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Entrepreneurship Education Relation to Mathematical Proficiency Amongst Secondary Youth

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ENTREPRENEURSHIP EDUCATION RELATION TO MATHEMATICAL PROFICIENCY AMONGST SECONDARY YOUTH

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ABSTRACT

ENTREPRENEURSHIP EDUCATION RELATION TO MATHEMATICAL PROFICIENCY AMONGST SECONDARY YOUTH

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Mathematical aptitude in the United States has been a concern over the past few decades, not only from an international perspective but from a student proficiency perspective. This phenomenon is also further negatively impacted due to COVID-19 associated learning loss. Correspondingly, there are calls for students to develop entrepreneurial skills to thrive in the 21st century economy. The purpose of this quasi-experimental study was to examine whether participation in an entrepreneurship class was related to mathematical proficiency (Algebra II) in high school. Data on students from two school districts were used, consisting of 2,741 and 1,172 Algebra II students in each school district, respectively. The data on each school district were disaggregated as each school district provided a differing dependent variable. School District One provided standardized assessment data from a state assessment in Algebra II as the dependent variable, while School District Two was only able to provide Algebra II grades instead. Data on student, classroom, and school characteristics were collected for this analysis. Multiple regression analyses and propensity score matching were used to explain relationships between individual variables and math proficiency in Algebra II.

Conclusions from this study add to the existing literature surrounding math proficiency and contextualized learning. The average treatment effect (ATE) was significant for School District One, indicating that had Algebra II students taken entrepreneurship, their Algebra II

post-test score was estimated to increase by 13-15 points. The average treatment effect on the treated (ATET) was not significant, indicating that students who actually took an entrepreneurship course did not see gains due to this course enrollment. However, the ATE significance depicts the positive relationship that entrepreneurship could have on the math outcomes of students who do not typically enroll in classes such as entrepreneurship.

Numerous variables were evaluated to determine individual relationships, of which the following were significant with relation to Algebra II: the Algebra I post-test score, Asian race variable, number of Advanced Placement (AP) and/or honors classes taken, math teacher years of experience, teacher staffing ratio within the school, entrepreneurship class enrollment, free and reduced lunch variable, Algebra I grade, and the gender variable.

This thesis is dedicated to my parents, first and foremost. Thank you for supporting me always and in all ways. You pushed me to be the best version of myself my entire life and have shown your support in vastly different ways. My mom raised me to believe in myself and supports me, without question, in every decision I make. My dad, on the other hand, challenges me and makes me defend my actions – in the best conceivable way. They are yin and yang when it comes to how they motivate and inspire me, but both have molded me into the woman I am today. You believed in me before I believed in myself. Growing up with two doctors as parents can put a lot of pressure on you as a kid, but you always made me feel like the smartest person in the room. From supporting me in my earliest days (elementary school speech competitions) to every accolade to date, I hope to continue making you proud every single day.

To my friends, my family, my nephews (X and Kairo), my colleagues, and all the teachers/professors who have taught me – thank you. This would not be possible without you.

Last but not least, this thesis is dedicated to all the students that I have taught. No book, class, or advice could truly prepare me for being in the classroom. I want to impact the world of education because of you, because of students just like you, and because of the inequities in schools that I witnessed firsthand. I will forever be grateful for what you taught me and your impact on my life

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CHAPTER I

Introduction

The American economy and education system have been systematically siloed in several ways that limit the ways in which education, as it stands, prepares students for the workforce. Although research indicates the positive returns education produces for the workforce (National Center for Educational Statistics [NCES], 1997), funding allocations and content offered in schools indicate the lack of collaborative planning that occurs within the talent pipeline across sectors. Data on unemployment within the United States depicts an apparent paradox as there are more job openings than those unemployed (Department of Labor, 2019). Many of the job openings of this era have a common requirement: some background in science, technology, engineering, and/or mathematics (STEM). Although only five percent of U.S. workers are employed within said fields, these sectors are responsible for over 50 percent of sustained economic development (Idugboe, 2016). In addition to being the source of many open positions, STEM related jobs are also much higher paying than typical employment (Graf et al., 2018). Studies have indicated that 65 percent of STEM graduates with a bachelor's degree earn more than their non-STEM counterparts who have master's degrees (Engler, 2012). Furthermore, 47 percent of STEM graduates with a bachelor's degree earn more than their non-STEM counterparts who have PhDs. Coincidingly, over 99 percent of STEM employment requires some level of postsecondary education, while only 36 percent of overall employment required some level of postsecondary degree (Bureau of Labor Statistics [BLS], 2017).

The list of reasons that STEM education is integral to the American economy is quite extensive, the international leverage and global presence is also of utmost importance. For U.S.

students to compete globally, STEM education and workforce readiness must be fostered by educators, businesses, government, and the like (Ginsburg, 2019).

The STEM occupation group that is anticipated to grow the fastest between 2014 and 2024, is mathematical science occupations, at a 28.2 percent growth rate (BLS, 2017). Over the same time period, computer systems design, computer occupations, and architecture and engineering are projected to grow 23, 12.5, and 8 percent, respectively (BLS, 2017). To put into relative terms, average occupational projected growth is 6.5 percent over this same time period. Within the mathematical sciences specifically, statisticians are projected to grow by 33.8 percent between 2014 and 2024 (BLS, 2017). The STEM sectors are interdisciplinary in nature, thus having a background in the basics of STEM can serve a variety of purposes. For instance, mathematics allows for a strong foundation in physics, while physics can provide valuable insight into engineering, engineering into technology, and so forth.

Due to technological advancements, there are a variety of unknowns regarding the American economy. The way in which people work, the types of jobs available, and the skills needed for said unknown jobs are all variable in nature. However, the notion that STEM-related skills and jobs will lead the workforce is strong (Berger, 2019). Another notion is that entrepreneurship and self-employment are and will be more prevalent in the economy (Holcombe, 1998). A phenomenon within the workforce is the ‘gig economy’ where short-term commitments are made based on projects/tasks (i.e., gigs), as opposed to full-time, traditional, employment, or even part-time employment that is based on the number of hours. Through the use of technology, people have been able to work as independent contractors, pick their own schedules, and have more autonomy on their work-life balance. As such, it is important to teach

entrepreneurial skillsets within the education system to prepare students to think of innovative alternative income streams, particularly within an economy with such a variety of possibilities.

Hypotheses

The purpose of this quasi-experimental study was to examine whether participation in an entrepreneurship class was related to mathematical proficiency (Algebra II) in high school. This problem was studied to inform school districts on how to potentially improve mathematical proficiency among students through contextual learning, while allowing for increased exposure to entrepreneurship education. Based on the literature on contextual learning, the study was centered on the following hypotheses:

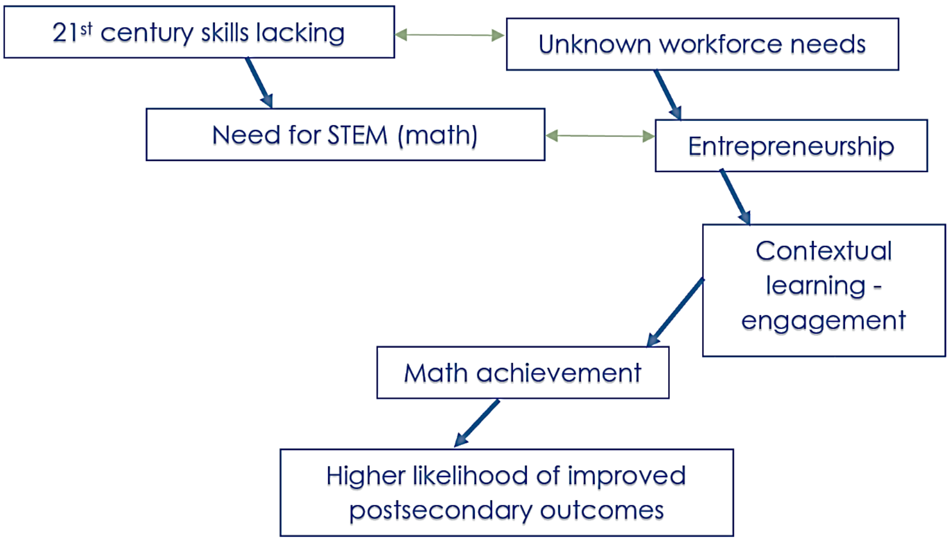
Hypothesis 1. There is a positive relationship between participation in entrepreneurship education and mathematical proficiency of high school students.

Hypothesis 2. There is a positive relationship between proficiency of entrepreneurship education and mathematical proficiency of high school students.

The conceptual framework (Figure 1) starts with two coinciding phenomena, a lack of 21st century skills among workforce entrants and an unknown economic outlook. Although both of these concepts are prevalent, the demand for STEM careers, with an emphasis on math, is evident based on the aforementioned workforce projections. Additionally, with the rise of automation and undetermined workforce needs, entrepreneurial ventures and the skills associated have become more common and will continue to rise (Gillespie, 2017).

Figure 1.

The Conceptual Framework Based on the Literature



Based on the literature indicating that students learn more in settings where they can make connections (Fiore, 2018), the purpose of this quasi-experimental study was to examine whether participation in an entrepreneurship class was related to mathematical proficiency (Algebra II) in high school. If so, higher mathematical proficiency may then lead to better postsecondary academic and career outcomes, which is supported in the literature review in Chapter II.

Rationale

The intent of this study was to examine whether participation in entrepreneurship education was related to mathematical proficiency in high school. This problem was researched to inform academic institutions of prospective ways to improve mathematical proficiency through the use of contextual learning, specifically an entrepreneurship class. Because the two classes utilized in this study were not integrated to create an interdisciplinary class, this study

observed the contextual relationship between the two classes rather than an integrated relationship. The results will inform educational administrators and policymakers on interdisciplinary best practices regarding mathematical performance, particularly with respect to 21st century skill-building simultaneously.

Mathematics achievement is one characteristic that has been identified as an integral factor to academic and career-readiness (Wignall, 2020). Problem-solving and critical thinking are fostered and developed through the use of mathematics and exemplify the importance of mathematics proficiency across education levels. A report by the National Center on the Educational Quality of the Workforce (EQW) depicted that 28-year old workers in the top quartile of mathematics skills earned 37 percent more, on average, than their counterparts in lower quartiles of mathematics skill level (Lappan, 1999). In contrast and fast forwarding to more recent years, the National Center for Educational Statistics (NCES) depicts that only 25 percent of 12th graders are proficient in mathematics for their age-level (NCES, 2015). This is inopportunely a trend stemming from a much earlier age bracket. The Baltimore Education Research Consortium (BERC, 2011) researched how failing core classes in sixth grade was associated with a decreased likelihood of graduation. Graduation was particularly unlikely for those who failed both English and mathematics in the sixth grade, as only 18.9 percent went on to graduate from high school. Although mathematics achievement is linked to various postsecondary outcomes, confounding variables such as race, gender, socioeconomic status (SES), among other attributes also contribute to the long-term outcomes of students.

Various research illustrates the correlation between mathematics achievement and college enrollment and lifetime earnings potential (James, 2013; Joenson & Nielsen, 2009). Joenson and Nielsen (2009) conducted a 13-year longitudinal study assessing the impact of mathematics

proficiency on earnings. The findings suggested that students who chose advanced mathematics and chemistry classes earned approximately 30 percent more than students who did not choose such classes. Through a unique pilot program that offered an experimental curriculum of advanced mathematics within an advanced physics class, the researchers were able to estimate the effects of advanced mathematics on market earnings 13 years post-high school. Although the experimental group of students was not randomly assigned, the students who enrolled had no knowledge of the new curriculum, thus allowing for the experimental curriculum to serve as an instrumental variable for the students partaking in advanced mathematics. The authors found that the causal effect of advanced mathematics was approximately 20 to 25 percent higher earnings. However, the authors also prescribe that earnings growth is impacted by the choice of higher education. The higher earnings are a result of higher mathematical qualifications, which in turn lead to higher test scores, higher educational attainability, and thus higher earnings.

In the same way mathematics achievement can depict earnings potential and career growth, entrepreneurship is seen as a viable option for people to gain financial autonomy and independence (Block & Koellinger, 2009). The intent of this study was to determine whether students can utilize their knowledge gained in an entrepreneurship class in a mathematics class to make academic gains. The field of entrepreneurship has grown significantly in the last 15 years (Dell, 2018) and provides a myriad of skills to ensure students are ready for the 21st century workforce, including, but not limited to, allowing students to take risks, think creatively, collaborate, and innovate (Barber, 2014). Entrepreneurs seek to solve problems, similar to mathematicians, and make a difference in this world, qualities that further society. Barber describes how students need to develop grit and that entrepreneurship is a clear avenue to provide such experiences to students. Entrepreneurship allows students to create their own

reality, where students can 'invent' a job based on a problem they aspire to solve (Friedman, 2013). Students are pushed to be college and career ready, while Friedman (2013) argues that students should more broadly be innovation ready. In hopes that students can gain an entrepreneurial spirit while making gains in mathematical content, the purpose of this quasi-experimental study was to examine whether participation in an entrepreneurship class was related to mathematical proficiency (Algebra II) in high school.

Academic Achievement Gaps and Math Education

The opportunity gap between education and adequate employment opportunities or lack thereof pertains to the skillset of youth in high school (Symonds et al., 2011). The lack of skills necessary does not allow for all high school graduates to enter the workforce and secure employment security. The United States has over one-million students drop out of high school annually and consequently has the highest dropout ratio in the world (Symonds et al.). Although many factors contribute to the "dropout nation" phenomena, a major factor is that students cannot see the connection between their curriculum and tangible opportunities in the workforce. As the economy changes, educational standards, practices, and curriculum must adapt so that the youth can better prepare themselves for employment. Coinciding, high school youth are less aware of community college programs and certifications, as compared to adults the age of 25 or older, creating prospective pathway delays for students seeking alternative career options to postsecondary education.

The U.S. rankings through the Programme for International Assessment (PISA) test, which is given to 15-year old students internationally and tests students in science, mathematics, and reading, show that there is much work to do. The PISA is facilitated in over 70 countries, of which the United States ranked 35^{th} in mathematics, falling below the average, and 24^{th} and 25^{th}

place in reading and science, respectively, just above the average for both (National Center for Education Statistics, 2015).

Mathematics achievement has been identified as one characteristic of academic and career-readiness. More specifically, problem-solving and critical thinking can be developed through the use of mathematics and exemplify the importance of mathematics aptitude (Attard, 2017). High levels of problem solving among the workforce are needed due to technological change and global economic competition, and not solely for mathematicians and scientists. However, the National Assessment of Educational Progress (NAEP) indicates that 37 percent of high-school seniors performed at *Below Basic* level on the mathematics portion of the assessment, while 45 percent and 18 percent performed at the *Basic* level and *Proficient* level, respectively (National Center for Education Statistics, 2018). These mathematics assessment results are also consistent with international standings, in which the United States ranked far below most industrialized countries. This phenomenon continues after high school, with nearly one-half of students requiring some level of remedial classwork upon entering college.

Workforce Needs

The American workforce is facing rapid changes pertaining to industry prevalence, job creation, jobs lost to automation, and technological developments, among other facets. It is imperative that members of the workforce remain versatile to compete both nationally and internationally. In an economy where over 35 percent of the workforce is freelancing, working as independent contractors, and/or working in the gig economy, developing entrepreneurial skills within our future workforce may become a pressing facet within the American education system (Gillespie, 2017). As inflation and the cost of living continue to rise at a rate much faster than median incomes can sustain, the gig economy remains a developing avenue for additional

income. The gig economy is made up of many short term and independent contractors, as well as freelancers, who take on gigs rather than partaking in full-time employment with a specific entity or person. Companies or individuals who engage in the gig economy are able to hire employees for a given task and do not have to pay the additional capital costs associated with the hiring of a permanent employee, whereas there are costs for physical space, healthcare, retirement contributions, etc. More broadly, traditional employees are considered less productive compared to gig economy workers who are paid purely for their assigned task (HR Daily Advisor, 2016). Participants simultaneously benefit in being able to determine their own schedules and can take on as many or as few gigs as they wish. The gig economy has specific entities that seek people to participate, such as with Uber, Task Rabbit, AirBnB, etc., while other participants join independently, such as freelance accountants, web/app developers, project consultants, etc. This phenomenon has subsequently risen due to the impacts of COVID-19, with more labor participants opting for contractual work to supplement their income or create income (Caza, 2020).

As the gig economy becomes more prevalent, students exiting from secondary school are faced with new challenges of an economy that has several unknowns. Although technological advances can be forecasted, the true impact will not be fully prevalent until the technology launches, and the effects come to fruition. As such, students may study fields that will have seemingly disappeared within a few years, leaving students unprepared for the workforce. Conversely, fields and jobs that do not exist today may disrupt economies and require several workers, for which the students currently graduating are unprepared. Regrettably, the education system cannot keep up with industry demands in such a fashion that it would make sense to do so. However, our education system can focus on building skillsets within our students to enable

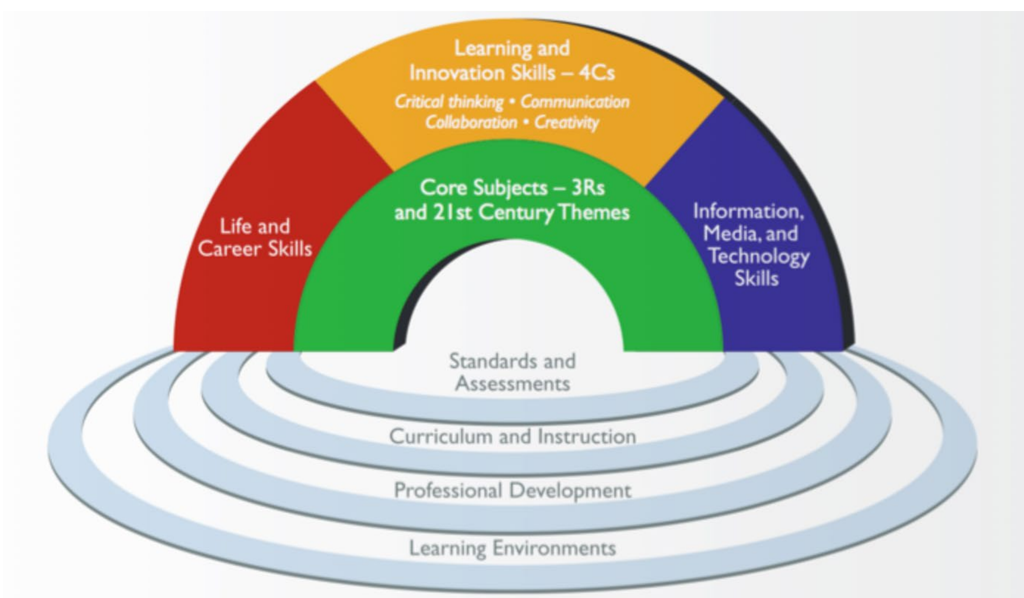
them to remain flexible in an everchanging economy. One such skillset is entrepreneurship, which enables students to learn risk taking, problem solving, identifying problems, all while encouraging creativity and innovation. While there are a number of unknown variables associated with the future of the American economy, mathematical sciences are forecasted to remain as an integral component of national workforce competitiveness (U.S. Department of Commerce, 2017).

21st Century Skills

Twenty-first century skills are cited to relate to future earnings, postsecondary outcomes, problem solving, a versatile workforce, increased self-sufficiency, and contextual learning (P21, 2009). The Partnership for 21st Century Skills has created a comprehensive framework for 21st century learning and its support systems (Figure 2).

Figure 1.

21st Century Learning Framework (P21, 2009).



The framework in Figure 2 illustrates the expertise, knowledge, and skills that students should master to prosper in their careers and life within the 21st century (P21, 2009). At the center of the framework are core subjects, which include English (reading/language arts), world languages, arts, mathematics, economics, science, geography, history, and government/civics. The core also represents the 21st century themes that allow for interdisciplinary learning through the core content classes. The interdisciplinary themes include global awareness, financial, economic, business and entrepreneurial literacy, civic literacy, health literacy, and environmental literacy. Other components of the framework are the learning and innovation skills, information, media and technology skills, and life and career skills. Learning and innovation skills have become imperative for success in the 21st century work environment and include critical thinking, communication, collaboration, and creativity. Information, media, and technology skills are based on the plethora of information now available, constantly evolving technology, and new means of collaboration and media usage. Life and career skills are based on skillsets that may not pertain to specific thought processes or content knowledge. Life and career skills include the ability to be flexible and adapt, taking initiative, working independently and collaborative work, social and cross-cultural interactions, productivity and accountability, and managing goals and time. These elements of 21st century skill building are supported through 21st century standards (content and skills), assessment of these skills, interdisciplinary curriculum and instruction, professional development for teachers integrating these skills in class content, and establishing 21st century learning environments (e.g., project based learning, expanding access, etc.).

