intended to determine how honors math students perceive their mathematical ability after attending Northeast Metro Tech for four years. This study will in no way interfere with their regular school activities, and participation or non-participation will have no effect in any way with regards to classroom grades.

I am asking for your permission to examine your child’s student record for the purposes of this study. The student record review will be important to help understand your child’s current academic status, as well as how they have progressed over the past four years, as a student in attendance at Northeast Metro Tech. The Family Educational Rights and Privacy Act (FERPA) require a disclosure in asking for your permission to view your child’s student records, which contains personal identifiable information. Through this records review, I will be looking at your child’s grades, specifically but not limited to their math courses. I will also be looking at any other honors or distinctions noted in your child’s student record. I will be the only person looking at you child’s record, and will be doing so in a locked room where no one can enter. Data taken from that room will solely be about themes developed and not contain any identifiable information about your child. By signing the consent form, you are acknowledging that I will be looking at your child’s student record, and grant me permission to do so.

Students who obtain permission will be asked to provide data through an interview. Your child will be asked to sit for a one-hour interview with me, explaining their experiences over the past four years of being an honors math student. There will not be any identifiable information on the interview recordings. After the interviews have been completed, one final meeting will be used to present the findings to the participants as a way to check that their experiences were recounted properly.

I would like to state again that this study is 100% voluntary. Students can choose not to participate or drop out at any time. Students can choose not to answer any questions that they feel uncomfortable with. Students will not face any type of adverse punishments for participation or non-participation.

Thank you,

Jarrod Richards
Math Instructor, Northeast Metro Tech
Doctoral Student University of New England
APPENDIX D

Student Interview Protocol

1. What made you decide to choose to go to this vocational high school instead of your town school?

2. What are your future plans for after graduation?

3. How do you feel about your ability to retain math content long-term?

4. Over the past four years, how has your perception of your mathematical ability changed?

5. How do you perform in your career technical major?

6. What role does your personal motivation play in your success in math class?

7. Which teaching methods/strategies help you to learn at your best in math class?

8. How does the school schedule impact your experiences with your math classes and content?

9. What suggestions do you have for the school in terms of future honors math students?