P21 has provided a framework in which educators and workforce stakeholders can utilize jointly. However, gaps remain in terms of skillsets high school students are entering the job

market with. Coinciding to this skills gap, the number of Americans who live below the poverty line and are not adequately prepared for financial responsibilities has remained exceedingly high the past few decades (Suiter & Meszaros, 2005). As personal finance and literacy become more important, the need to incorporate such content into academic spaces is pressing. Although many states have created high school economics and personal finance classes, the majority are offered as an elective, thus leaving many students without the information needed to be prepared consumers and financial decision makers (Auslin, 2017). Suiter and Maszaros (2005) make the case for earlier implementation of financial education, in elementary and middle school. By integrating economics and finance into social studies, mathematics, reading, etc., students can still engage in learning standards while becoming more financially literate. Additionally, through the use of technology, allowing students to manage expenditures online, participate in stock market simulations, and partake in the economic process, students can better understand the world around them and how the fiscal decisions they make impact their lives.

Contextualized Learning and Career and Technical Education

Contextual learning is theorized to occur when students process information based on their own lived experiences, memories, etc. (Baker et al., 2009). The contextual piece is one that pertains to the individual student and their ability to understand or remember information based on the context in which it is provided. Students are able to make connections to theory with practical application in a format that allows for elaboration/insight. Contextual learning comes from the constructivism theory of education, where students are inherently responsible for developing their own understanding based on experiences and informational linkages (Cobern, 1993). The use of mathematics in entrepreneurship fits well with the constructivist theory of

education, whereas students can apply their prior mathematical knowledge to new situations (Loop, 2018).

Career and Technical Education (CTE), the practice of teaching specific career skills to students (Stauffer, 2020), allows students to experience a myriad of options in terms of career pathways. Although CTE seems as it would fit within the constructivist theory, it is generally seen from a behaviorist or cognitive perspective. Historically, vocational education has taken a competency-based education and training (CBET) approach, where the inclusion of rewards is connected to particular behaviors, such as workplace tasks for monetary compensation. Another facet of CBET is that learning outcomes are clearly articulated, learners understand the expected outcomes, and learners are actively participating in said learning (Barrick, 2019).

The learning theory of connectivism has since emerged, where connectivism surrounds the idea that people prove information through connections (Fiore, 2018). As technology has become an integral component of learning in this era, this learning theory indicates that people continue to learn past their formal education through job skills, networking, and access to other information and experiences through technology.

Contextualized learning is interdisciplinary in nature and allows for academic integration across subject areas. Career and Technical Education allow for this contextualized learning to happen through the use of practical applications of reading, writing, problem solving, mathematics, etc. from a career-focused lens. Kovalik and Olsen (1994) recognize conditions within learning environments that allow for an integrated environment, including: absence of threat in the classroom; connected, meaningful content; choice as a tool to heighten interest; adequate time to complete work; an enriched, hands-on learning environment; classroom collaboration and teamwork; immediate feedback; and mastery learning, measuring

interpretation through visuals, inferencing, prediction, estimation for mathematics integration specifically.

Research shows curriculum integration can improve student engagement, student learning outcomes, students' perceptions of school generally, and student attitudes towards academic subject areas (Bodilly et al., 1993). Conversely, academic experiences that are passive and do not aid in student engagement, relate to high school dropout ratios (American Psychological Association, 2012). Researchers tout CTE as a practical application of academic content that can contribute to higher levels of schoolwide academic integration (Grubb et al., 1991).

Research also shows how professional development, when coupled with a pedagogical framework, can aid in teaching mathematics. Stone et al. (2008) depict how students who learn to use mathematics to solve contextualized and real-world problems can advance their mathematics proficiency and understanding. Students who received mathematical instruction through CTE curricula (Mathematics-in-CTE model) scored significantly higher on standardized mathematics tests than students who received their regular mathematical instruction (Stone et al., 2008). CTE provides students alternate opportunities to learn through interdisciplinary classwork and allows for the integration of academic standards through a career-oriented lens, aligning with current workforce needs.

There is inconsistency among CTE programs across the United States, due to diploma designations, program establishments, credentialing, etc. (Pechota et al., 2020). This inconsistency creates issues in aligning high schools with post-secondary programs, particularly related to transferring credits, that create a barrier for many students. The lack of consistency is in part due to varying levels of involvement by private sector correspondents, further separating

program goals with market needs (Hasak, 2016). This furthers the narrative behind the stigma of CTE programs compared to other college preparatory pathways.

Assumptions

The assumptions of this study were as follows:

1. Participation in an entrepreneurship class was voluntary as an elective class, thus allowing for external motivating factors that potentially influence mathematics achievement.
2. Curriculum is followed in a similar manner across mathematics classes to mitigate class discrepancies.
3. Mathematics teachers did not differentiate instruction to the students in the entrepreneurship classes.
4. Students who were not considered ELL (English language learners) were at comparable reading levels.

Limitations

Limitations of this study include the following:

1. Mathematics and entrepreneurship were not integrated classes thus the contextualized learning aspect may not have translated in the same way that an interdisciplinary class would have. An interdisciplinary class compared to a traditional class may have had a more significant impact on proficiency.
2. External factors were not collected, such as outside tutoring, extracurricular activities, or other variables that occur outside of school that may pertain to math performance. However, this limitation was mitigated based on matching methods and utilizing pre-test scores.

3. Students enrolled in the entrepreneurship class on a voluntary basis, potentially implying a more quantitative/logical frame of thinking, or just generally a different type of student/learner.
4. Data were not collected on whether students were enrolled in other Career and Technical Education (CTE) classes being taken (e.g., Engineering, public health, business, etc.) and thus interaction effects or even multiplier effects could not be considered.
5. COVID-19 impacted the data collection process and limited the number of school districts that were able to participate, thus reducing the sample size and restricting the more general notions that could be made.

Procedures

Using a propensity score matching (PSM) mechanism, students who took both mathematics and entrepreneurship were matched with their most similar peers who only took mathematics, to make comparisons among closely matched students. Matching was based on a myriad of other independent variables (gender, race, classroom/teacher level characteristics, socioeconomic status, prior year mathematics achievement [Algebra I score], advanced placement [AP] or honors classes the student is enrolled in, CTE concentration if applicable, etc.). The classroom level characteristics (teacher effect and learning environment) were based on the number of years of teacher experience in mathematics, while the school effect variable was based on the school staffing ratio. Both ordinary least squares (OLS) regression and propensity score matching (PSM) will be compared.

Because it is difficult to emulate an experimental study within educational settings, an attempt was made to control for the wide variation in performance amongst individual participants, particularly as both the control (mathematics class) and treatment (entrepreneurship

class and mathematics class) cannot be assigned to each student. A propensity score matching mechanism was used to align similar students across the various classrooms/schools to make reliable inferences. Although propensity score matching techniques are traditionally utilized with single-level data, multilevel data were accounted for by adding teacher effects and school effects as independent variables in the matching process.

To create the propensity score for each student, the first step was to estimate the propensity score through a logistic regression. This was done to allow for an initial assessment on students based on the shared covariates and to ensure balanced groups. Students with similar propensity scores from the control group (mathematics only) and the treatment group (mathematics and entrepreneurship) were matched. The second step was to estimate the prospective treatment effect through regression, using propensity score as a predictor, in addition to weighting and stratification.

Definition of Terms

Many commonly used terms within this study are defined below to support the readers understanding:

Average Treatment Effect: The average effect, at the population level, of moving an entire population from the control group to the treatment group (Rosenbaum & Rubin, 1983).

Average Treatment Effect on the Treated: The average effect of treatment on those subjects who ultimately received the treatment (Rosenbaum & Rubin, 1983).

Career and Technical Education (CTE): The practice of teaching specific career skills to students in middle school, high school, and post-secondary institutions (Stauffer, 2020).

Career Cluster: Career areas that span 16 industries that make up CTE programs within secondary schools (Advance CTE, n.d.).

Career Pathway: Sequence of classes, and electives, within one of the 79 career pathways available to secondary students (Advance CTE, n.d.).

Contextual teaching and learning (CTL): A teaching and learning approach that relates academic content to real world situations through interdisciplinary, problem/project-based, cooperative, service learning.

Financial, economic, business, and entrepreneurial literacy: Knowing how to make appropriate personal economic choices, understanding the role of the economy in society, and using entrepreneurial skills to enhance workplace productivity and career options (P21, 2009)

Entrepreneurship class: In this study these include various courses within the Entrepreneurship and Business Academy pathway (Entrepreneurship Accounting, Incubator, Corporate Finance, Business Law, and Intro to Entrepreneurship), in addition to Entrepreneurship, Advanced Entrepreneurship, Accounting, and Economics and Personal Finance.

Entrepreneurial skills: Being able to take initiative, recognize opportunities, develop products/services to meet unmet demands, take risks, and make decisions. Other skills include creativity, self-confidence, flexibility, passion, leadership/management, teamwork, and communication skills, self-confidence, creativity (Kourilsky &Walstad, 2000).

Gig economy: A labor market made up of many short-term/independent contractors and freelance work, rather than permanent jobs (Forbes, 2018).

Learning gap: The observed disparity of student achievement as compared to their grade level expectations of acquired knowledge (Glossary of Education Reform, 2013).

Mathematics achievement gap: The observed disparity in mathematical performance among subgroups of students; groups include specific racial groups, gender, socioeconomic status (SES), etc. (Glossary of Education Reform, 2013).

Ordinary Least Squares (OLS): A type of linear least squares method for estimating the unknown parameters in a linear regression mode, by minimizing the sum of the squares of the differences between the observed dependent variable and the predicted values (Albert, 2016).

Propensity Score Matching: Statistical method to reduce the bias in the estimation of treatment effects with observational data sets. Matches 'treatment group' observations to 'control group' observations based on the likelihood to have the 'treatment' and then determines the Average Treatment Effect (ATE) and the Average Treatment Effect on the Treated (ATET) (Littnerova et al., 2013).

Science, Technology, Engineering, and Mathematics (STEM): Occupations, and education, that fall under science, technology, engineering, or mathematics.

21st century skills: A wide skillset that enables people to be successful in modern day careers and collegiate programs. Skills pertain to life and career skills, academic content knowledge, information, media, and technological skills, and innovation skills (P21, 2009)

Overview

A more in-depth discussion of the importance of and ways to integrate changing workforce needs within education, the mathematics achievement gap, and CTE in context of the mathematics achievement gap, will be provided in Chapter II, the Literature Review. Within Chapter III, the methodology that was used to collect and analyze the data will be provided. The analytical results of this study are provided in Chapter IV. These results were based on the

specified sample set of students. Lastly, Chapter V covers the summary, recommendations, future considerations, and conclusions of the study.

CHAPTER II

Literature Review

The intent of this study was to determine whether there was a correlation between mathematics scores and enrollment in an entrepreneurship class. This literature review describes mathematical student achievement over recent decades, what factors relate to mathematical achievement, and how mathematics plays a role in postsecondary outcomes. Correspondingly, the changing workforce needs within the 21st century and how students develop entrepreneurial thinking skills, while still retaining their academic knowledge of core subjects, is analyzed. This literature review concludes with research on how contextualized learning and Career and Technical Education (CTE) connect with mathematical achievement. This literature review is structured in a way to give a broad overview of the expectations and outputs within mathematical education, in comparison to the needs of the workforce pertaining to mathematical sciences. Because the focus of the hypotheses pertains to mathematical achievement, the beginning of the literature review provides context for this subject.

The following sections of the literature review pertain to the demands of the workforce and how both mathematical sciences and entrepreneurial thinking need to be fostered within the K-12 space. The literature review will conclude with research on how contextualized learning, or more specifically, CTE, connects with mathematical sciences. This background contributes to the basis of the hypotheses that participation or proficiency in entrepreneurship education relates to mathematics proficiency among high school students.

Mathematical Achievement Over Time

Mathematical outcomes stemming from the U.S. education system have been an ongoing topic of concern within education over recent decades. Apprehension in education has been centered on whether schools are adequately preparing students for the workforce and postsecondary education. This apprehension led to various government initiatives over a number of years, several of which have focused on class taking and rigor (Rose & Betts, 2001).

Upon the release of the report *A Nation at Risk* (National Commission on Excellence in Education, 1983), the widespread perceptions that the education system was failing to meet the overarching goal of ensuring American students remained better educated and maintained higher workforce skillsets than their international counterparts were depicted. This report recommended greater rigor in high school settings, which pushed for at least four years of English education and three years of mathematics education in high school. Many states have since then adopted said recommendations. The report also gave light to a variety of educational issues, of which mathematics was heavily emphasized. The shortage of mathematics teachers, and more specifically qualified mathematics teachers at the secondary level, was a key issue and a second key issue was that the average salary of an entry-level mathematics teacher was 60 percent that of an entry-level private industry job requiring a bachelor's degree in mathematics (National Commission on Excellence in Education, 1983). As of 2020, this disparity remained similar, with the median salary for a mathematician at $105,030 and the median salary for a math teacher was $61,660 (Trade Schools, 2020).

Following *A Nation at Risk*, improving mathematics and science across schools became a core focus of varying agendas and initiatives. Additionally, traditional methods were pitted against new approaches that were exemplified advancement during the computer age. The report

also issued several secondary mathematics recommendations, such as: ensuring students understood geometric concepts, algebraic concepts, and probability and statistics, in addition to applying mathematics to everyday situations and testing for accuracy of calculations. The same educational issues remain prevalent over 30 years later and these recommendations still apply and should be addressed as part of mitigating the mathematical achievement gap.

Another issue highlighted within *A Nation at Risk* was the lack of application that students could perform when it came to mathematics and real-world, contextualized, scenarios. At the time of the report, only 31 percent of recent high school graduates had completed Algebra II and 60 percent of students enrolled in calculus while only six percent completed it. Although these numbers have risen over the years, with 76 percent of students completing Algebra II and 16 percent of student completing calculus (NCES, 2009), the rankings of how the United States compares to other nations has remained stagnant, signified by mathematics performance of 17-year-olds on the National Assessment of Educational Progress (NAEP) which has remained stationary since 1973 (Steen, 2003). The NAEP mathematics test for 12th graders is based on a 0-300 scale. Historically, and internationally, the U.S. mathematics literacy rate has lagged behind other Organization for Economic Cooperation and Development (OECD) nations that have developed economies.

Regrettably, the achievement gaps between low- and high-performing students have been considerably vast. The difference between students scoring in the highest and lowest quartiles of the NAEP, for 17-year-olds, was equivalent to the average scores for a 17- and a nine-year-old, respectively (Steen, 2003). The achievement gaps are also ubiquitous amongst students coming from poverty. Twelfth-grade students who qualify for free lunch perform similarly to eighth graders who do not qualify for free lunch. In 2015, the achievement gap between students at

high-poverty schools compared to low-poverty schools was 36 points, remaining similar to prior years and significant. Additionally, students who were considered English language learners (ELL) scored 37 points lower than their non-ELL peers. Furthermore, the achievement gaps amongst people of color are extensive, where only one out of 25 Black and Hispanic 12th graders test as proficient on the NAEP compared to one out of three Asian/Pacific Islander students and one out of five White students. The 2013 and 2015 NAEP results depict that the gender achievement gap is marginal, with the gap being between one and three points. The most recent NAEP results (2015) indicate that 12th graders who are eligible for free and reduced lunch scored an average of 137 while those ineligible for the program scored an average of 160. On average, Black and Hispanic students scored 130 and 139, respectively, on the most recent NAEP exam. Comparatively, Asian/Pacific Islander and White students scored an average of 170 and 160, respectively. These aforementioned results were statistically significant and were similar to the 2013 results. Additionally, students who came from families where the parents did not finish high school had statistically lower results than their peers with parents who had finished high school or even college. Overall, the 2015 NAEP mathematics examination for 12th graders depicted that 62 percent performed at a basic level (similar the 2005 results but declining from 65 percent in 2013), 35 percent performed at a proficient level, while only three percent performed at an advanced level. The percentage of students who performed at a proficient or an advanced level remained similar to the 2005 and 2013 results of the NAEP.

Although there are numerous variables that can be attributed to differing mathematical achievement, level of class taking is one that is not as commonly used as a moderator. Over the past 30 years there has been an inclination to increase academic class requirements, and yet the performance metrics illustrate that U.S. students have not improved in terms of basic skill sets

(Ravitch & Chubb, 2009). Over this time the requirements for mathematics has not changed based on market demands. Students who complete a calculus class, compared to students who complete an Algebra II class, have had minimally an additional two years of mathematics instruction, allowing them to have a deeper understanding and a wider subset of postsecondary options. This issue partially stems from graduation requirements, in which only 16 states require four classes of mathematics for high school graduation (NCES, 2016). However, studies that account for class-taking discrepancies depict that there are still achievement differences across racial groups. A study comparing advanced mathematical students found that advanced mathematics students who were Black had significantly lower proficiency than their White counterparts (Minor, 2016). Taking this notion even further, Black students who had completed calculus had similar achievement levels as White students who had only taken pre-calculus/trigonometry.

In efforts to integrate problem-solving skills within mathematics curriculum, researchers within the LieCal project found that tenth grade students who had integrated curriculum (mathematics and purposeful problem solving) had significantly higher average scores compared to their peers within the non-integrated curriculum (Cai et al., 2017). Such findings were consistent regardless of the covariables used.

Mathematics Classwork Selection

Classwork and selection are highlighted in the literature as powerful predictors of postsecondary earnings. In a longitudinal study using the *High School and Beyond survey*, students who were in tenth grade as of 1980 were assessed in terms of their class selections and postsecondary outcomes 10 years later (Rose & Betts, 2004). This study showed how mathematics class selection was related to the probability of graduating from college and

earnings, of which roughly half were directly influenced by the postsecondary education obtained. However, approximately half of the earnings growth appeared to be a direct impact, independent of educational attainment. The researchers within this study took a deeper look at class taking trends across other subjects besides mathematics. They found that taking an advanced English class increased earnings by more than a typical additional mathematics class (i.e., algebra, geometry, or intermediate algebra). However, an advanced level English class predicted lower earnings than an advanced mathematics class (i.e. higher than intermediate algebra). Concurrently, any mathematics class above the algebra/geometry level was found to increase earnings more so than the average additional English class. These findings account for confounding variables such as student motivation and prior achievement. The researchers also found that students who took an intermediate algebra class and an advanced algebra class, compared to just taking algebra and geometry, were expected to increase their earnings by 17.3 percent (7.5 percent based on the class taking and an additional 9.8 percent based on the postsecondary outcomes as a result).

In a similar context, James (2013) studied earning differences among students who had or had not taken geometry or Algebra II, as compared to stopping at pre-algebra or Algebra I. This research depicted that workers who graduated from high school earned approximately $1.30 more per hour if they had completed geometry or Algebra II. These findings portray that higher-level classes in mathematics benefit students at about a 10 percent return, equating to a similar return as that of a year of college. These studies shed light on how rigorous class-taking can have long term effects on both educational and earnings outcomes. These studies also depict the limited literature that exists on performance based on elective class-taking, specifically, particularly those coupled with mathematics. This lack of information creates uncertainty around

whether all students would benefit from this classwork and what other student outcomes benefit from rigorous class-taking.

In terms of class-taking and high school graduation requirements, five states allow local school boards to determine requirements and among the remaining states; two states require two math classes, 27 states require three math classes, and 16 states require four math classes for their high school graduation requirements (Education Commission of the States, 2019). Among the states that require three or more math classes for high school graduation, 10 states and the District of Columbia require Algebra II specifically. However, states that require three or four math classes may inadvertently require Algebra II since Algebra II serves as a prerequisite for trigonometry, precalculus, calculus, and other classes. Based on the National Center for Education Statistics (NCES, 2016) the percentage of high school graduates who completed Algebra II increased from 54 percent to 76 percent between 1990 and 2009. Table 1 illustrates the mathematical graduation class requirements by state.

Table 1

Mathematic requirements for high school graduation across the United States

Requirements	States and D.C.
Two classes	California and Montana
Three classes	Connecticut, Hawaii, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Maryland, Nebraska, Minnesota, Missouri, Nevada, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Virginia, Washington, Wisconsin, and Wyoming
Four classes	Alaska, Alabama, Arizona, Arkansas, District of Columbia, Delaware, Florida, Georgia, Louisiana, Michigan, Mississippi, New Mexico, Ohio, Rhode Island, South Carolina, Tennessee, and West Virginia
Set by local boards	Colorado, Maine, Massachusetts, Pennsylvania, and Vermont

Algebra II specific requirement	Arkansas, Arizona, Alabama, Delaware, District of Columbia, Kentucky, Louisiana, Michigan, New Mexico, Ohio, and Virginia

Note. Reprinted from *Education Commission of the States* (2019).

Math Achievement: Variables of Interest

Various factors are identified in the literature that impact mathematics achievement. Research shows that race, socioeconomic status (SES), gender, classroom/peer environment, number and quality of mathematics classes, prior mathematical success, and attitudes towards mathematics are commonly found as factors relating to mathematical achievement (Lee et al., 2018; Reyes & George, 1998; Reynolds &Walberg, 2010). Reyes and George (1988) explore a theoretical framework of mathematics proficiency through an extensive literature review. The individual-level variables researched included race, sex, and SES, whilst the external influences included six identified factors to include societal influences, teacher attitudes, school mathematics curricula, student attitudes and achievement-related behavior, classroom processes, and student achievement. The societal influences factor was further broken down to include family variables, community attributes, religious institutions, mass media, and occupational roles, all of which can change over time.

Socioeconomic Status (SES) and Racial Disparities

Gaps in academic achievement are often represented among major student subgroups. The gaps in academic achievement often depict comparisons of White and minority students, male and female students, low SES and high SES students, native and nonnative English speakers, special education and general education students, first generation and non-first-generation students, among other groups (Schiller et al., 2002; Siegler et al., 2012; Papay & Kraft, 2014).

Alongside racial and gender disparities, disparities exist for students coming from families and communities with lower SES. Using national longitudinal data, Lee et al. (2018) conducted a path analysis on low SES students to determine how background, psychological, and behavioral variables impact postsecondary outcomes. This research depicted high school mathematics scores as the most powerful predictor of postsecondary educational attainment for low SES students. Variables that were also considered strong predictors were academic expectations, reading scores, and behavioral problems, among others. Beyond SES, Schiller et al. (2002) found that higher parental education is associated with higher mathematical achievement.

Demographic factors such as race, socioeconomic status (SES), and parental education/employment are prevalent across the literature, being strong predictors for mathematics achievement and early placement into higher level mathematics classes (Mccoy, 2010; Schiller et al., 2002; Spielhagen, 2006). However, Lubienski (2001) found that differences in SES accounted for some but not all the race-related differences in mathematics performance. Underlying factors that related to race, after controlling for SES, were limited calculator use, multiple choice assessment use, lack of teacher emphasis on reasoning, and student views on mathematics as memorization. This shows how there are school-related (somewhat controllable) factors that influence mathematics performance alongside uncontrollable demographic-type factors. These findings were consistent across a variety of ages (4^{th}, 8^{th}, and 12^{th} grade). In this study, these variables will be controlled for by utilizing pre-test scores, with the intent to capture any inherent mathematical achievement differences.

Although several studies have been conducted regarding mathematics proficiency, and even algebra specifically, Mccoy (2010) examined the effects of both attitudes and demographic factors in relation to 8^{th} grade algebra achievement. Students within four classes completed the

North Carolina State End-of-Grade Mathematics Test and the North Carolina State End-of-Class Algebra I Test in addition to a questionnaire on demographic factors and attitudes about mathematics. Mccoy found that ethnicity, SES, and attitudes about mathematics significantly affected mathematics proficiency.

Research also shows that as students progress along their academic journey, the achievement gap widens and the confounding variables become more significant. Entwisle and Alexander (1992) researched the achievement gap between elementary-school children of different SES and ethnicity. The authors used a longitudinal study to evaluate students in first grade and then in third grade. They found that students are similar in terms of mathematics achievement in first grade but differed based on ethnicity and SES by the third grade. These authors also evaluated how mathematics achievement was impacted by the summer months. The most important variables in their model, associated with predicting mathematics achievement, were SES followed by school segregation. Entwisle and Alexander (1992) also found that lower SES students of both races in the sample (White and African-American) were negatively affected by the lack of school interaction in the summer. This was tested by assessing changes in mathematics achievement test results from before the start of the summer and at the end of summer.

Class Taking and Prior Assessments

Rigorous classes, such as advanced placement (AP) class or honors classes, are found to strengthen high school test scores, college entrance exam results, high school graduation, and postsecondary entrance/performance (Attewell & Domina, 2008; Gamoran & Hannigan, 2000). Additionally, students who had additional instructional time in Algebra I had positive correlation

to the number credits earned, assessment results, high school graduation rate, and college enrollment (Cortes et al., 2009).

A strong factor in high school mathematics achievement is prior mathematical content learned. Siegler et al. (2012) found that content learned in elementary school (fractions, division, etc.) impacts algebra achievement and overall mathematics achievement later in life. Prior assessments are also strong indicators for mathematics proficiency (Reynolds & Walberg, 2010; Spielhagan, 2006). The prior achievement has shown large effects on achievement because it cumulates across the years (Siegler et al., 2012). Mathematics achievement is very much based on building blocks and is heavily influenced by fundamentals. In a study examining the relationship between elementary mathematics achievement to high school mathematics achievement, Siegler et al. (2012) found that information learned in elementary school (such as fractions, division, etc.) have a significant impact on algebra and overall mathematics achievement at a high school level.

Students pursuing STEM fields are often required to take more rigorous mathematics classes, thus influencing wage disparities among varying groups. Postsecondary outcomes of students have been researched from a gender and racial disparity perspective. Findings suggest that gender disparities within STEM occupations are more likely to occur because women are less likely to pursue a STEM field. However, racial disparities are more likely to occur based on a few Black and Hispanic students being prepared for STEM studies in their secondary schools (Tyson et al., 2007). Thus, this conveys the need for more rigorous class-taking to occur in high schools.

Educational initiatives show a push for earlier access to Algebra I, which can spur additional mathematical class-taking (Spielhagen, 2006). Spielhagen utilized a logistic regression

to assess how different individual-level background variables can determine earlier placement into algebra. Variables that were found to contribute to early placement included whether students were identified as gifted, prior-year mathematics grades, ethnicity, and SES. Spielhagen also found that students who were placed in algebra earlier (in 8th grade, specifically) took more mathematics classes in high school than those who had to wait until high school to take algebra, although they are not required to.

Classroom and Teacher Effects

Classroom effects and learning environments are highlighted in the literature as having an impact on academic achievement (Ornstein, 2010). The learning environment may include student interactions with peers, classroom culture, and a variety of other facets that are particular for a given class. However, a primary factor within classroom effects is the role of the teacher. Teacher effects have also been highlighted in the literature as having a strong impact on academic achievement (Chetty et al., 2014; Reynolds & Walberg, 2010; Schmitt, 2012; Subedi et al., 2011).

In terms of classroom level effects (learning environment), studies have portrayed how the classroom environment can impact mathematics achievement and achievement generally. The learning environment can allow for positive peer collaboration in addition to feelings of comfort and safety, allowing students to feel comfortable asking questions and taking academic risks (Ornstein, 2010). Because it is difficult to capture many of the classroom environment factors quantitively, teacher effect is often used in studies unaided. The general trend in teacher effect is that as experience increases, student achievement also rises, although in the later years there are marginal declines (Rice, 2010; Schmitt, 2012). In a quadratic fashion, years teaching experience is much more monumental in terms of student achievement in the earlier years. The

first year of teaching accounts for approximately half of the cumulative effect of experience on student achievement (Schmitt, 2012). Higher-poverty schools often have higher ratios of inexperienced teachers (Rice, 2010) and also have lower payoff related to their experienced teachers due to various confounding variables that pertain to achievement that are more prevalent in higher-poverty schools.

Other factors that impact academic achievement are teacher experience, most prominently represented as number of years in the classroom. Literature depicts that novice teachers are less effective as compared to experienced teachers, although almost half the cumulative growth they make in their career occurs in their first year (Papay & Kraft, 2014). Research regarding the relationship between teaching experience and academic achievement of students shows that the growth in students tapers off at the fifth year of a teacher's experience. Although there is still growth after five years of experience, it is marginal (Kini & Podolsky, 2016). Additionally, most of the growth occurs between year one and two. Some research depicts that the relationship is quadratic showing that teachers with more years of experience may incur marginal declines in student outcomes, with scores declining after the thirteenth year in the profession (Sass et al., 2010).

Other confounding factors to teacher experience include stability, such as teachers teaching the same grade/content at the same school, and the ratio of other experienced or novice teachers. Based on the ratio of experienced to novice teachers, the learning community as a whole is impacted. Teacher stability and retention seemingly go hand in hand. Ronfeldt et al. (2013) found that students who experienced high levels of teacher turnover performed at lower levels in English Language Arts and mathematics when compared to students who did not

experience turnover, controlling for other variables. The effect sizes were larger in mathematics and for students who were considered minorities and/or were of a lower SES.

Goe and Stickler (2008) empirically determined four indicators of teacher quality that were often captured as primary variables within the literature. The four indicators include teacher qualifications, teacher characteristics, teacher practices, and teacher effectiveness, which are due, in part, to the "highly qualified teacher" provisions of the No Child Left Behind (NCLB) Act (No Child Left Behind [NCLB], 2002). These indicators are most commonly associated with teacher hiring and how teachers climb the career ladder. With respect to secondary education, the content matter requires a higher level of understanding than elementary and middle school content, thus making degree/certification an even more critical facet. Advanced degrees have a positive effect on secondary mathematics student achievement, but only if the advanced degree is related to mathematics (Aaronson et al., 2007).

In conjunction with student achievement being linked with teacher value, future earnings of students are also impacted by the value of their teachers. Chetty et al. (2014) found that an improvement of a teacher value, in a single grade, raised prospective earnings for their students. The implications of these findings indicate that replacing a low 'value' teacher (whose value is at the lowest five percent of teachers) with an average teacher would result in a lifetime earnings increase of $250,000 on average, for those students. Research also suggests that in addition to teacher experience, teacher certification (mathematics content) is also a predictor of student level mathematics achievement (Subedi et al., 2011). Teacher value is formed by a variety of factors, of which years of experience, certification, and test score impacts are integral.

Attitudes towards mathematics, and mathematics interests, are highlighted across the literature as having a predictive ability on mathematics achievement (Gilpin, 2010; Jones et al.,

2012; Mccoy, 2010). The literature in regard to mathematics achievement and mathematics interest expand beyond algebra and includes a variety of age groups. Fisher et al. (2012) studied the relationship between mathematics interest and mathematics proficiency in a sample of preschoolers. These researchers found that the relationship was, in fact, reciprocal, in that higher levels of mathematics interest correlated to a stronger mathematics skillset and vice versa. The researchers studied 118 children in eight different head start classes and assessed both mathematics skills and interest. Additionally, half the classrooms received a mathematics intervention and the results indicated that those children who participated in the intervention showed improved numeracy skills and higher levels of interest compared to the control group.

Contrastingly, studies have also been conducted on this topic within higher education. Hackett and Betz (1989) studied how mathematics performance impacted mathematics self-efficacy, attitudes towards mathematics, and choice of mathematics-related majors by college students. Assessing 262 students through a regression analysis, the authors found that mathematics performance was correlated with attitudes toward mathematics and enrolling in a mathematics-related major. This shows the circular reasoning mathematics achievement and mathematics interest/attitudes convey.

Students are often expected to understand difficult academic concepts using an abstract/lecture method, although they must be able to apply said knowledge to the larger society in which they work and live (CORD, 2016). Students have been anticipated to make these connections on their own, outside of the classroom. However, contextualized learning and connecting student interest with academic content have become a proven and well-respected concept, where students who understand how content is used in the real world are also more likely to be engaged (CORD, 2016).

Impact of CTE on Student Achievement in Mathematics

In Career and Technical Education (CTE), various challenges and gaps persist that require school reform to initiate upward growth in education. *The Pathways to Prosperity Project* (Symonds et al., 2011) identifies various issues prevalent to this underlying challenge. In terms of underlying challenges, the researchers describe the opportunity gap, the term 'dropout nation', U.S. high school rankings internationally, and the inconsistency and inadequate quality of CTE programs (Symonds et al., 2011). The opportunity gap between education and adequate employment opportunities pertains to the skillset of youth in high school, or lack thereof, that does not allow for high school graduates to enter the workforce and adulthood smoothly and with employment security. The 'dropout nation' term coined for the United States referenced that over one million high school students drop out annually in addition to the United States having the highest college dropout rate in the world. Although many factors contribute to the "dropout nation" phenomena, a major factor is that students cannot see the connection between their curriculum and tangible opportunities in the workforce. As the economy changes, educational standards, practices, and curriculum must adapt so that the youth can better prepare themselves for employment.

The U.S. ranking of student achievement through the Programme for International Assessment (PISA) test, which is given to 15-year-old students internationally and tests students in applied studies. The United States ranked 17^{th} and 25^{th} in relation to science and mathematics scores, respectively (OECD, 2015). The inconsistency and inadequate quality of CTE programs across the United States creates issues in aligning high schools with post-secondary programs, particularly related to transferring credits which creates a barrier for many students. The lack of consistency is due to the local control of education, further separating program goals with market

needs. This creates a cultural stigma on CTE programs being inferior to typical university settings.

However, Career and Technical Education (CTE) is an avenue to contextualize mathematics, allowing students to potentially apply mathematical concepts to real-world problems. In order to improve mathematics achievement, and student achievement generally, CTE instructors may look to integrate core academic curriculum within their CTE area of expertise.

Various research depicts how contextualized learning can aid in mathematics achievement, in addition to how CTE can aid in student achievement generally (Surya et al., 2016). In a quasi-experimental study, contextual learning is shown to increase student confidence in mathematics content and student problem-solving capabilities within mathematics (Surya et al., 2016). Although in this case CTE was not involved, CTE classes depict how academic subjects are used contextually in the workforce. Students who take three or more classes in a specific CTE area are considered CTE concentrators.

Comparing student proficiency outcomes generally, Plank (2001) studied how CTE students compared to 'academic concentrators' in terms of content area achievement (mathematics, science, history, and reading). Plank found that academic concentrators outperformed CTE students in all the aforementioned subjects. By expanding this research to post-secondary outcomes, the research showed that CTE concentrators were more likely to be fully employed while academic concentrators were more likely to be in school fulltime. Additionally, in assessing student dropouts, Plank found that the likelihood of dropping out was lowest at an optimal point where students take three CTE credits for every four academic credits, after controlling for prior achievement and demographic characteristics. The pattern found is

curvilinear, indicating that any ratio lower or higher increases the likelihood for a student to drop out. These findings suggest that an optimal mix and exploration of classes leads to a lower likelihood of high school dropouts.

Extending beyond CTE concentrators, studies also highlight the effects of career-themed programs-of-study (POS) on high school achievement outcomes across the United States. Castellano et al. (2017) conceptualize a framework to indicate that contextualized teaching/learning may be the integral piece to CTE POS participation, leading to greater academic achievement. Castellano et al. (2017) simulated a natural experiment where POS participation was through a 'functionally random' lottery, the experimental group (sample) came from a large urban school district, and the POS were academies at three high schools. The control group came from 25 of the other high schools in the district that did not offer academies. Each academy had a designated theme that was driven by local and state-level economic and workforce development initiatives. By using an instrumental variable approach alongside structural equation modeling (SEM), the results in this study portrayed that POS enrollment increased a student's probability of graduation by 11.3 percent. Additionally, each additional CTE credit that a student took, within their POS, increased their probability of graduating by an additional four percent. The researchers found that the effect of POS participation on high school GPA was not significant. However, covariates found to be significantly related to GPA included: gender, free and reduced lunch, English language learners, special education, discipline incidents, grade eight science, mathematics, and reading scores, and race. Covariates found to be significantly related to graduation included age, free and reduced lunch, discipline incidents, and race.

Contrastingly to the general academic content performance by CTE students, Dyer et al. (2006) focus on technology students and their mathematical outcomes. In a study analyzing high-school end-of-class mathematics performance, these researchers found that students who took an illustration and design technology class, while enrolled in Algebra I and/or geometry, performed better than students who merely took the mathematics class without the technology class.

A similar study focusing on middle-school students illustrates how enhanced anchored instruction (EAI) can improve the mathematics skills of students within technology classrooms. EAI embeds instructional skills in authentic problems to improve student abilities in problem-solving and computation (Bottge et al., 2010). Using a pre- and post-test, and by separating students into an EAI group and a typical technology education instruction group, the results indicated that EAI students showed higher mathematical aptitude compared to their peers.

Math and Career and Technical Education (CTE)

Bottom and Sharpe (1996) define the integration of CTE and mathematics as the understanding of mathematical concepts rooted in occupational content. The *Building Academic Skills in Context: Testing the Value of Enhanced Mathematics Leaning in CTE* (Stone et al., 2006) study recognized that merely increasing mathematics requirements does not always have an effective impact on assessment, depicted by the general trend of declining graduation and high-school completion rates albeit mathematics requirements increasing over the past three decades. Additionally, this study discusses the lack of mathematical skills CTE students possess due to the nature of their occupational classwork. These students often stem from at-risk or disenfranchised groups and need to garner the mathematical framework just as much as, if not more than, their peers. The researchers in this study saw an opportunity to test whether CTE concepts that were mathematical in nature could be taught in congruence with conceptual

mathematics to enhance mathematics assessment levels and skill transferability of CTE students.

Stone et al. (2006) aimed to find whether the Mathematics-In-CTE model improved student mathematics performance as measured by traditional assessments of mathematical skills, whether the model decreased the students' likelihood of requiring mathematics remediation in college, and whether this change in curriculum would adversely impact students' occupational knowledge within the respective CTE area. The Mathematics-in-CTE model had both quantitative and qualitative impacts in correspondence with three goals: to help students solve practical problems by using mathematics in their occupational area; to recognize mathematics occurring in other contexts; and to do the former without weakening the technical knowledge within the CTE class. At 11 percent of the overall class instruction time, the Mathematics-in-CTE model depicted enhanced levels of mathematical skill. The Mathematics-in-CTE model was used in five CTE classes representing five different industries, with each class having between four and 23 classrooms studied. Three tests (TerraNova, ACCIPLACER, and WorkKeys) were administered to depict mathematical aptitude, college placement aptitude, and mathematical application. Between the experimental and control groups, with and without the Mathematics-In-CTE model, the experimental group students performed better on two of the three mathematics/aptitude tests administered. In terms of CTE knowledge, the results indicated that the experimental classrooms were not adversely impacted based on occupational test scores.

The TerraNova test, a general mathematics aptitude test, depicted that students with the mathematics-enhanced curriculum scored four percent higher than the control group (49 compared to 45 percent), on average. These results were significant, implying that the mean score of the experimental group was at the same level of those at the 71st percentile in the control group. Additionally, 13 percent of variation in classrooms was accounted for by the experimental

condition. The ACCUPLACER test, a college placement aptitude test, depicted that students with the mathematics-enhanced curriculum scored three percent higher than the control group (42 compared to 39 percent), on average. These results were significant, which implies that the mean score of the experimental group was at the same level of those at the 66th percentile in the control group. Additionally, 10 percent of variation in classrooms was accounted for by the experimental condition. The WorkKeys test, an applied form of mathematical testing, found that the difference in results between the two groups were not statistically significant.

In terms of the qualitative results, the Mathematics-In-CTE model incorporated professional development, partnerships (between teachers within mathematics and CTE) and cooperative learning, and a seven-element pedagogy to infuse both the CTE knowledge and the related mathematical concepts associated. There was a consensus that the professional development across disciplines did not vary significantly and was beneficial. Teachers expressed that the program was worthwhile, teachers needed each other for reinforcement of the concepts and for shared responsibility amongst the disciplines, CTE curriculum already has a lot of mathematics embedded, and allowing the teachers to take ownership of the lesson plans reaped positive results.

Career and Technical Education (CTE) – Challenges

Within *Pathways to Prosperity: Meeting the Challenge of Preparing Young Americans for the 21st Century* (Symonds et al., 2011), both issues and lessons learned regarding CTE, particularly in regards to international best practices, were articulated. This and other literature depicts the notion that many nations have surpassed the United States in regards to graduation rates. These countries offer rigorous and distinct pathways to career progression within their school systems leading to better academic retention rates. *Learning for Jobs* (OECD, 2010), a

17-country study, indicated that, if done well, work-based learning is the best way for youth to prepare for the labor market.

Symonds et al. (2011) reference various mechanisms and programs that should be developed and/or expanded upon to stimulate CTE in the school system. Three major themes envisioned by the authors of the *Pathways to Prosperity* report include broadening school reform to include several differing pathways to transition youth from high school to adulthood, expanding the role of employers in creating work-based learning opportunities.

A key challenge in CTE reformation is showing increases in return with respect to graduation rates and student retention in STEM fields. Regarding graduation rates, programs such as career academies (ACTE, 2009) which incorporate a paid internship within high school, have shown that 90 percent of program participants graduate high school, significantly greater than average graduation rates. Additionally, over 80 percent of this program's participants attend college. Another program related to CTE is Washington States I-BEST (Integrated Basic Education and Skills Training) program, which trains remedial English and mathematics students in CTE programs such as nursing, auto mechanics, etc. (Washington State Board for Community and Technical Colleges, 2019). These students were found to acquire additional certifications and continue their educational track at a greater rate compared to regular remedial students.

Career and Technical Education (CTE) – Pathways

The Carl D. Perkins Career and Technical Education Act (PL 98-524) seeks to create academic and work-based learning opportunities for students to thrive in the 21st economy (Gordon, 2003). The original Perkins Act of 1984 amended the Vocational Education Act of 1963 and its subsequent revisions (Gordon, 2003). Within the Perkins act, Career Clusters organize industries and their respective jobs based on skillsets, outcomes, advancements, and

ultimately pathways. In 1990, due to a shift in demand of academic and vocational skills integration and through the development of the Carl D. Perkins Vocational and Applied Technology Act of 1990, also known as Perkins II (PL 101-39), broad occupational clusters were created with corresponding certification standards. Since this time, the Perkins Act has been amended to the Carl D. Perkins Career and Technical Education Act of 2006, also known as Perkins IV (PL 115-22). Perkins IV became the Strengthening Career and Technical Education for the 21st Century Act, Perkins V (PL 88-210), as of 2018 (U.S. Department of Education, Office of Career and Technical Education, 2019).

In 1996, the Build Linkages Project, designed to create a skills standard system, developed pilot programs for the clusters which are now considered Career Pathways – specific tracks within the clusters with specific steps for achievement. The Career Clusters encompass a wide variety of industries within the workforce and stem from varying CTE areas, pertaining to: Agriculture; Business and Marketing; Health Sciences; Information Technology; Skilled and Technical Sciences; and Technology and Engineering. There are currently 16 Career Clusters and 79 Career Pathways within the Clusters. The following sections describe the Business and Marketing CTE area (business, finance, and marketing Career Clusters). Entrepreneurship is a Career Pathway (classes include Entrepreneurship and Advanced Entrepreneurship) within this CTE area, although the classes can be taken in conjunction with any of the pathways as an elective. Although entrepreneurship is housed within the Business and Marketing CTE area, entrepreneurship can be taken by any CTE or non-CTE student.

Entrepreneurship is considered a critical component within the CTE pathways. Figure 3 (Minnesota State Career Wise, 2019) depicts the relevancy as both entrepreneurship and employment are considered pillars within each CTE area.

Figure 2.

Minnesota's CTE areas (2010). Reprinted from Minnesota State Career Wise.

The Business Management and Administration Career Cluster assists students in learning about careers related to planning, organizing, leading, and evaluating business functions vital for efficient and effective business operations (Minnesota State Career Wise, 2019). This cluster has five Career Pathways related to administration, business information, management, human resources (HR), and operations. Students within this cluster can get involved in their communities by starting their own businesses, becoming a team captain in their Career and Technical Student Organization (CTSO), managing a fundraiser, or by serving on a committee involved with business practices (Minnesota State Career Wise, 2019).

The Finance Career Cluster assists students in learning about careers in financial and investment planning, banking, insurance, and business financial management (Minnesota State Career Wise, 2019). This cluster has five Career Pathways related to accounting, banking,

finance, insurance, and securities/investments. Students within this cluster can get involved in their communities by organizing fundraisers, joining a local investment club, assisting local businesses with financial planning and projections, participating in entrepreneurial hackathons, or assisting in teaching financial literacy (Minnesota State Career Wise, 2019).

The Marketing Career Cluster assists students in learning about careers related to planning, managing, and performing marketing activities to reach organizational objectives (Minnesota State Career Wise, 2019). This cluster has five Career Pathways related to marketing management, professional sales, merchandising, communications, and research. Students in this cluster can get involved in their communities by participating in design competitions and assisting local agencies with marketing design for fliers or social media management, working in public relations, working on marketing for school events and social activities, etc. (Minnesota State Career Wise, 2019).

Entrepreneurship

Entrepreneurship benefits society through new enterprise and innovation, allowing for technological advancements and the creation of new jobs. The gig economy calls for workers to be flexible, independent, risk-takers, and to embody a variety of other skills. These skills are similar to those that entrepreneurs possess, in terms of the characteristics they embody. Dell Technologies (2018) forecasts that 85 percent of the jobs in 2030 have not been invented yet, posing entrepreneurship as a viable and worthwhile option for new workforce entrants.

Entrepreneurship encourages autonomy and self-sufficiency in the economy. As such, entrepreneurship education has become more prevalent in formal education settings. Whereas 15 years ago, merely a handful of universities offered entrepreneurship education, over 1,500 universities to date offer entrepreneurship education (Dell, 2018). Entrepreneurship education is

seen as an applied approach to learning business through enriching and integrative experiences, driving both critical thinking and decision-making skills (Charney & Libecap, 2000). Other advantages to entrepreneurship education include improved academic performance and school attendance, advancement of problem-solving capabilities, increased job readiness, among a variety of other positive attributes (U.S. Department of Labor, n.d.)

The Aspen Youth Entrepreneurship Strategy Group report (2008) that high school students who have exposure to entrepreneurship curricula have heightened leadership behaviors and increased interest in college and occupational aspirations generally. Although entrepreneurship education programs are prevalent in some communities, the majority of American youth have little to no access to such opportunities in their K-12 education. The Aspen Group suggests that in order to mitigate the U.S. high school dropout rate, entrepreneurship education should be taught as an engaging life skill. Entrepreneurship education trains youth to be responsible, allows them to invest in themselves and know they have options, and immerses them into real-life learning and risk taking. The Aspen group depicts that entrepreneurship education is helpful for students regardless of whether they take an entrepreneurial leap or simply adopt an entrepreneurial mindset. The Aspen group made various local policy recommendations, including introducing entrepreneurship in all schools; increased funding to support entrepreneurship teacher training, curriculum, and evaluation services; developing mentorship networks among schools, businesses, and community organizations. Several state and federal policy recommendations were proposed as well, including: adopting state standards for entrepreneurship education particularly within educational statutes, creating formal partnerships among K-12 and postsecondary institutions, expanding funding for entrepreneurship

within the Department of Labor, creating an Office of Entrepreneurship Education, and adding entrepreneurial literacy to the President's Council on Financial Literacy (Aspen).

The need for entrepreneurship education is prevalent across literature, from the need to create opportunities for creativity, innovation, and collaboration within schools, to the learning power of ownership and grit (Barber, 2014; Mariotti, 2012). Rosen (2014) describes how entrepreneurship education is important to youth generally but more specifically disadvantaged students. The argument coming from research that indicates that students with underprivileged backgrounds are more willing to take risks and have higher economic motivation (Rosen, 2014). Mariotti (2012), the founder of the National Foundation for Teaching Entrepreneurship (NFTE), echoes this sentiment by describing how students from low socioeconomic backgrounds become excited for school when they learn how they can participate in the economy at a personal level while risk taking. In addition to risk taking, students learn to identify problems, which takes problem solving even further by putting ownership back into the hands of the students (Barber, 2014).

In an effort to ensure math classes depict real-world problems and context, Evanston Township High School has developed two math and CTE integrated classes, Geometry in Construction and Algebra in Entrepreneurship (Witt, 2015). The class is taught by a CTE entrepreneurship instructor and an Algebra I instructor. Entrepreneurship and mathematics are both educational areas that show great potential within the economy, in addition to posing many contextual linkages through integrated education. In a study comparing students in integrated math classes and students in tradition math classes, researchers found that students within integrated math classes outperformed students in traditional classes through three outcome measures (Grouws et al., 2013). However, limited research has been conducted on whether these

connections across content areas can occur across classes that are not integrated but occur simultaneously.

This study is designed to investigate whether students concurrently enrolled in an entrepreneurship class and Algebra II outperformed students who merely took algebra, with respect to growth between their pre-and post-test in algebra. This literature review was organized to provide context to mathematical achievement in the U.S. and the relevant variables associated with such achievement. Additionally, this literature review included context on the prior literature on math and CTE. Finally, this literature review described the importance of entrepreneurship and the potential relationship to mathematics. The following chapter (Chapter III) will describe the sample and reach methodology.

CHAPTER III

Methodology

The intent of this study was to determine whether there was a correlation between student mathematics scores and enrollment in an entrepreneurship class. Entrepreneurship classes are often offered within a given business or marketing CTE program. These classes are available to students in schools that offer entrepreneurship as an elective. Conversely, Algebra I and Algebra II are often taken to fulfill high school graduation requirements pertaining to mathematics. This chapter describes the procedures and methods used to conduct this research study. This chapter provides an overview of the sample, research design and rationale, and threats to validity. The statistical technique used, propensity score matching (PSM), and the data collection methods are also addressed within this chapter.

Research Design and Rationale

Within educational settings are the elements of strong experimental research design, albeit it is often difficult to implement true experiments. This study was set up as a quasi-experimental design to assess the effects of entrepreneurship class enrollment on mathematical student performance. The quasi-experimental design was used because students cannot be randomly placed into an entrepreneurship class, as they are considered electives. Because students opt into these classes but could still be matched to similar peers through pre-test scores, demographic variables, and enrollment variables, this study is best suited as a quasi-experimental design. The primary independent variable was a binary variable (treatment variable), of entrepreneurship class enrollment, while the primary dependent variable was a continuous variable, mathematics performance growth. The study was based on post-test scores obtained for mathematics achievement in Algebra I (predictor variable) and Algebra II (dependent variable).

Three major controls of the study include: 1) All participants took their districts' mathematics pre- and post-test, 2) All participants did not have any attendance concerns in both the mathematics and entrepreneurial classes they were enrolled in, and 3) Analyses were conducted at the district level to ensure pre- and post-tests were the same.

Variables collected and used in the analysis include race; gender, socioeconomic status (SES) based on free and reduced lunch (FRL) data, English proficiency based on English language learner (ELL) data, special education status based on whether they have an individualized education plan (IEP), mathematics pre-test of proficiency (Algebra I score), mathematics post-test of proficiency (Algebra II score); number of AP or honors classes the student is enrolled in, and whether they have taken three or more classes in a CTE concentration (CTE concentrator). The classroom level variables of teacher effect and learning environment will be the number of years of mathematics teaching experience of the instructor and the school effect variable will include school staffing ratio.

In research that studies teachers and school impacts, hierarchical linear models (HLM) are often used. HLM is a form of ordinary least squares (OLS) regression that assesses multilevel data, such as a student within a classroom, within a school, and/or within a district. The students in each classroom share variance based on the common classroom environment and teacher. However, only a select group of said students within any given mathematics class will be dually enrolled in an entrepreneurship class, in some cases a math class may not have any dually enrolled students. A typical HLM study would capture the classroom level effects; however, the intent of this study was not to measure based on the common environment or the common teacher but rather specific students within that cohort. Because the researcher was interested in studying individual-level effects for each student who was dually enrolled in mathematics and

entrepreneurship, the researcher utilized propensity score matching (PSM) to estimate treatment effects. Because teacher effect and classroom environment have an impact on individual-level effects, the researcher included the aforementioned teacher level and classroom level variables for matching. To account for the wide variation amongst individual participants, as the researcher could not assign both the control and treatment to each person and make that sort of comparative, the researcher used a propensity score matching mechanism to align similar students across the various locations to make reliable inferences.

Statistical Method

Randomized controlled trials (RCTs) are considered the golden standard for estimating treatment effects. However, much research in education does not involve randomization of subjects into control and treatment groups, thus non-experimental and observational studies are more commonplace (Stanovich & Stanovich, 2003). In observational studies, the treatment selection is influenced by the characteristics of the subjects, in this case the decision to enroll in an entrepreneurship course was based on the characteristics of the individual students. Therefore, differences among the treatment and control groups are not randomized.

Ordinary least squares (OLS) regression, although the most common statistical method for linear models, contains seven underlying assumptions that primarily pertain to the error term in a model. A key assumption is that the model is linear in both the coefficient estimates as well as the error term, where the model represents the relationship between the mean of the dependent variable and all the independent variables. This can cause issues when the distribution of the independent variables varies widely between the treatment and control groups (Albert, 2016).

The researcher considered the OLS regression results as a preliminary step to obtain contextual information on each covariate used prior to conducting a matching method, more

specifically propensity score matching (PSM). Propensity score matching (PSM) uses an average of the outcomes of similar subjects (students) to estimate the treatment effect on those treated and to estimate the missing potential outcomes for each untreated subject through counterfactual estimation (Littnerova et al., 2013). PSM reduces the impact of confounding variables among other advantages described in the next sections (Littnerova et al., 2013).

Matching Methods

There are four common matching methods that are often used, one being propensity scores. With each method comes limitations and considerations regarding bias and variance (Bryson et al., 2002). The radius matching method is also based on the nearest neighbor principle, albeit it imposes a threshold level. The threshold limits the number of potential matches but simultaneously reduces the risk of bad matches. The kernel matching method uses weighed averages to estimate the counterfactual results. Although the kernel method uses more information, it also comes with the risk of bad matches. Stratification is also considered interval matching, as intervals divide the dataset by a specific variable, match students within the intervals, and requires a large dataset. Stratification has been found to reduce the bias of confounding variables (Rosenbaum & Rubin, 1983). The nearest neighbor (NN) matching method is used most often and matches treated (having taken the entrepreneurship class) and untreated students based on the closest propensity score with potential overlap where two students from the treatment group may be matched with the same student in the non-treatment group. However, a STATA function can eliminate replacement, in which case no overlap would occur.

Propensity Score Matching

In STATA 14.2 the teffects psmatch command determines how near subjects are to each other by using estimated treatment probabilities (propensity scores). PSM does not need bias correction as it matches on a single continuous covariate. Students (subjects) were matched based on their likelihood to participate in the treatment (enrolling in an entrepreneurship class) using the rest of the covariates. The PSM estimator parameterizes the bias-correction term in the model for treatment probability (STATA manual, n.d.) and was used in conjunction with the nearest neighbor matching method in this analysis.

There are several advantages to using propensity score matching (PSM) over traditional regression analysis (Baser, 2007). PSM can allow for observational studies to mimic randomized control trials, by not involving outcome variables in the initial matching process. Comparatively, regression analysis uses the outcome variable, which should not be available during randomization. Confounding by treatment variables is a main issue in the validity of regression analyses, while in PSM the matching focuses on the treatment variable of interest. Another advantage is that matched analyses, generally, can eliminate non-comparable subjects. Regression sometimes relies on extrapolation when data do not overlap between the treatment and control groups. Matching aims to balance the distribution of covariates by depicting the non-overlapping data. These, among other factors, make researchers who work with retrospective data more inclined to use propensity score matching (Baser, 2007).

Propensity scores represent the subjects', in this case the students', probability of belonging to the same comparable population based on their demographic and descriptive characteristics (covariates). Propensity score matching results in two statistical results, the Average Treatment Effect on the Treated (ATET) and the Average Treatment Effect (ATE). The

Average Treatment Effect on the Treated (ATET) depicts the average effect of the treatment on math outcomes in the treated group specifically, students who took an entrepreneurship course. The Average Treatment Effect (ATE) depicts the average effect of the treatment on math outcomes if the treatment was given to the entire population in the sample, the entire Algebra II student population.

Propensity scores are created without taking the treatment outcome, in this case the Algebra II post-test score, into account. The baseline characteristics, which are the independent variables, are used to determine the likelihood for treatment itself, in this case the likelihood that a student would enroll in an entrepreneurship class. Once a propensity score is created for each student (subject) in each group and students are 'matched' across the treatment and control groups, the researcher can see if there are many unmatched students (Austin, 2011). Unmatched students would indicate that there are large differences in the baseline characteristics of the two groups that are not accounted for within the independent variables (Austin, 2011). This could also indicate that the differences are too large between the groups to assess the meaning, or efficacy, behind the treatment outcome.

According to Rosenbaum and Rubin (1983), a propensity score is the "conditional probability of assignment to a particular group, given a vector of covariates" (p. 41). Propensity score matching techniques are typically used with single-level data and although the data in this study are multilevel, the researcher used both teacher effects and school effects as variables within the propensity score matching. There are two major steps in creating a propensity score. The first step is to estimate the propensity score through logistic regression. This is done to ensure balanced groups and to assess individuals based on covariates. The closer participants' scores are, the more inferences can be made of how the intervention truly affected, or did not

affect, the individuals. The second step is to estimate the treatment effect by incorporating the estimated propensity score, which is done through weighting, stratification, regression using propensity score as a predictor, or matching (Schuler et al., 2016). However, STATA 14.2 allows for these two steps to occur through one function, the teffect psmatch command.

Estimated Treatment Effects

The goal was to estimate the average treatment effect of taking an entrepreneurship class on mathematical outcomes (Average Treatment Effect on the Treated) and the average treatment effect if a student were to take an entrepreneurship course on mathematical outcomes (Average Treatment Effect). As compared to linear regression, the key assumption in to interpret the differences in outcomes between the treatment and the control group as a casual effect is that the outcome of the control group, of mathematics performance growth, is independent of the treatment itself, of taking an entrepreneurship class, conditional on a derived propensity score, conventionally denoted as e_i (between 0 and 1).

Let $\{Y_i, Z_i, X_i; i = 1, 2, \ldots, n\}$ denote independent and identically distributed data from n subjects, where Y_i is the continuous outcome variable (Algebra II post-test scores), Z_i is the treatment variable of taking entrepreneurship ($Z_i = 1$ if treated and $Z_i = 0$ if control), and X_i is the vector of baseline covariates. The potential outcome framework, sometimes referred to as Rubin's causal model (Rubin, 1986) states that for subject i, there exists a pair of potential outcomes: Y_{0i}, which is the outcome if the subject were to be assigned to the control group, and Y_{1i}, which is the outcome if the subject were to be assignment to the treatment group. However, only one of these potential outcomes is observed in reality, being Y_i:

$$Y_i = Z_i Y_{1i} + (1 - Z_i) Y_{0i}.$$

The casual effect at the individual level, Δ_i, is defined as the difference between the pair of potential outcomes:

$$\Delta_i = Y_{1i} - Y_{0i}.$$

Randomization ensures that between the treatment and control group, the baseline covariate differences exist only by chance. However, observational studies such as this one, are prone to lack of randomization. To mitigate this problem, Rosenbaum and Rubin (1983) developed the propensity score concept (e_i).

$$e_i \equiv e(X_i) = Pr(Z_i = 1|X_i).$$

Therefore, averaged treatment effect (ATE), denoted as Δ, is the expected difference between subjects with the same value of propensity score but different treatments:

$$\text{ATE} = E[\Delta_i] = E_e\{E[Y_i(1) - Y_i(0)|e_i]\}$$

$$= E_e\{E[Y_i(1) - Y_i(0)|Z_i, e_i]\}$$

$$= E_e\{E[Y_i(1)|Z_i, e_i] - E[Y_i(0)|Z_i, e_i]\}$$

$$\text{ATE} = E_e\{E[Y_i|Z_i = 1, e_i] - E[Y_i|Z_i = 0, e_i]\},$$

where E_e, the outer expectation, denotes the expectation with respect to the distribution of the propensity score (e_i) in the entire population. The average treatment effect on the treated (ATET), conversely, is the difference between the outcomes of the treated subjects and the outcomes of the treated subjects had they not been treated:

$$\text{ATET} = E_e\{E[Y_i|Z_i = 1, e_i] - E[Y_i|Z_i = 1, e_i]\},$$

where the second term, the outcome had they not been treated, is a counterfactual, so it is not observed and needs to be estimated (Cameron & Trivedi, 2005).

Assumptions of Propensity Scores

To find valid casual estimation through propensity score matching, three assumptions are assumed:

1. The stable unit treatment value assumption (SUTVA) indicates that an observation on one unit should not be affected by the particular assignment of treatments to the other units (Rubin, 1986).
2. The assumption of strong affordability or confoundedness, which specifies that conditional on the propensity score, the potential outcomes are independent of the treatment assignment and there is no organized difference between the treatment and control groups (McMurry et al., 2015).
3. The overlap assumption, which indicates that the distributions of propensity scores range between 0 and 1 where each subject can potentially receive treatment or not (Hansen, 2017).

Sample Overview

The sample used in this study was a sample from school districts across the Mid-Atlantic area of the United States, that offered entrepreneurship, alongside Algebra II, and were willing to participate. The non-treatment population consisted of secondary students within the same school districts enrolled in an Algebra II class without being in an entrepreneurship class. The treatment group consisted of students who were dually enrolled in an entrepreneurship class and Algebra II. Students in this study were protected with de-identified data by obtaining datasets that only used student ID numbers rather than names. Additionally, no contact information was collected. Students who were enrolled in an entrepreneurship class and a different math class were not included as part of this study. The IRB for this project was reviewed and approved prior to the

start of this study to ensure participant protection. A copy of the IRB approval is provided in Appendix A.

Each district develops their own requirements for enrolling in an entrepreneurship class, in addition to the sequence in which students take their required mathematics classes. In the districts utilized for this study, students were required to take Algebra II as part of their high school requirement. However, these districts varied in their requirements for when students could take an entrepreneurship class, with some barring students from taking the class in their first year of high school. The approvals by each school district can be found in Appendix B and Appendix C.

Threats to External and Internal Validity

The generalizability of findings may be limited due to the specific districts (locations) that participated in this study. To allow for similar curriculum and academic standards, in addition to controlling for district level variables, the researcher conducted within-district analyses rather than across district. This limits the generalizability of the findings, particularly as there are only two districts participating in this study. Because these districts have opted to participate, they are considered volunteers and not randomly selected.

There are various threats to internal validity, including potential selection bias and history. Selection bias is noted due to the motivation of students who enroll in an entrepreneurship class potentially being different than students who opt for alternate electives. Historical events outside of the study are bound to play a role over the period of the study. Facets such as political changes, economic changes, after-school support, activities, etc., can all impact the level to which a student actively participates within their classwork. Another threat to validity was confounding variable bias, which was mitigated by using pre-test scores. A

confounding variable is a variable that correlated to the dependent variable and the main independent variables.

Ways to mitigate such threats to validity include restriction, matching, or randomization. In this study, the researcher used propensity score matching to alleviate said threats in addition to using pre-test scores to reduce confounding variable bias. Repeated testing in this study should not appear biased because the post-assessment is similar to the pre-assessment in terms of concepts and standards but is not an identical test.

Summary

This chapter outlined the research design and methodology of this study. Random assignment of students in elective class selection is inevitably unheard of in public education spaces, thus making this study quasi-experimental. All variables collected were based on the literature and their correlation with math proficiency. In the case where some variables that had an impact on math were unable to be collected(e.g., family dynamics, trauma, etc.), pre-test scores were collected to mitigate. A propensity score matching method was described in this chapter that provides each student in the control group and each student in the experimental group a number, centered on every variable collected. Based on these numbers, students that have similar numbers across the two groups are compared since their variables indicate a likeness, aside from the entrepreneurship enrollment. The following chapter (Chapter IV) will describe the data obtained and results of the study.

CHAPTER IV

Findings

This chapter will describe the data collection and statistical analyses conducted through School District One and School District Two. The purpose of this quasi-experimental study was to examine whether participation in an entrepreneurship class was related to mathematical proficiency (Algebra II) in high school. This problem was studied to inform school districts on how to potentially improve mathematical proficiency among students through contextual learning, while allowing for increased exposure to entrepreneurship education. The outcomes of this study are presented within this chapter. Based on the literature on contextual learning, the study was centered on the following hypotheses:

Hypothesis 1. There is a positive relationship between participation in entrepreneurship education and mathematical proficiency of high school students.

Hypothesis 2. There is a positive relationship between proficiency of entrepreneurship education and mathematical proficiency of high school students.

School District One Findings

Descriptive Statistics, Response Rate, and Data Screening: School District One

Through this quasi-experimental study, data were collected on 2,741 students across a sample of 12 schools within School District One, a large school district in the Mid-Atlantic region of the United States. The sample was reflective of 2,741 Algebra II students, of which 121 students (four percent) took at least one entrepreneurship class, herein known as the treatment group. When there are missing data, STATA automatically omits the subject from regression and matching analyses. Thus only 2,719 students were used in the propensity score analysis (121 entrepreneurship students).

Of the 121 entrepreneurship students, 14 students took two or three entrepreneurship-related classes although this was not considered as part of the model due to collinearity with the entrepreneurship variable itself. Entrepreneurship-related classes included various courses within the Entrepreneurship and Business Academy pathway (Entrepreneurship Accounting, Incubator, Corporate Finance, Business Law, and Intro to Entrepreneurship), in addition to Entrepreneurship, Advanced Entrepreneurship, Accounting, and Economics and Personal Finance. This list of classes was provided by School District I and all of the aforementioned classes were considered entrpenuship classes for this study. Thus 2,620 students (96 percent) in the sample took Algebra II but not entrepreneurship. Descriptive statistics of the entire sample are presented in Table 2 and descriptive statistics of the control group and the treatment group are presented in Table 3.

Table 2

School District One: Descriptive Statistics of Entire Sample

Variable	Number of Observations	*M*	*SD*	Min	Max
Entrepreneurship	2,741	0.0441	0.2054	0.0	1.0
Algebra II Score	2,741	453.2984	43.9001	302.0	600.0
Math Teacher Years of Experience	2,719	16.7797	11.0048	0.0	47.0
Teacher Ratio	2,741	15.2969	0.9078	12.0	16.0
Algebra I Score	2,741	458.7647	42.0912	354.0	600.0
Gender	2,741	0.4564	0.4981	0.0	1.0
Free and Reduced Lunch	2,741	0.2422	0.4285	0.0	1.0
Race - Asian	2,741	0.0850	0.2789	0.0	1.0
Race - Black	2,741	0.1473	0.3545	0.0	1.0
Race - Hispanic	2,741	0.0893	0.2853	0.0	1.0
Race - White	2,741	0.5822	0.4932	0.0	1.0
Special Education	2,741	0.0164	0.1270	0.0	1.0
Race - Other	2,741	0.0959	0.2945	0.0	1.0
AP and Honors	2,741	1.6846	0.9963	0.0	5.0
CTE Concentrator	2,741	0.0510	0.2201	0.0	1.0

Table 3

School District One: Descriptive Statistics of Non-Entrepreneurship Students and Entrepreneurship Students

Non-Entrepreneurship Students

Variable	Number of Observations	*M*	*SD*	Min	Max
Algebra II Score	2,620	453.5477	44.18991	302.0	600.0
Math Teacher Years of Experience	2,599	17.28396	10.85921	0.0	47.0
Teacher Ratio	2,620	15.30382	0.924025	12.0	16.0
Algebra I Score	2,620	458.6092	42.01286	354.0	600.0
Gender	2,620	0.457252	0.498264	0.0	1.0
Free and Reduced Lunch	2,620	0.241603	0.428137	0.0	1.0
Race - Asian	2,620	0.085115	0.279105	0.0	1.0
Race - Black	2,620	0.145038	0.352207	0.0	1.0
Race - Hispanic	2,620	0.08855	0.284147	0.0	1.0
Race - White	2,620	0.585878	0.492664	0.0	1.0
Special Education	2,620	0.016794	0.128523	0.0	1.0
Race - Other	2,620	0.09542	0.29385	0.0	1.0
AP and Honors	2,620	1.669656	1.002734	0.0	5.0
CTE Concentrator	2,620	0.04313	0.203188	0.0	1.0

Entrepreneurship Students

Variable	Number of Observations	*M*	*SD*	Min	Max
Algebra II Score	121	447.9008	36.8167	367.0	585.0
Math Teacher Years of Experience	120	5.8583	8.1108	1.0	34.0
Teacher Ratio	121	15.1487	0.4012	14.0	16.0
Algebra I Score	121	462.1322	43.8001	398.0	600
Gender	121	0.4380	0.4982	0.0	1.0
Free and Reduced Lunch	121	0.2561	0.4383	0.0	1.0
Race - Asian	121	0.0826	0.2764	0.0	1.0
Race - Black	121	0.1983	0.4004	0.0	1.0
Race - Hispanic	121	0.1074	0.3109	0.0	1.0
Race - White	121	0.5041	0.5020	0.0	1.0
Special Education	121	0.0082	0.0909	0.0	1.0
Race - Other	121	0.1074	0.3109	0.0	1.0
AP and Honors	121	2.0082	0.7825	0.5	3.5
CTE Concentrator	121	0.2231	0.4180	0.0	1.0

The Algebra I and II test results were based on standardized testing within the district, via a state assessment for Algebra I and Algebra II. The Algebra I post-test scores ranged from 354 to 600 with a mean score of 459 and a standard deviation of 42 points. Conversely, the Algebra II post-test scores ranged from 302 to 600 (*M* = 454, *SD* = 44), depicting there was a wider range of scores in Algebra II.

In terms of some of the demographic variables, gender was coded as a binary variable (0 = female, 1 = male) with this sample including 1,490 female students (54 percent) and 1,251 male students (46 percent). A binary variable was created for each race variable (0 = not of that race, 1 = of that race) and the sample was representative of 1,596 White students, 404 Black students, 245 Hispanic students, 233 Asian students, and 263 students who identified as Native American, Pacific Islander, Hawaiian, two or more races, or other (all classified as 'other' in this analysis). The Hispanic variable was excluded from the regression and propensity score model through an automatic default of STATA due to perfect collinearity with the other race variables. When categorical variables are used, K-1 dummy variables should be used as one of the dummy variables can be explained as a linear combination of others set to "0" (UCLA, 2016).

Of the 2,741 students in the sample, 2,077 (76 percent) did not qualify for free and reduced lunch (FRL) while 664 (24 percent) did qualify. In terms of specialized populations, there were seven English Language Learners (ELL), albeit no ELL students were also in an entrepreneurship class thus the ELL variable was excluded from the propensity score model. Another specialized population is students with individualized education plans (IEPs) who are considered to be Special Education (SPED) students. There were 45 SPED students (less than two percent) in the sample. The Career and Technical Education (CTE) concentrator variable was also a binary variable (0 = student is not a CTE concentrator, 1 = student is a CTE

concentrator). The descriptive statistics show that 140 students (five percent) of the sample were considered CTE concentrators. To be considered a CTE concentrator, students need to have at least three classes in a specific CTE area. The number of honors or Advanced Placement (AP) classes taken is an ordinal variable, ranging between 0 and 5.0 within this sample. Each honors class taken was worth 0.5 credits and each AP class was worth 1.0 credit. Thus, a student enrolled in 1.5 credits could have been enrolled in three honors classes or could have been enrolled in one AP class and one honors class. The mean level of AP and/or honors class taking within the sample was 1.6 credits. Table 4 depicts the frequencies of AP and honors class taking.

Table 4

School District One: Frequency Table: AP & Honors

AP and Honors	Freq.	Percent	Cum.
0.0	302	11.02	11.02
0.5	265	9.67	20.69
1.0	354	12.91	33.60
1.5	495	18.06	51.66
2.0	389	14.19	65.85
2.5	506	18.46	84.31
3.0	343	12.51	96.83
3.5	69	2.52	99.34
4.0	13	0.47	99.82
4.5	4	0.15	99.96
5.0	1	0.04	100.00
Total	2,741	100.00	

The classroom and school-level variables include the math teacher's years of experience and the school's staffing ratio. In terms of teacher experience, teachers within this sample ranged between 0 and 47 years of experience, with 0 representing first year teachers who had not completed a full year at the time of the Algebra II assessment. The mean number of years of

experience was 17 years while the median was 16 years. Table 5 depicts the frequencies of math teacher years of experience.

Table 5

School District One: Frequency Table: Math Teacher Years of Experience

Math Teacher Years of Experience	Freq.	Percent	Cum.
0	96	3.53	3.53
1	85	3.13	6.66
2	189	6.95	13.61
3	90	3.31	16.92
4	48	1.77	18.68
5	34	1.25	19.93
6	134	4.93	24.86
8	1	0.04	24.9
9	191	7.02	31.92
11	115	4.23	36.15
12	80	2.94	39.1
13	36	1.32	40.42
15	227	8.35	48.77
16	34	1.25	50.02
17	60	2.21	52.23
18	172	6.33	58.55
20	55	2.02	60.57
21	107	3.94	64.51
22	5	0.18	64.69
23	249	9.16	73.85
24	28	1.03	74.88
25	147	5.41	80.29
26	42	1.54	81.83
27	1	0.04	81.87
28	31	1.14	83.01
29	70	2.57	85.58
32	71	2.61	88.19
33	143	5.26	93.45
34	87	3.20	96.65
35	1	0.04	96.69
41	87	3.20	99.89
47	3	0.11	100
Total	2,719	100.00	

The school staffing ratio was the number of students per school staff number. Schools with higher ratios of students to staff are often stretched in terms of resources and capacity. Among the schools in this sample, the range was between 12 and 16 students for every one staff member, with over half of the schools having a school staffing ratio of 16:1. This school district's staffing ratio was not considered problematic, based on research that indicates student to teacher ratios of 18:1, or less, is optimal for academic success (Barrington, 2018).

Regression and Propensity Score Matching - Hypothesis 1: School District One

OLS Regression: School District One

Two tests for normality were conducted for this analysis, the Shapiro Wilk test prior to running the OLS model, which indicated the non-binary variables were not normally distributed, and the Jarque-Bera test for skewness and kurtosis after running the OLS model, which indicated that the residuals were not normally distributed (Table 6). Even after using logged variables, the distributions were not normally distributed. Although having non-normally distributed data does not hinder analysis, it is still important to check data distributions to better understand data (Kim, 2015). The OLS regression output is available in Table 7 and illustrates several predictors for the dependent variable (Algebra II post-test scores). Tests for multicollinearity (variance inflation factor) and heteroskedasticity were conducted, with robust standard errors being utilized to limit the heteroskedasticity, as part of the regression. As indicated in the prior section, the Hispanic variable was excluded due to collinearity with the other race variables.

Table 6

School District One: Tests for Normality

Shapiro-Wilk W Test for Normal Data					
Variable	Number of Observations	*W*	*V*	*z*	Prob > *z*
Algebra II Score	2,741	0.968	50.016	10.065	0.00
Math Teacher Years of Experience	2,719	0.971	44.732	9.775	0.00
Teacher Ratio	2,741	0.947	83.486	11.383	0.00
Algebra I Score	2,741	0.942	90.090	11.578	0.00
AP and Honors	2,741	0.987	20.150	7.726	0.00
CTE Concentrator	2,741	0.986	21.809	7.929	0.00
Skewness/Kurtosis Tests for Normality					
Variable	Number of Observations	Pr(Skewness)	Pr(Kurtosis)	adj $X^2(2)$	Prob > X^2
Residual	2,719	0.002	0.000	45.120	0.00

The overall model was significant (at the 0.001 level) and the variables explained 43.11 percent of the variance in the Algebra II post-test scores (based on the R^2 statistic). Of the variables included, the Algebra I post-test score, the Asian race variable, the number of AP and/or honors classes taken, the math teacher years of experience, and the teacher staffing ratio within the school were all significant ($p < 0.001$). The entrepreneurship class enrollment variable, the primary independent variable (the treatment) was significant ($p < 0.05$).

Of the significant variables, the coefficients generally matched what prior literature has indicated (see Chapter II). The primary variable of interest, entrepreneurship enrollment, depicted a negative coefficient, indicating that students who took an entrepreneurship course saw

Table 7

School District One: OLS Regression (All Variables)

Linear regression				Number of Observations =		2,719
				F (13, 2,705) =		121.600
				Prob > F =		0.000
				R^2 =		0.431
				Root MSE =		33.083
Dependent Variable: Algebra II Score	Coef.	Robust Std. Err.	t	P > | t |	[95% Conf. Interval]	
Entrepreneurship	-6.5010	2.9741	-2.18	0.029	-12.3291	-0.6655
Math Teacher Years of Experience	0.2890	0.0613	4.75	0.000	0.1708	0.4114
Teacher Ratio	-2.9408	0.7219	-4.08	0.000	-4.3637	-1.5327
Algebra I Score	0.5569	0.0191	29.07	0.000	0.5192	0.5943
Gender	0.6484	1.3018	0.51	0.618	-1.8946	3.2106
Free and Reduced Lunch	-2.5384	1.5770	-1.60	0.108	-5.6138	0.5707
Race - Asian	12.6136	3.0318	4.18	0.000	6.7254	18.6152
Race - Black	0.6024	2.7330	0.20	0.826	-4.8091	5.9089
Race - Hispanic	0.0000	(omitted)				
Race - White	2.3748	2.3339	1.02	0.309	-2.2068	6.9462
Special Education	-4.8800	5.1599	-0.96	0.345	-15.0509	5.1846
Race - Other	2.1587	3.0597	0.70	0.481	-3.8693	8.1300
AP and Honors	7.1340	0.7615	9.33	0.000	5.6106	8.5970
CTE Concentrator	-3.0317	2.7403	-1.09	0.269	-8.3666	2.3799
Constant	223.9918	13.9920	16.02	0.000	196.7759	251.6480

a decline in their Algebra II post-test score. However, there are various limitations of OLS regression thus a propensity score matching model was conducted using these variables. The OLS results were reported to provide context on the overall model and model variables. However, there are several advantages to using propensity score matching (PSM) over traditional regression analysis as previously indicated, through mimicking randomized control trials, mitigating confounding by the treatment variable, and eliminating non-comparable subjects rather than extrapolating (Baser, 2007).

The OLS regression resulted in a coefficient for the Algebra I post-test score of 0.55 ($p < 0.001$). As a continuous variable, this indicates that for every one-point increase in a student's Algebra I post-test score, their Algebra II post-test score is estimated to increase by 0.55 points, ceteris paribus. This depicts one of the inherent limitations of OLS regression, the assumption of linearity (Baser, 2007). If a student scored perfectly, or close to it, on the Algebra I post-test, it would not be possible to exceed the maximum score of 600 on the Algebra II post-test. Thus, Algebra I as a predictor variable may have an exponentially rising slope or a marginally declining slope, but a stagnant coefficient does not make practical sense when it comes to student test outcomes, particularly as one cannot hold all other variables constant. This, among other factors, provides the base rationale for using propensity score matching.

The OLS regression resulted in a coefficient for the Asian race variable of 12.61 ($p < 0.001$). As a binary variable, this indicates that if a student was Asian, their Algebra II post score increased by 12 points compared to their peers of other races, ceteris paribus.

The OLS regression resulted in a coefficient for the number of AP and/or honors classes taken of 7.13 ($p < 0.001$). This variable ranged from 0 points (no AP or honors classes) to 5.0 points (could be five AP classes or a combination of AP and honors classes). Each AP class is

equivalent to 1.0 point and each honors class is equivalent to 0.5 points, within this variable. Thus, an increase of one credit results in an additional seven points on an Algebra II post-test score.

The OLS regression resulted in a coefficient for the math teacher years of experience of 0.28 ($p < 0.001$). This variable ranged from 0 years of experience (new teacher) to 47 years. The result indicates that for every year of additional teaching experience a math teacher has, students would see an increase in their Algebra II post-test score by 0.28 points.

The OLS regression resulted in a coefficient for the teacher staffing ratio within the school of -2.94 ($p < 0.001$). Across the 12 schools within the sample, the student to staff ratio for each school ranged between 12:1 to 16:1. As the number of students per staff member rises, staff resources are stretched across a wider subset of students. These results depict that an increase of one to the ratio at a specific school leads to a decrease in Algebra II post-test scores by 2.9 points for an individual student, ceteris paribus.

OLS regression is limited in several ways (Albert, 2016), one of which being the inherent assumption that the data are linear when, in reality, they are not. Due to the limitations in linear regression, a propensity score matching (PSM) method was also used and is analyzed in the following section.

Propensity Score Matching (Using All Variables): School District One

Propensity score matching (PSM) matches subjects based on covariates to determine two main statistics, the average treatment effect (ATE) and the average treatment effect on the treated (ATET). Using the average of outcomes of similar students, in this case, the PSM imputes the missing potential outcome for each student, which is the ATE. The ATE is derived by taking the average of the difference between the observed and potential outcome for each student (STATA

manual, n.d.). Using the *teffects psmatch* command in STATA allows for propensity scores to be derived for each student, matching them across the control and treatment groups based on their estimated likelihood of treatment, in this case their likelihood to enroll in an entrepreneurship class based on all the covariates in the model. Because the PSM matched the students on a single continuous covariate, there is no bias correction needed as the estimator parameterizes the bias-correction term in the treatment probability model (STATA manual, n.d.). This subsequently mitigates the bias in the calculation of the ATE and ATET (Frisco et al. 2007).

Although only six variables were significant (at the 0.001 and 0.05 levels) in the OLS regression, all the original variables were included in the matching portion of the PSM to estimate the ATE and ATET. Table 8 shows the results of the ATE and ATET.

The ATE depicts how the entire sample would fare if they were to have taken the treatment; in this case, how all Algebra II students would have done if they had taken entrepreneurship. The ATE had a coefficient of 13.15 ($p < 0.001$) and the 95 percent confidence interval was between 2.78 and 23.52 (results in Table 8). These results depict that after matching students on all the independent variables, and using entrepreneurship enrollment as the treatment, the average Algebra II post-test score would increase by approximately 13 points had everyone participated in entrepreneurship. However, when analyzing the ATET, the results were not significant and thus inconclusive on whether entrepreneurship made a meaningful change to the Algebra II scores of the students who actually took an entrepreneurship course (Table 8).

Table 8

School District One: ATE and ATE – Using All Variables

Treatment-effects estimation	Number of Observations =					2,719
Estimator: propensity-score matching	Matches: requested =					1
Outcome model: matching	min =					1
Treatment model: logit	max =					5

Algebra II Score	Coef.	AI Robust Std. Err.	*z*	P > | *z* |	[95% Conf. Interval]	
Average Treatment Effect (ATE)						
Entrepreneurship (1 vs 0)	13.1545	5.2926	2.49	0.013	2.7811	23.5279
Average Treatment Effect on the Treated (ATET)						
Entrepreneurship (1 vs 0)	-1.417	5.986	-0.24	0.813	-13.1506	10.3156

Covariate Balance: School District One

Table 9 depicts the covariate balance by comparing the treatment and matched control groups for every variable used within this analysis. Based on the comparative mean differences across the two groups (Cohen's *d*), the standard deviations should be less than 0.25 units apart to be considered balanced (Stuart, 2010). All the variables except for three met this criterion. The three variables that exceeded the 0.25-unit measure were math teacher years of experience, the CTE concentrator variable, and AP and/or honors class enrollment, as shown in the comparative descriptive statistics for the entrepreneurship students and non-entrepreneurship students (Table 3). Students who took an entrepreneurship course had math teachers with an average of five years of experience, while non-entrepreneurship students had math teachers with an average of 17 years of experience (d = 1.06). For CTE concentrators, 22 percent of the entrepreneurship students were CTE concentrators, compared to only four percent of the non-entrepreneurship

students (d = -0.82). The AP and/or honors variable is also unbalanced among the two groups, with entrepreneurship students taking an average of 2.0 AP and/or honors classes and non-entrepreneurship students taking an average of 1.6 AP and/or honors classes (d = -0.34).

Table 9

School District One: Covariate Balance

		Number of Observations per group:	
		Entrepreneurship=0	2,620
		Entrepreneurship=1	121
Effect Size (Cohen's *d*)	Estimate	[95% Conf. Interval]	
Algebra I Score	-0.08369	-0.26595	0.09857
Gender	0.03860	-0.14364	0.22085
Free and Reduced Lunch	-0.03405	-0.21630	0.14819
Race - Asian	0.00885	-0.17339	0.19109
Race - White	0.16578	-0.01652	0.34807
Race - Black	-0.15039	-0.33267	0.03190
Race - Hispanic	-0.06618	-0.24843	0.11607
Race - Other	-0.04079	-0.22303	0.14146
Special Education	0.06710	-0.11515	0.24935
AP and Honors	-0.34061	-0.52305	-0.15811
CTE Concentrator	-0.82914	-1.01263	-0.64550
Math Teacher Years of Experience	1.06249	0.87723	1.24757
Teacher Ratio	0.17087	0.01144	0.35315

Stepwise Regression: School District One

To limit issues with confounding variables, a stepwise regression was also conducted to better estimate the final propensity score matching. Table 10 depicts the results from the stepwise regression, which resulted in seven variables being selected. STATA includes all statistically significant variables that have a p value less than 0.1 within stepwise regressions. The overall model was significant ($p < 0.001$) and the variables explained 42.87 percent of the variance in the Algebra II post-test scores (adjusted $R^2 = 42.87$). The seven variables selected were all significant in the OLS regression (entrepreneurship enrollment, Algebra I post-test

score, math teacher years of experience, the Asian race variable, teacher staffing ratio, and AP and/or honors class enrollment) in addition to the free and reduced lunch variable ($p < 0.1$).

Propensity Score Matching (Using Stepwise Variables): School District One

The first hypothesis was that there was a positive relationship between participation in entrepreneurship education and mathematical proficiency of high school students. Based on the propensity score matching (PSM) process, the average treatment effect (ATE) and the average treatment effect on the treated (ATET) were computed. The ATE depicts the counterfactual estimated result of all students in the population if they were to take an entrepreneurship course. The ATET depicts the effect of the treatment applied to those treated. Through the propensity score matching, this resulted in an ATE with a coefficient of 15.81 ($p < 0.05$) and the 95 percent confidence interval between 4.48 and 27.15 (results in Table 11). These results depict that after matching students on the independent variables that were significant (through stepwise regression), and using entrepreneurship enrollment as the treatment, the estimated average Algebra II post-test score would increase by nearly 16 points had everyone participated in entrepreneurship. However, when analyzing the ATET, the results were not significant and thus inconclusive on whether entrepreneurship made a meaningful change to the Algebra II scores of the students who actually took an entrepreneurship course. These results are consistent with the propensity score matching analysis in Table 8.

Regression - Hypothesis 2: School District One

To evaluate the second hypothesis, which stated that there was a positive relationship between proficiency of entrepreneurship education and mathematical proficiency of high school students, an OLS regression was performed (Table 12). Taking just the students who participated in an entrepreneurship class, in conjunction with Algebra II (n = 121 students), a regression was

conducted to determine whether an increase in entrepreneurship grades was correlated to an increase in Algebra II post-test score. However, due to missing data in the math teacher years of experience variable, only 120 students were used in this analysis. As indicated in the prior section, STATA automatically omits a subject from the regression when there is missing data. Because students took between one to three courses within the Entrepreneurship and Business Academy pathway, a new variable was created that averaged entrepreneurship grades, which was the primary independent variable for this hypothesis. The range was limited in terms of grade range and thus logged variables were used for the entrepreneurship grade, the Algebra I grade and Algebra II grade, to allow for consistent interpretation. School District One was only able to provide grades based on letter grades (ranging between C- and A) and thus the researcher created a coding mechanism to quantify the grades (Table 13). This coding mechanism was based on an average based on several school districts in the mid-Atlantic region of the United States. This was due to the fact that grading scales vary across school districts and even across schools (Thompson, 2017).

Table 10

School District One: Stepwise Regression (Backwards Selection of Variables)

Begin with full model (all variables)
p = 0.8401 >= 0.1 removing Race - Black
p = 0.6091 >= 0.1 removing Gender
p = 0.4624 >= 0.1 removing Race - Other
p = 0.3624 >= 0.1 removing Special Education
p = 0.3169 >= 0.1 removing Race - White
p = 0.2949 >= 0.1 removing CTE Concentrator

Source	*SS*	*df*	*MS*		
Model	2237589.21	7	319655.601	Number of Observations =	2719
Residual	2964273.33	2711	1093.424	F (7, 2711) =	292.340
				Prob > F =	0.000
				R^2 =	0.430
Total	5201862.53	2718	1913.857	Adj R^2 =	0.428
				Root MSE =	33.067

Dependent Variable: Algebra II Score	Coef.	Std. Err.	t	P > | t |	[95% Conf. Interval]	
Entrepreneurship	-7.1604	3.1743	-2.26	0.024	-13.3849	-0.9360
Algebra I Score	0.5582	0.0171	32.62	0.000	0.5247	0.5918
Math Teacher Years of Experience	0.2952	0.0600	4.92	0.000	0.1774	0.4129
Free and Reduced Lunch	-2.9900	1.5412	-1.94	0.052	-6.0121	0.0321
Race - Asian	10.9169	2.2926	4.76	0.000	6.4215	15.4124
Teacher Ratio	-2.8582	0.7203	-3.97	0.000	-4.2707	-1.4458
AP and Honors	7.2993	0.7381	9.89	0.000	5.8518	8.7467
Constant	223.7834	13.4033	16.7	0.000	197.5010	250.0652

Table 11

School District One: ATE and ATET – Using Stepwise Regression Variables

Treatment-effects estimation	Number of Observations =					2,719
Estimator: propensity-score matching	Matches: requested =					1
Outcome model: matching	min =					1
Treatment model: logit	max =					10
Algebra II Score	Coef.	AI Robust Std. Err.	*z*	P > | *z* |	[95% Conf. Interval]	
Average Treatment Effect (ATE)						
Entrepreneurship (1 vs 0)	15.8165	5.7845	2.73	0.006	4.4785	27.1541
Average Treatment Effect on the Treated (ATET)						
Entrepreneurship (1 vs 0)	-6.050	5.841	-1.04	0.300	-17.4983	5.3983

Table 12

School District One: OLS Regression Results for Entrepreneurship Students Only

Source	*SS*	*df*	*MS*		
				Number of Observations =	120
Model	0.4082	13	0.0314	F (13, 106) =	9.330
Residual	0.3564	106	0.0033	Prob > F =	0.000
				R^2 =	0.533
Total	0.7650	119	0.0064	Adj R^2 =	0.476
				Root MSE =	0.058

Dependent Variable: Log Algebra II Score	Coef.	Std. Err.	*t*	P > | *t* |	[95% Conf. Interval]	
Average Log Entrepreneurship Grade	0.1153	0.0011	1.21	0.228	-0.0731	0.0303
Log Algebra I Score	0.5716	0.0636	8.96	0.000	0.4444	0.6970
Gender	-0.0072	0.0122	-0.57	0.557	-0.0312	0.0173
Free and Reduced Lunch	-0.0190	0.0139	-1.35	0.176	-0.0466	0.0087
Race - Asian	-0.0516	0.0264	-1.95	0.056	-0.1040	0.0009
Race - Other	-0.0111	0.0242	-0.47	0.646	-0.0593	0.0368
Race - Black	-0.0099	0.0215	-0.46	0.646	-0.0526	0.0328
Race - White	-0.0267	0.0198	-1.35	0.180	-0.0660	0.0125
Special Education	-0.0946	0.0626	-1.51	0.134	-0.2188	0.0296
AP and Honors	-0.0116	0.0082	-1.42	0.164	-0.0281	0.0046
CTE Concentrator	0.0235	0.0146	1.61	0.111	-0.0054	0.0527
Math Teachers Years of Experience	0.0039	0.0008	4.46	0.000	0.0021	0.0056
Teacher Ratio	-0.0129	0.0163	-0.79	0.430	-0.0453	0.0195
Constant	2.2978	0.4747	5.68	0.000	1.7540	3.6365

Table 13

Grading Scale Coding used for Analysis

Grade	Numerical Value
A	95
A-	92
B+	89
B	85
B-	82
C+	79
C	75
C-	72

The OLS regression output in Table 12 illustrates several predictors for the dependent variable (Algebra II post-test scores). Tests for multicollinearity and heteroskedasticity were conducted, with robust standard errors being utilized to limit the heteroskedasticity, as part of the regression. Due to low number of observations in the non-White race variables, only the White race variable was included. Additionally, the SPED and ELL student variables were also excluded for the same reason.

The overall model was significant ($p < 0.001$) and the variables explained 53.9 percent of the variance in the Algebra II post-test scores (based on the R^2 statistic). Of the variables included, the Algebra I post-test score and the math teacher years of experience variables were both significant ($p < 0.001$). The variable of interest for the second hypothesis, the average entrepreneurship grade, was not significant ($p > 0.1$). These results indicate that the hypothesis on entrepreneurship proficiency (grades) and its relationship to math proficiency was not significant.

Of the significant variables, the coefficients generally matched what prior literature has indicated and the prior OLS regression for the first hypothesis (see Table 7). The OLS regression

resulted in a coefficient for the Algebra I post-test score of 0.57 ($p < 0.001$). As a continuous variable, this indicates that for every one percentage-point increase in a student's Algebra I post-test score, their Algebra II post-test score is estimated to increase by 0.57 percent, ceteris paribus. The OLS regression resulted in a coefficient for the math teacher years of experience variable of .0039 ($p < 0.001$). This result indicates that for every year of additional teaching experience a math teacher has, students would see an increase in their Algebra II post-test score by 3.9 percentage points.

School District Two Findings

Descriptive Statistics, Response Rate, and Data Screening: School District Two

Through this quasi-experimental study, data were collected on 1,172 students across a sample of four schools within School District Two, a large school district in the Mid-Atlantic region of the United States. The sample was reflective of 1,172 Algebra II students, of which 74 students (six percent) took at least one entrepreneurship class. Of the 1,172 students, 1,098 students (94 percent) in the sample took Algebra II but not entrepreneurship. However, due to missing data, only 1,003 students were used in the propensity score analysis (63 entrepreneurship students). Descriptive statistics of the entire sample are presented in Table 14 and descriptive statistics of the control group and the treatment group, specifically, are presented in Table 15.

It should be noted that the Algebra I and II results were based on school grades as state assessments were not available for Algebra II as the Algebra II state assessment was retired. However, Algebra I state assessment scores were collected as that exam was still administered in this school district. The Algebra I grades ranged between 58.65 and 101.06, in which three students had score just over 100 points. The Algebra II grades ranged between 50 and 100 points.

Table 14

School District Two: Descriptive Statistics of Entire Sample

Variable	Number of Observations	*M*	*SD*	Min	Max
Algebra II Score	1,172	79.7928	11.255	50.00	100.00
Entrepreneurship	1,172	0.0631	0.244	0.00	1.00
Algebra I State Assessment	1,172	512.0939	21.554	425.00	575.00
Algebra I Score	1,003	83.5760	7.998	58.65	101.06
English Language Learners	1,172	0.0204	0.141	0.00	1.00
Free and Reduced Lunch	1,172	0.5418	0.498	0.00	1.00
Special Education	1,172	0.0401	0.196	0.00	1.00
Grade	1,172	10.1570	0.796	8.00	12.00
Race - Other	1,172	0.0332	0.179	0.00	1.00
Race - Asian	1,172	0.0614	0.240	0.00	1.00
Race - Black	1,172	0.2465	0.431	0.00	1.00
Race - White	1,172	0.3575	0.479	0.00	1.00
Race - Hispanic	1,172	0.3011	0.458	0.00	1.00
Gender	1,172	0.5110	0.500	0.00	1.00
AP and Honors	1,172	1.6868	0.943	0.00	6.00
Math Teacher Years of Experience	1,172	12.7604	8.900	7.00	31.10
Teacher Ratio	1,172	14.2798	2.527	8.00	18.00

The Algebra I state assessment scores ranged from 425 and 575 points ($M = 512$, $SD = 21.5$). In terms of gender, which was coded as a binary variable (0 = female, 1 = male), 580 (49 percent) were female, and 592 students (51 percent) were male. A binary variable was created for each race variable (0 = not of that race, 1 = of that race) and the sample was representative of 419 White students, 289 Black students, 359 Hispanic students, 72 Asian students, and 33 students as Native American, Pacific Islander, Hawaiian, two or more races, or other (all classified as ‘other’ in this analysis). The Asian variable was excluded from the regression and propensity score model through an automatic default of STATA due to perfect collinearity with the other race variables. When categorical variables are used, K-1 dummy variables should be

Table 15.

School District Two: Descriptive Statistics of Non-Entrepreneurship Students and Entrepreneurship Students

Non-Entrepreneurship Students					
Variable	Number of Observations	*M*	*SD*	Min	Max
Algebra II Score	1,098	79.9542	11.4030	50.00	100.00
Algebra Score (State Assessment)	1,098	512.3087	21.4983	425.00	575.00
Algebra I Score	940	83.6318	8.0151	58.65	101.06
English Language Learner	1,098	0.0209	0.1432	0.00	1.00
Free and Reduced Lunch	1,098	0.5218	0.4997	0.00	1.00
Special Education	1,098	0.0400	0.1962	0.00	1.00
Grade	1,098	10.1575	0.8122	8.00	12.00
Race - Other	1,098	0.0355	0.1851	0.00	1.00
Race - Asian	1,098	0.0628	0.2427	0.00	1.00
Race - Black	1,098	0.2349	0.4241	0.00	1.00
Race - White	1,098	0.3679	0.4824	0.00	1.00
Race - Hispanic	1,098	0.2987	0.4579	0.00	1.00
Gender	1,098	0.5063	0.5001	0.00	1.00
AP and Honors	1,098	1.6671	0.9430	0.00	6.00
Math Teacher Years of Experience	1,098	13.0346	8.9102	0.70	31.10
Teacher Ratio	1,098	14.3797	2.5232	8.00	18.00
Entrepreneurship Students					
Variable	Number of Observations	*M*	*SD*	Min	Max
Algebra II Score	74	77.3981	8.4839	57.10	99.60
Algebra Score (State Assessment)	74	508.9054	22.2846	425.00	575.00
Algebra I Score	63	82.7441	7.7582	64.00	97.72
English Language Learner	74	0.0135	0.1162	0.00	1.00
Free and Reduced Lunch	74	0.8378	0.3711	0.00	1.00
Special Education	74	0.0405	0.1985	0.00	1.00
Grade	74	10.1486	0.5150	9.00	12.00
Race - Other	74	0.000	0.000	0.00	0.00
Race - Asian	74	0.0405	0.1985	0.00	1.00
Race - Black	74	0.4189	0.4967	0.00	1.00
Race - White	74	0.2027	0.4047	0.00	1.00
Race - Hispanic	74	0.3378	0.4762	0.00	1.00
Gender	74	0.5810	0.4967	0.00	1.00
AP and Honors	74	1.9797	0.9120	0.00	4.00
Math Teacher Years of Experience	74	8.6932	7.7377	0.70	31.10
Teacher Ratio	74	12.7973	2.1000	8.00	18.00

used as one of the dummy variables can be explained as a linear combination of others set to "0" (UCLA, 2016).

Of the 1,172 students in the sample, 537 (46 percent) did not qualify for free and reduced lunch (FRL) while 635 (54 percent) did qualify. In terms of specialized populations, there were 24 English Language Learner (ELL), albeit only one ELL student was also in an entrepreneurship class, thus the ELL variable was excluded from the propensity score model. Another specialized population is students with individualized education plans (IEPs) who are considered Special Education (SPED) students. There were 47 SPED students (less than four percent) in the sample. The Career and Technical Education (CTE) concentrator variable was not available within the School District Two data. The number of honors or Advanced Placement (AP) classes taken is an ordinal variable, ranging between 0 and 6.0 within this sample. Each honors class taken was worth 0.5 credits and each AP class was worth 1.0 credit. Thus, a student enrolled in 1.5 credits could have been enrolled in three honors classes or could have been enrolled in one AP class and one honors class. The mean level of AP and/or honors class taking within the sample was 1.7 credits. Table 16 depicts the frequencies of AP and honors class taking.

Table 16

School District Two: Frequency Table: AP & Honors

AP and Honors	Freq.	Percent	Cum.
0.0	111	9.47	9.47
0.5	81	6.91	16.38
1.0	159	13.57	29.95
1.5	217	18.52	48.46
2.0	354	30.20	78.67
2.5	101	8.62	87.29
3.0	100	8.53	95.82
3.5	24	2.05	97.87
4.0	17	1.45	99.32
4.5	4	0.34	99.66
5.0	2	0.17	99.83
5.5	1	0.09	99.91
6.0	1	0.09	100.00
Total	1,172	100.00	100.00

The classroom and school-level variables include the math teacher's years of experience and the school's staffing ratio. In terms of teacher experience, teachers within this sample ranged between 0.7 and 31.1 years of experience. The mean number of years of experience was 17 years while the median was 9.8 years. Table 17 depicts the frequencies of math teacher years of experience.

Table 17

School District Two: Frequency Table: Math Teacher Years of Experience

Math Teacher Years of Experience	Freq.	Percent	Cum.
0.7	35	2.99	2.99
2.0	140	11.95	14.93
4.5	38	3.24	18.17
5.0	136	11.60	29.78
6.0	87	7.42	37.20
7.0	33	2.82	40.02
9.0	115	9.81	49.83
9.8	39	3.33	53.16
14.0	107	9.13	62.29
16.0	48	4.10	66.38
19.7	97	8.28	74.66
21.0	86	7.34	82.00
25.0	58	4.95	86.95
25.9	108	9.22	96.16
31.1	45	3.84	100.00
Total	1,172	100.00	100.00

The school staffing ratio was the number of students per school staff number. Schools with higher ratios of students to staff are often stretched in terms of resources and capacity. Among the schools in this sample, the range was between eight and 18 students for every one staff member. This school district's staffing ratio was not considered problematic, as research that indicates student to teacher ratios of 18:1, or less, is optimal for academic success (Barrington, 2018).

Regression and Propensity Score Matching - Hypothesis 1: School District Two

OLS Regression: School District Two

Two tests for normality were conducted for this analysis, the Shapiro Wilk test prior to running the OLS model, which indicated the non-binary variables were not normally distributed,

and the Jarque-Bera test for skewness and kurtosis after running the OLS model, which indicated that the residuals were not normally distributed (results in Table 18). Even after using logged variables, the distributions were not normally distributed. Although having non-normally distributed data does not hinder analysis, it is still important to check data distributions to better understand data (Kim, 2015).

Table 18

School District Two: Tests for Normality

Shapiro-Wilk W Test for Normal Data					
Variable	Number of Observations	*W*	*V*	*z*	Prob > *z*
Algebra II Score	1,172	0.9758	17.577	7.144	0.00
Math Teacher Years of Experience	1,172	0.9357	46.802	9.585	0.00
Algebra I Score	1,003	0.9836	10.353	5.789	0.00
Algebra I State Assessment	1,172	0.9838	11.739	6.138	0.00
AP and Honors	1,172	0.9886	8.291	5.272	0.00
Skewness/Kurtosis Tests for Normality					
Variable	Number of Observations	Pr(Skewness)	Pr(Kurtosis)	adj X^2 (2)	Prob > X^2
Residual	1,003	0.000	0.003	27.30	0.00

The OLS regression output is available in Table 19 and illustrates several predictors for the dependent variable. Tests for multicollinearity and heteroskedasticity were conducted, with robust standard errors being utilized to limit the heteroskedasticity, as part of the regression. As indicated in the prior section, the Asian variable was excluded due to collinearity.

The overall model was significant ($p < 0.001$) and the variables explained 39 percent of the variance in the Algebra II grade (based on the R^2 statistic). Of the variables included, the Algebra I grade and the teacher staffing ratio within the school were both significant ($p < 0.001$), as well as the gender variable ($p < 0.05$).

Table 19

School District Two: OLS Regression (All Variables)

Linear regression		
	Number of Observations =	1,003
	F (14, 988) =	53.300
	Prob > *F* =	0.000
	R^2 =	0.393
	Root MSE =	8.819

Dependent Variable: Algebra II Score	Coef.	Robust Std. Err.	*t*	P > | *t* |	[95% Conf. Interval]	
Entrepreneurship	-0.0566	1.0502	-0.05	0.957	-2.117	2.004
Algebra I Score	0.7224	0.0554	13.04	0.000	0.613	0.831
Algebra I State Assessment	0.0361	0.0197	1.83	0.068	-0.002	0.074
Special Education	-0.8576	1.3846	-0.62	0.536	-3.574	1.859
Free and Reduced Lunch	-0.0803	0.7555	-0.11	0.915	-1.563	1.402
English Language Learner	0.9520	5.8212	0.16	0.870	-10.471	12.357
Race - Other	2.6842	1.9144	1.40	0.161	-1.072	6.441
Race - Asian	0.0000	(omitted)				
Race - Black	-0.3387	1.2996	-0.26	0.794	-2.889	2.211
Race - White	-0.6236	1.2248	-0.51	0.611	-3.027	1.779
Race - Hispanic	0.3738	1.2715	0.29	0.769	-2.121	2.869
Gender	-1.7550	0.5765	-3.04	0.002	-2.886	0.623
AP and Honors	0.4838	0.3870	1.25	0.212	-0.275	1.243
Math Teacher Years of Experience	0.0696	0.0394	1.77	0.078	-0.007	0.147
Teacher Ratio	0.7706	0.1408	5.47	0.000	0.494	1.047
Constant	-10.6654	8.3573	-1.28	0.202	-27.065	5.734

Of the significant variables, the coefficients generally matched what prior literature has indicated. The OLS results were reported to provide context on the overall model and model variables.

The OLS regression resulted in a coefficient for the Algebra I grade of 0.72 ($p < 0.001$). As a continuous variable, this indicates that for every one-point increase in a student's Algebra I grade, their Algebra II grade is estimated to increase by 0.72 points, ceteris paribus.

The OLS regression resulted in a coefficient for the teacher staffing ratio within the school of 0.77 ($p < 0.001$). Across the four schools within the sample, the student to staff ratio for each school ranged between 8:1 to 18:1.

The OLS regression resulted in a coefficient for the gender variable of -1.7 ($p < 0.05$). This indicates that male students, holding all else equal, had lower Algebra II grades than their female peers by 1.7 points.

OLS regression is limited in several ways (Albert, 2016), one of which being the inherent assumption that the data are linear when in reality they are not. Due to the limitations in linear regression, a propensity score matching (PSM) method was used and is analyzed in the following section.

Propensity Score Matching (Using All Variables): School District Two

Using the same procedures as outlined for School District One, both the ATE and ATET were estimated using PSM. Although only three variables were significant in the OLS regression, all the original variables were included in the matching portion of the PSM. However, three variables were excluded due to collinearity – the EL variables and two race variables (Other and Asian). Table 20 show the results of the ATE and ATET.

The ATE depicts how the entire sample would fare if they were to have taken the treatment, in this case how all Algebra II students would have done if they had taken entrepreneurship. The ATE was not significant and thus indicated that entrepreneurship would not have made a meaningful change to the Algebra II grades of the students in this sample (results in Table 20). When analyzing the ATET, how the entrepreneurship students fared, the results were also not significant indicating that entrepreneurship did not have a meaningful change to the Algebra II grades of the students who actually took an entrepreneurship course (results in Table 20).

Table 20

School District Two: ATE and ATET – Using All Variables

Treatment-effects estimation	Number of Observations =					1,003
Estimator: propensity-score matching	Matches: requested =					4
Outcome model: matching	min =					4
Treatment model: logit	max =					4
Algebra II Score	Coef.	AI Robust Std. Err.	*z*	P > | *z* |	[95% Conf. Interval]	
Average Treatment Effect (ATE)						
Entrepreneurship (1 vs 0)	-1.2669	1.2063	-1.05	0.294	-3.631	1.097
Average Treatment Effect on the Treated (ATET)						
Entrepreneurship (1 vs 0)	-0.0154	1.7947	-0.01	0.993	-3.533	3.502

Covariate Balance: School District Two

Table 21 depicts the covariate balance by comparing the treatment and matched control groups for every variable used within this analysis. Based on the comparative mean differences

across the two groups (Cohen's *d*), the standard deviations should be less than 0.25 units apart to be considered balanced (Stuart, 2010). Out of 14 variables, six variables exceeded the 0.25-unit measure indicating imbalance across the two groups for the following variables: free and reduced lunch, White students, Black students, the number of AP and honors courses students took, the number of years of math teacher experience, and teacher ratio. Examples of this imbalance are further illustrated in Table 15, which provides comparative descriptive statistics for the entrepreneurship students and non-entrepreneurship students. Students who took an entrepreneurship course had a higher proportion of students who qualified for free and reduced lunch (82%) compared to the control group, which has 52% of students who qualified for free and reduced lunch (*d* = -0.64).

Table 21

School District Two: Covariate Balance

		Number of Observations per group:	
		Entrepreneurship=0	1,098
		Entrepreneurship=1	74
Effect Size (Cohen's *d*)	Estimate	[95% Conf. Interval]	
Algebra I Score	0.1109	-0.1441	0.3660
Gender	-0.1494	-0.3848	0.0860
Free and Reduced Lunch	-0.6413	-0.8780	-0.4043
Race - Asian	0.0928	-0.1426	0.3282
Race - White	0.3456	0.1098	0.5814
Race - Hispanic	-0.0852	-0.3206	0.1502
Race - Black	-0.4287	-0.6646	-0.1925
Race - Other	0.1980	-0.0374	0.4335
Special Education	-0.0023	-0.2377	0.2330
AP and Honors	-0.3321	-0.5678	-0.0963
Math Teacher Years of Experience	0.4910	0.2546	0.7271
Teacher Ratio	0.6332	0.3963	0.8699
Algebra I State Assessment	0.1579	-0.0775	0.3933
Algebra II Score	0.2273	-0.0082	0.4628

*Algebra I score were only reported for 940 non-entrepreneurship students and 63 entrepreneurship students

Of the students who took an entrepreneurship course, 20% were White, compared to the control group where 37% were White (*d* = 0.34). Moreover, 42% of the students who took an entrepreneurship course were Black, while the control group was only 23% Black (*d* = -0.42). Students who took an entrepreneurship course took an average of 1.9 AP and/or honors courses, while the control group took an average of 1.6 AP and/or honors courses (*d* = -0.33). Students who took an entrepreneurship course had math teachers with an average of 8.6 years of experience, while non-entrepreneurship students had math teachers with an average of 13 years of experience (*d* = 0.49). In terms of teacher ratio, students who took an entrepreneurship course had an average teacher to student ratio of 12.8, while the control group had an average teacher to student ratio of 14.4 (*d* = 0.63).

Stepwise Regression: School District Two

To limit issues with confounding variables, a stepwise regression was conducted to better estimate the final propensity score matching, following the same procedures as School District One. Table 22 depicts the results from the stepwise regression, which resulted in five variables being selected (Algebra I grade, Algebra I state assessment, math teacher years of experience, gender, and the teacher staffing ratio). The overall model was significant ($p < 0.001$) and the variables explained 38.51 percent of the variance in the Algebra II grades (adjusted $R^2 = 38.51$).

Propensity Score Matching (Using Stepwise Variables): School District Two

Although the entrepreneurship enrollment variable was not significant in the stepwise regression, this variable was included in the PSM estimation as it was the primary independent variable of interest. The first hypothesis was that there was a positive relationship between participation in entrepreneurship education and mathematical proficiency of high school

students. Based on the propensity score matching (PSM) process, the ATE and the ATET were computed. The ATE depicts the counterfactual estimated result of all students in the population if they were to take an entrepreneurship course. The ATET depicts the effect of the treatment applied to those treated (the entrepreneurship students). Both the ATE and ATET were not significant, indicating that entrepreneurship did not have meaningful change on the Algebra II grades of the students in the sample (Table 23). These results were consistent with the propensity score matching analysis in Table 20.

Regression - Hypothesis 2: School District Two

The second hypothesis, which stated that there was a positive relationship between proficiency of entrepreneurship education and mathematical proficiency of high school students, was not able to be evaluated for School District Two as no numerical or grade-level data were provided.

Table 22

School District One: Stepwise Regression (Backwards Selection of Variables)

Begin with full model (all variables)
p = 0.9695 >= 0.1 removing Entrepreneurship
p = 0.9066 >= 0.1 removing Free and Reduced Lunch
p = 0.5607 >= 0.1 removing Special Education
p = 0.1488 >= 0.1 removing Race - Hispanic
p = 0.5858 >= 0.1 removing Race - Asian
p = 0.2444 >= 0.1 removing Race - Black
p = 0.1714 >= 0.1 removing Race - White
p = 0.1168 >= 0.1 removing AP and Honors

Source	*SS*	*df*	*MS*
Model	49,179.11	5	9,835.822
Residual	77,501.05	997	77.734
Total	126,680.16	1,002	126.427

Number of Observations =	1,003
F (5, 997) =	126.53
Prob > F =	0.000
R^2 =	0.388
Adj R^2 =	0.385
Root MSE =	8.816

Dependent Variable: Algebra II Score	Coef.	Std. Err.	*t*	P > | *t* |	[95% Conf. Interval]	
Teacher Ratio	0.7778	0.1275	6.10	0.000	0.5274	1.0281
Algebra I State Assessment	0.0381	0.0191	2.00	0.046	0.0006	0.0756
Algebra I Score	0.7346	0.0494	14.85	0.000	0.6375	0.8317
Gender	-1.9901	0.5655	-3.52	0.000	-3.0998	-0.8803
Math Teacher Tears of Experience	0.0663	0.0340	1.95	0.051	-0.0003	0.1331
Constant	-12.0055	7.4067	-1.62	0.105	-26.5401	2.5290

Table 23

School District Two: ATE and ATET – Using Stepwise Regression Variables

Treatment-effects estimation Estimator: propensity-score matching	Number of Observations =					1,003
	Matches: requested =					1
Outcome model: matching	min =					1
Treatment model: logit	max =					1
Algebra II Score	Coef.	AI Robust Std. Err.	*z*	P > | *z* |	[95% Conf.	Interval]
Average Treatment Effect (ATE)						
Entrepreneurship (1 vs 0)	1.7245	2.3505	0.73	0.463	-2.8825	6.3316
Average Treatment Effect on the Treated (ATET)						
Entrepreneurship (1 vs 0)	-2.1819	1.4396	-1.52	0.130	-5.003	0.639

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Summary of Chapter IV

The purpose of this quasi-experimental study was to examine whether participation in an entrepreneurship class was related to mathematical proficiency (Algebra II) in high school. This chapter provided findings on two school districts through a variety of statistical analyses, on individual variables, overall average treatment effect (ATE), and overall average treatment effect on the treated (ATET). First, demographic characteristics on the variables of interest were described for each school district. Second, demographic characteristics were reported by the control group (non-entrepreneurship students) and the treatment group (entrepreneurship students) to better understand sub-group differences. Third, OLS regression was used to determine significant variables and also the relationship between particular variables and math proficiency in Algebra II. Within School District One, the overall model was significant and the

following variables were all significant with relation to Algebra II post-test scores: the Algebra I post-test score, the Asian race variable, the number of AP and/or honors classes taken, the math teacher years of experience, the teacher staffing ratio within the school, and the entrepreneurship class enrollment. Within School District Two, the overall model was significant and the following variables were all significant with relation to the Algebra II grades (as post-test scores were not able to be provided by School District Two): the Algebra I grade, the teacher staffing ratio within the school, and the gender variable. Fourth, tests for normality and covariate balance were conducted to better understand the data on each school district. Fifth, stepwise regression was used to further validate the OLS regression results.

Overall, the answer to Research Question I came from two primary statistics, the average treatment effect (ATE) and the average treatment effect on the treated (ATET). The ATE depicts how the entire sample would fare if they were to have taken the treatment in this case how all Algebra II students would have done if they had taken entrepreneurship. The ATE was significant for School District One but not significant for School District Two. The ATET depicts how the treatment group, the students who took an entrepreneurship course, fared with respect to the treatment. In both School District One and Two, the ATET was not significant. With regards to Research Question II, only School District One could be evaluated, whereas the results were not significant. Chapter V will summarize the study and the results, discuss conclusions and implications, and conclude with recommendations for future research.

CHAPTER V

Summary, Conclusions, and Recommendations

This chapter highlights the original problem/purpose of the study, the findings, and illustrates the major conclusions that can be drawn. This chapter also includes implications and recommendations for further research and practitioner application.

Problem and Purpose of the Study

The purpose of this quasi-experimental study was to examine whether participation in an entrepreneurship class was related to mathematical proficiency (Algebra II) in high school. This problem was studied to inform school districts on how to potentially improve mathematical proficiency among students through contextual learning, while allowing for increased exposure to entrepreneurship education. Based on the literature on contextual learning, which is theorized to occur when students process information based on their own lived experiences, memories, etc. (Baker et al., 2009), this study was centered on the following hypotheses:

Hypothesis 1. There is a positive relationship between participation in entrepreneurship education and mathematical proficiency of high school students.

Hypothesis 2. There is a positive relationship between proficiency of entrepreneurship education and mathematical proficiency of high school students.

Sample/Population

The population of interest was U.S. high school students who took Algebra II in a public high school. Twelve high schools, in School District One, and four high schools, in School District Two, were included in the population of the study based on a convenience sample. After accounting for missing data, School District One consisted of 2,719 students, of which 121 students were enrolled in entrepreneurship, and School District Two consisted of 1,003 students,

of which 63 were enrolled in entrepreneurship. The following sections will provide the interpretation and implication of findings for School District One and School District Two.

Variable Analysis: Regression Results (School District One)

The dependent variable of interest was Algebra II post-test scores, based on a state assessment out of 600 points. This dependent variable was used in an OLS regression to provide context on all the variables within the model in addition to the propensity score match analysis to determine average treatment effect (ATE) and average treatment effect on the treated (ATET), discussed in the next section.

From the OLS regression results, six variables were significant. The Algebra I post-test score was positive and significant, which is consistent with the literature that exemplifies how prior math knowledge is highly influential on current math achievement (Siegler et al., 2012). The Asian race variable was positive and significant. This is also consistent with the literature where there is significance of race variables on math outcomes, more specifically with Asian students yielding positive significance (Steen, 2003). The AP and honors variable was positive and significant which is consistent with the literature regarding higher-level class-taking characteristics of students and the relation to mathematical proficiency (Attewell & Domina, 2008). Using the range to exemplify this impact, students who had 5.0 points for this variable would have an increase of 35 points for their Algebra II post-test score compared to their peers who took no AP or honors classes, ceteris paribus. The math teacher years of experience variable was positive and significant. These results were consistent with what is in the literature, whereas additional teacher experience often results in higher proficiency of core subjects by students (Papay & Kraft, 2014). However, there is research showing that the growth in students tapers off at the fifth year of a teacher's experience and although there is still growth after five years of

experience, it is marginal (Kini & Podolsky, 2016). This declining marginal return concept is very much dependent on the school district and other district specific factors (Kini & Podolsky, 2016). Using the range of 0 years of experience to 47 years of experience to exemplify the impact, students who had a teacher with 47 years of experience would have an increase of approximately 13 points to their Algebra II post-test score (47 years x 0.28 coefficient), compared to their peers who had a new teacher with zero years of experience, ceteris paribus. The teacher ratio variable was negative and significant which is in line with the literature that depicts that higher ratios of student to staff are less optimal for student success (Barrington, 2018). Using the range across the 12 schools, students at schools with a ratio of 16:1 compared to 12:1 would see a decline of over 11 points (4 students to staff members x 2.9 coefficient) in their Algebra II post-test scores, ceteris paribus.

When comparing the two groups of students, those who took an entrepreneurship course and those who did not, there was imbalance among the groups within certain variables. Students who took an entrepreneurship course had math teachers with an average of five years of experience, while non-entrepreneurship students had math teachers with an average of 17 years of experience ($d = 1.06$). Due to the small number of students within the entrepreneurship group, it was likely that there would be limited variation and the covariate would not be balanced among the two groups. For the CTE concentrator variable, 22 percent of the entrepreneurship students were CTE concentrators, compared to only four percent of the non-entrepreneurship students ($d = -0.82$). This imbalance is likely due to the fact that to be a CTE concentrator, students must be CTE participants (U.S. Department of Education, 2019), thus it is more likely that students already within a CTE class are CTE concentrators over their peers. The AP and/or honors variable is also unbalanced among the two groups, with entrepreneurship students taking

an average of 2.0 AP and/or honors classes and non-entrepreneurship students taking an average of 1.6 AP and/or honors classes (*d* = -0.34). This is likely due to the small number of entrepreneurship students which limits the variation and emphasizes the covariate imbalance. In terms of the other significant variables, the percentage of Asian students was approximately eight percent of each group and the school staffing ratio for both groups was approximately 15 students per staff member, thus these were balanced upon matching across groups.

Treatment Effect Analyses: ATET and ATE Results (School District One)

Propensity score matching results in two primary statistics, an average treatment effect on the treated (ATET) and an average treatment effect (ATE). Both reported statistics use matching to determine the estimated treatment effect. The ATET utilizes the treatment group to determine the estimated effect that the treatment had if the subjects (students) did not have the treatment, that is, if the entrepreneurship students did not take an entrepreneurship course, what would be their estimated Algebra II post-test score outcome? The ATE utilized the entire sample population to determine the estimated effect that the treatment has if the subjects (students) did have the treatment, that is, if the entire student population were to have taken entrepreneurship, what would be their estimated Algebra II post score outcome?

To address the first hypothesis, which states that there is a positive relationship between participation in entrepreneurship education and mathematical proficiency of high school students, both the ATET and the ATE were used. The ATET was not significant in this case, indicating that it is indeterminable whether the entrepreneurship student math results would have been different had they not taken entrepreneurship. However, the ATE was significant ($p < 0.05$) and positive, indicating that the average estimated effect of taking entrepreneurship, on the general population of Algebra students, would lead to an increase of 13 points in an Algebra II

post-test score. This corresponds with the literature on creating learning environments that allow for integrated information and connected content to improve student engagement, student learning outcomes, and student attitudes towards academic subject areas (Bodilly et al., 1993; Kovalik & Olsen, 1994) and more specifically how using math to solve contextualized and real-world problems can advance mathematical proficiency among students (Stone et al., 2008)

The non-significant ATET ($p > 0.1$) and significant ATE ($p < 0.001$) could stem from a few varied factors, one of which being that the students who took an entrepreneurship course had an average Algebra I post-test score of 462 points, while their peers who did not take an entrepreneurship course had an average Algebra I post-test score of 458 points (Table 3). This initial average difference may insinuate that these students were more mathematically inclined, and thus partaking in the entrepreneurship class may not have affected their math proficiency as much as it could have another student. However, the covariate balance between the two groups and their associated Algebra I post-test scores was met. Math teacher experience varied significantly between the two groups, with entrepreneurship students having math teachers with an average of five years of teaching experience while non-entrepreneurship students having math teachers with an average of 17 years. This depicts that entrepreneurship students, on average, did not have math instruction from more tenured staff members. This could be a reason as to why the ATET was not significant, whereas regardless of entrepreneurship enrollment, teacher experience was more of a factor in mathematical achievement (Chetty et al., 2014; Reynolds & Walberg, 2010; Schmitt, 2012; Subedi et al., 2011). In terms of AP and honors classes, entrepreneurship students took an average of 2.0 credits compared to non-entrepreneurship students who took an average of 1.6 credits. This average difference could depict that the rigorous class taking was more inherent for the treatment group already and thus depicting

entrepreneurship students may be more academically inclined. High academic inclination would mean students enroll in a higher number of rigorous courses than lower academically inclined students. The ATE was positive and significant, compared to the ATET which was not significant, thus this could potentially illustrate that lower academically inclined students could benefit, mathematically, from an entrepreneurship class compared to higher academically inclined students. Subsequently, higher rigorous course selection is associated with higher math achievement (Long, et al,, 2012), thus exemplifying another facet to why entrepreneurship students, with higher rigorous course taking on average, may not have seen an impact from the entrepreneurship enrollment itself (non-significant ATET). This is further exemplified in the literature with regard to how both previous math achievement and current rigorous course taking have shown large effects on current math achievement (Bosman & Schulze, 2018; Siegler et al., 2012). The students taking entrepreneurship courses in this study had both higher average prior year math scores and higher average AP/honor class enrollment.

Another potential reason why entrepreneurship students may not have seen an impact is related to the contextual nature of other classes they have taken or are taking. If entrepreneurship students are enrolled in other business-oriented and quantitative classes, taking an additional class in this area may not lead to an increase in math proficiency as it might in the general population of students.

Variable Analysis: Regression Results (School District Two)

Although the dependent variable of interest in this study was Algebra II post-test scores, this school district was unable to provide these data. Algebra II grade data were provided in place of an assessment. This creates disparity among the interpretation of the results between School Districts One and Two. Additionally, grades do not depict proficiency solely but rather a

variety of variables such as proficiency, work ethic, effort, student behaviors, etc., and grading is not always standardized across teachers within a school or a district and does inherently allow for some level of subjectivity (Bennet, 2019). The Algebra II grades as the dependent variable were used in an OLS regression to provide context on all the variables within the model in addition to the propensity score match analysis to determine average treatment effect (ATE) and average treatment effect on the treated (ATET).

From the OLS regression results, three variables were significant. The Algebra I grade variable was positive and significant, which is consistent with the literature that exemplifies how prior math grades are influential on current math grades (Bosman & Schulze, 2018). The gender variable was negative and significant, indicating that male students, ceteris paribus, had lower Algebra II grades than their female peers. This is also supported through the literature, which indicates that male students typically perform better on math achievement tests and assessments than their female peers, but female students have better grades than their male peers (Voyer & Voyer, 2014). The teacher ratio variable was positive and significant which contradicts literature that depicts higher ratios of student to staff are less optimal for student success (Barrington, 2018). Using the range across the four schools, students at schools with a ratio of 18:1 compared to 8:1 would see an increase of over 7.7 points (10 students to staff members x 0.77 coefficient) in their Algebra II grades, ceteris paribus. Although this is not consistent with what the literature indicates in terms of linear relationship, research indicates that student to teacher ratios of 18:1, or less, are optimal for academic success (Barrington, 2018). Typically, as the number of students per staff member rises, staff resources are stretched across a wider subset of students. There may be other factors as to why the staff to student ratio was much lower at certain schools in this district, as low as 8:1, indicating an inherent need for smaller class sizes that could be the

reason for contradictory results. Perhaps the schools with the higher student to staff ratios may also be able to obtain some economies of scale when it comes to academic resources beyond staff that are potentially allowing students to achieve at higher levels. As a comparison, the average Algebra II grade across the students who attended a school with a student to staff ratio of 8:1 was 73, compared to students who attended a school with a student to staff ratio of 18:1 was 83.

The math teacher years of experience variable was not significant in School District II albeit being significant in School District I and in the literature. There are a few factors as to why this may have occurred. Since School District II had grade data rather than assessment data, the teach years of experience was no longer being compared to student outcomes specifically, but rather how that particular teacher was grading said students. There is limited research on the topic of whether newer teachers grade differently, whether more liberally or strictly, compared to more tenured teachers (Anderson, 2019). Additionally, the same in School District II was much smaller than School District I, with only 4 schools and thus the range of teacher experience was narrower than School District I. The minimum number of years of teaching experience in the range for School District II was seven years to 31 years, thus there weren't any "new" teachers compared to more tenured teachers in this sample. This echoes the literature indicating that after about five years the math teacher experience that impact on achievement tapers off (Kini & Podolsky, 2016).

When comparing the two groups of students, those who took an entrepreneurship course and those who did not, there was imbalance among the groups within six variables. Students who took an entrepreneurship course had a higher proportion of students who qualified for free and reduced lunch (82%) compared to the control group, which has 52% of students who qualified

for free and reduced lunch (*d* = -0.64). Thus, this imbalance depicts that from a socio-economic status, these groups are unalike, which may impact math classroom grades (Mccoy, 2010; Schiller et al., 2002; Spielhagen, 2006). Of the students who took an entrepreneurship course, 20% were White, compared to the control group where 37% were White (*d* = 0.34). Moreover, 42% of the students who took an entrepreneurship course were Black, while the control group was only 23% Black (*d* = -0.42). These imbalances also depict how the two groups are inherently different and thus makes it harder to match across groups. Students who took an entrepreneurship course took an average of 1.9 AP and/or honors courses, while the control group took an average of 1.6 AP and/or honors courses (*d* = -0.33). This indicates that the entrepreneurship students may have been more academically inclined than the general population of Algebra II students, which is what I found in School District I. In terms of teacher ratio, students who took an entrepreneurship course had an average teacher to student ratio of 12.8 staff for every one student, while the control group had an average teacher to student ratio of 14.4 staff for every one student (*d* = 0.63). This indicates that on average, entrepreneurship students had less staff per student than their peers, exemplifying a variance in resources among the groups. Students who took an entrepreneurship course had math teachers with an average of 8.6 years of experience, while non-entrepreneurship students had math teachers with an average of 13 years of experience (*d* = 0.49). This also depicts the inequity among students who took an entrepreneurship course and those who did not, as teacher experience is strongly associated with math outcomes and grades (Chetty et al., 2014; Reynolds & Walberg, 2010; Schmitt, 2012; Subedi et al., 2011). Due to the small number of students within the entrepreneurship group, it was likely that there would be limited variation and several of the covariates would not be balanced among the two groups.

Treatment Effect Analyses: ATET and ATE Results (School District Two)

Propensity score matching results in two primary statistics, an average treatment effect on the treated (ATET) and an average treatment effect (ATE). Both reported statistics use matching to determine the estimated treatment effect. The ATET utilizes the treatment group to determine the estimated effect that the treatment had if the subjects did not have the treatment. The ATE utilized the entire sample population to determine the estimated effect that the treatment has if the subjects did have the treatment.

To address the first hypothesis, which states that there is a positive relationship between participation in entrepreneurship education and mathematical proficiency of high school students, both the ATET and the ATE were used. The ATET was not significant in this case, indicating that the math grades of students who had taken an entrepreneurship course would not have been different had they not taken an entrepreneurship course. Coincidingly, the ATE was also not significant, indicating that in this school district, entrepreneurship did not have an impact on math grades among the general student population.

The non-significant ATET ($p > 0.1$) and ATE ($p > 0.1$) could stem from a few varied factors. One factor is that this school district only included four schools, of which only 63 entrepreneurship students were utilized, thus limiting the scope of the analysis. Another factor is that the primary dependent variable was not mathematical proficiency but rather class grade. Although grades may allude to proficiency, there are varying components to academic grades in which there is also subjectivity based on teacher and school. Thus, this school district's analysis ultimately did not serve as an accurate depiction of the intent of the study.

Interpretation of Findings and Implications

The initial hypothesis posed whether participation in entrepreneurship education related positively to mathematics proficiency. This analysis depicts that, through PSM, the estimated average treatment effect on the treated (ATET) was not significant in both School District One and Two, thus students taking entrepreneurship courses did not specifically see a positive result based on their entrepreneurship course enrollment. However, the estimated average treatment effect (ATE) was positive and significant in relation to Algebra II post-test scores in School District One, indicating that there is a potential benefit on math proficiency when general population students take an entrepreneurship course. These results were, however, not consistent with School District Two, albeit School District Two only had grade data rather than assessment data for the dependent variable. Thus, this may indicate the exposure to entrepreneurship could have a positive influence on math proficiency but not math grades. The positive and significant ATE results in School District One depicts that students could perform better than their expected outcome in Algebra II if they concurrently enroll in an entrepreneurship class. This finding has various implications and notions.

In terms of causality, as with any statistical analysis, nothing can be determined with 100 percent accuracy. The results of this study were generally consistent with literature in the field related to contextualized and interdisciplinary learning on mathematics performance (CORD, 2016; Stone et al., 2008; CORD, 2016).

In terms of implications, the results provide a frame of reference when advocating for entrepreneurship education to be expanded and potentially serve as a high school requirement or for cross-disciplinary planning. Although entrepreneurial skillsets are important to develop in the 21st century, regardless of trickle-down effects, the added facet of prospectively increasing

mathematics scores makes for a stronger argument to policymakers and educational decision makers. Additionally, many school districts and states base literacy standards and metrics for "success" on mathematic achievement, thus this could serve as an opportunity for a school district to reimagine Algebra content to allow for more integrated learning and potentially garner higher student outcomes.

Another implication of this study is that contextualized learning may not necessarily have to happen within the same subject matter or course, as it has typically been touted (Kovalik & Olsen, 1994). Students may be able to make cross content connections in differing classes so long as the content has applicable ties. Students are building businesses at a much earlier age in today's era and with much more ease due to advances in technology, fulfillment, and marketing (Clifford, 2021). Thus, many students who may already employ mathematical practices or need such mathematical proficiency, could benefit from interdisciplinary coursework pertaining to entrepreneurship and mathematics.

Although mathematical engagement was not discussed in depth in this study, using real-world examples and allowing students to understand the content from an entrepreneurial lens is likely to increase engagement. Algebra involves concepts such as the slope-intercept equation and problems where students solve for a variable. Subsequently, entrepreneurship involves concepts such as the cost equation, where fixed and marginal costs are directly related to the slope-intercept equation. When we think of pricing strategies, for example, one has to solve for the optimal price based on their given parameters (demand, supply, and costs). There are various connections that can be made across content areas, highlighting skills that students need in the 21st century economy.

Future Research

Future research pertaining to this topic may explore additional covariates and potentially employ a hierarchical linear model with propensity score matching (PSM), although this is not commonly done. Multilevel models are common in educational studies due to the nested structure of data (students within a classroom, within a school, within a district, within a state, etc.). Additional covariates that could have been explored but were unable to be accessed included parental education, family income, teacher quality, participation in extra-curriculuar activities, and mathematics engagement by student.

These results shed light on how contextualized learning classes can potentially impact core classes. Ways to expand upon this research include looking at how the integration of entrepreneurship in earlier grades (e.g., elementary and middle school) relates to mathematics proficiency and looking at how developing a business, in a practicum environment, relates to math proficiency at the secondary or postsecondary levels. In a follow up study, it would be insightful to survey all math students to gain understanding on mathematics engagement and survey students who take an entrepreneurship course on their reasoning for selecting the elective. Furthermore, this study can be replicated to assess interdisciplinary learning in non-integrated environments. Research can also be conducted to assess whether enrollment in other Career and Technical Education (CTE) classes relate to mathematics proficiency.

This study provides an interesting perspective around contextualized learning through CTE, as the right mix of classes is dependent on various factors such as student's goals, post-secondary opportunities, graduation requirements, holistic understanding, etc. Students taking too few CTE classes may not see the relevance of their classwork to their goals, while students taking too many CTE classes may feel as though they are stigmatized compared to their peers.

Further research in this regard is pertinent to determine whether overall course selection impacts the cross-disciplinary connections students can make and what are ideal levels of contextualized learning.

Additionally, studying middle and elementary schools that may have programs similar to entrepreneurship that are embedded could help determine whether these results would cross math content areas prior to Algebra.

Recommendations for Future Studies

There are various recommendations and next steps that stem from this study pertaining to future research:

1. Researchers may further study the outcomes that stemmed from the ATE of School District One. This outcome indicated that had the general population of Algebra students taken an entrepreneurship course, they would have fared better. Thus, taking this into practice to determine whether this holds true, researchers may conduct a true experiment whereas a randomized subset of students would be offered to take an entrepreneurship class, an interdisciplinary class (Algebra and entrepreneurship), or said students would be offered to be part of an after-school entrepreneurship program.
2. Researchers may conduct a qualitative study with students taking entrepreneurship courses to determine if their mathematical engagement improved and whether cross-content connections were formed across classes rather than within classes. This research could shed light on specific components of the content that students clearly see a connection between and those that were not made.
3. Researchers may explore how other math courses potentially provide additional layers of connections to entrepreneurship beyond Algebra, such as Statistics, pre-

Algebra, Discrete Math, etc. through similar analyses to determine where the greatest connections, if any, exist.

4. Researchers may explore what other skills students who partake in an entrepreneurship course garner by introduction to such coursework. Whether said skills are considered soft or technical, whether skills fostered include financial literacy and/or innovation, etc.; skills that extend beyond the coursework requirements and are interdisciplinary by nature.
5. Researchers may explore if similar findings are prevalent in varying grade levels in math education. Particularly as entrepreneurship involves basic statistics, arithmetic, and simple equations, the implications of integrating such content in earlier math courses may be significant. The impact of cross content connections at an earlier stage in math course-taking could have long lasting effects on students, from both an engagement and proficiency perspective.
6. Finally, researchers may study the effects on core content and other skills through co-curricular student organization activities or an after-school club geared towards entrepreneurship. These activities may be target a specific career and technical student organization (CTSO) or another type of offering by schools. This club could be used to not only shed light on entrepreneurial content but also allow students to discuss math courses and other core content to see alignments/connections. Researchers could take this further by seeing if these students perform better on math assessments than their peers.

Recommendations for Practitioners

There are various recommendations and next steps that stem from this study that relate to practitioners in the classroom and school district staff.

1. School districts may opt to further study the effects of contextualized learning by integrating entrepreneurship into Algebra courses, through curriculum reform and/or interdisciplinary planning. This could work by providing professional development and/or common planning time for math and entrepreneurship course teachers to not only collaborate on content, but to also establish relationships among newer teachers and tenured teachers to inform best practices. This could lead to project-based learning opportunities for students and content/curriculum creation opportunities for teachers and staff.
2. Because not every student would think to take an entrepreneurship course through their high school course load, due to the fact that they only get a certain number of classes and are often filling requirements for graduation, college, etc., offering an after school option where students are exposed to entrepreneurial topics would allow for a potentially wider subset of students to partake, limiting the imbalance among groups by learner/student type.
3. Classroom teachers may opt to utilize financial/entrepreneurial examples in class, through homework, project, etc. This may allow for a more holistic view of mathematical concepts as students can see how different standards with math can be used in a variety of business scenarios but build upon one another.
4. School districts may take a broader approach to curriculum integration and explore what other content areas could possibly incorporate interdisciplinary units or cross

content collaboration, to constantly think through possible connections that can be made for students. An example is if an English/Language Arts class is learning about proofing and editing, using content from science courses such that not only students understand the importance of proof-reading/editing, but also creating skillsets in scientific writing of results.

Conclusions

Mathematical proficiency in the United States continues to be a concern, with only 25 percent of 12th graders, on average, being proficient in mathematics for their age-level (NCES, 2015). These results are likely to be amplified due to the impacts of the COVID-19 associated learning loss, further deepening this math achievement gap (Sawhuk & Sparks, 2020). The implications of the lack of mathematical proficiency are vast, but specifically include decreased earning potential and limitations on post-secondary success – academically and career related. In parallel, the rise of the gig economy among other facets has created an apparent need for students to develop entrepreneurial/21st century skills. The purpose of this quasi-experimental study was to examine whether participation in an entrepreneurship class was related to mathematical proficiency (Algebra II) in high school, through the use of propensity score matching to determine the average treatment effect of Algebra II students who actually took an entrepreneurship course and the average treatment effect of Algebra II students had they taken an entrepreneurship course.

Conclusions from this study add to the existing literature surrounding math proficiency and contextualized learning. The average treatment effect (ATE) was significant for one of two school districts in this study, indicating that had Algebra II students taken an entrepreneurship course, their Algebra II post-test score was estimated to increase between 13 and 15 points.

Contextually, individual variables were studied to determine individual relationships, of which the following were significant among the two school districts with relation to Algebra II: the Algebra I post-test score, the Asian race variable, the number of AP and/or honors classes taken, the math teacher years of experience, the teacher staffing ratio within the school, the entrepreneurship class enrollment (School District One only), the free and reduced lunch variable (School District One only), Algebra I grade (School District Two only), and the gender variable (School District Two only).

Continued research with regards to math proficiency and ways in which contextualized learning can improve student outcomes is critical. Particularly in an era where students have faced immense learning loss and the overall demand and need for math proficiency is high, the impacts of such research could be game-changing. Overall, this study contributes to the greater body of work pertaining to math aptitude with hopes to push the narrative for students to not only gain entrepreneurial, financial, and economic literacy by using math, but also for students to gain mathematical proficiency through the use of entrepreneurial, financial, and economic literacy.

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APPENDIX A: IRB

OLD DOMINION UNIVERSITY

OFFICE OF THE VICE PRESIDENT FOR RESEARCH

aaalac INTERNATIONAL
PROUDLY, AN AAALAC ACCREDITED PROGRAM

Physical Address
4111 Monarch Way, Suite 203
Norfolk, Virginia 23508
Mailing Address
Office of Research
1 Old Dominion University
Norfolk, Virginia 23529
Phone(757) 683-3460
Fax(757) 683-5902

DATE:	April 29, 2020
TO:	Philip Reed
FROM:	Old Dominion University Education Human Subjects Review Committee
PROJECT TITLE:	[1597285-1] Entrepreneurship Education Relation To Mathematical Proficiency Amongst Secondary Youth
REFERENCE #:	
SUBMISSION TYPE:	New Project
ACTION:	DETERMINATION OF EXEMPT STATUS
DECISION DATE:	April 29, 2020
REVIEW CATEGORY:	Exemption category # *4*

Thank you for your submission of New Project materials for this project. The Old Dominion University Education Human Subjects Review Committee has determined this project is EXEMPT FROM IRB REVIEW according to federal regulations.

We will retain a copy of this correspondence within our records.

If you have any questions, please contact Laura Chezan at (757) 683-7055 or lchezan@odu.edu. Please include your project title and reference number in all correspondence with this committee.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within Old Dominion University Education Human Subjects Review Committee's records.

APPENDIX B: SCHOOL DISTRICT ONE APPROVAL EMAIL

From: Mariam Abdelhamid <mabde004@odu.edu>
Sent: Tuesday, May 26, 2020 6:37 PM
To: [redacted]
Subject: Application to Conduct Research

CAUTION: This email is **NOT** from [redacted]ail account. Be careful about the content. Look carefully at the sender's email address before clicking links, opening attachments or sharing information.

...

[redacted] Jun 23, 2020, 11:32 AM
to me

Mariam,
Just a quick update, your application has been approved and I have been approved to get the cost estimate for the data. I'll let you know when I have that cost estimate completed.
[redacted]

From: Mariam Abdelhamid <mabde004@odu.edu>
Sent: Tuesday, May 26, 2020 6:37 PM
To: [redacted]

APPENDIX C: SCHOOL DISTRICT TWO APPROVAL EMAIL

Research Notice of Approval Inbox ×

[redacted] L. <[redacted] Mon, Dec 14, 2020, 1:36 PM

to me

Hi Mariam

Congratulations! Your application to conduct the study "Entrepreneurship Education Relation to Mathematical Proficiency Among Secondary Youth" was approved. Our data team just sent me your data. I wasn't expecting it so soon, so it's a nice surprise. Attached is an Excel file with your data as well as a document with a description of each variable.

Please keep the attached Research Notice of Approval in a safe location for future reference. You will need to attach the Research Notice of Approval within all initial communication to[redacted]istrators and have it available at all times while conducting research activities. This approval does not include any interaction w[redacted]ff or students.

If you have any questions, please email us at research@[redacted]

Thank you,

[redacted]

[redacted] Ph.D.

Senior Administrator, Research and Evaluation

[redacted]

APPENDIX D: VITA

EDUCATION AND PUBLICATIONS

Old Dominion University (ODU), Norfolk, VA

Ph.D. in Education, Occupational and Technical Studies (Summa Cum Laude, 2017 - Present)

Abdelhamid, M. (2019). Innovation in economic education. *Journal of Interdisciplinary Studies in Education, 8*(1), 175-178.

Abdelhamid, M. (2017). Down but not out: CTE and apprenticeship for youth in the justice system. *New America.*

Master of Arts in Economics (Magna Cum Laude, 2014 - 2016)

Abdelhamid, M. (2015). A panel data analysis of criminal activity related to unemployment insurance [Unpublished master's thesis]. *Old Dominion University*.

Bachelor of Science in Finance and Business Analytics (Cum Laude, 2010 - 2013)

Johns Hopkins University (JHU), Baltimore, MD

Teaching Certifications: Virginia K-6 Elementary Education, Business Education (2018 - 2020)

PROFESSIONAL EXPERIENCE

Office of Resource Strategy, District of Columbia Public Schools, Washington, DC

Budget & Strategy Specialist (October 2020 - Present)

Flintstone Elementary, Prince Georges County Public Schools, Oxon Hill, MD

5th Grade Teach for America (TFA) Teacher (August 2018 - August 2020)

STEM Education & Professional Studies Department, Old Dominion University, Norfolk, VA

Instructor (August 2017 - August 2018)

Budget & Strategic Planning, City of Norfolk, Norfolk, VA

Budget & Policy Analyst (August 2015 - May 2017)

Novogradac & Company LLP, Bethesda, MD

Research Analyst (July 2013 - May 2014)

OTHER EXPERIENCES

Federal Department of Education - Student Volunteer, January 2021 - April 2021
Chief Financial Officer - Real Deal Lifestyle, July 2019 - Present
Math Teacher - Art of Problem-Solving Academy, August 2019 - September 2021
STEM Adjunct Faculty - Old Dominion University, August 2019 - December 2019
College and Career Prep Instructor - Blueprint Summer Programs, June 2019 - July 2019
Journal Reviewer - Journal of Interdisciplinary Studies in Education - March 2019 - Present
Preschool Substitute - Norfolk First Presbyterian, February 2018 - May 2018
Center on Education and Skills Intern - New America, May 2017 - August 2017
Research Consultant/Contractor - Lisa Sturtevant & Associates, July 2016 - May 2017
Internal Audit Intern - Portfolio Recovery Associates, June 2015 - August 2015
Economic Intern - Economic Development (City of Norfolk), January 2015 - May 2015
Entrepreneurship Research Intern - HATCH Accelerator, November 2014 - January 2015
Graduate Assistant - Entrepreneurial Center, August 2014 - May 2015
Executive Intern - City of Norfolk, June 2014 - August 2014
Student Body President - Student Government at ODU, June 2012 - May 2013
Representative - State Council for Higher Education in Virginia, June 2012 - May 2013
Search Engine Optimization (SEO) Intern - Dominion Enterprises, May 2012 - July 2012
Finance Director - Student Government at ODU, August 2011 - May 2012
Investments Intern - Keel Point Advisors LLC, May 2011 - August 2011
Tour Guide - Admissions Office at ODU, August 2010 - May 2013
Data Intern - Center for Infrastructure Protection/Homeland Security, July 2009 - May 2010