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El Dilema en los Números: An examination of the historical exclusionary mathematics placement practices that prevent Hispanic level 1 and 2 EL student participation in higher-level mathematics courses.

Rardy Leandro Pena
Lesley University

EL DILEMA EN LOS NÚMEROS:

AN EXAMINATION OF THE HISTORICAL EXCLUSIONARY MATHEMATICS PLACEMENT PRACTICES THAT PREVENT HISPANIC LEVEL 1 AND 2 EL STUDENT PARTICIPATION IN HIGHER-LEVEL MATHEMATICS COURSES

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is submitted for final approval by Rardy Peña under the direction of the chair of the dissertation committee listed below. It was submitted to the Counseling and Psychology Division and approved in partial fulfillment of the requirements for the degree of Doctor of Philosophy Degree at Lesley University.

Approved:

____
Chair: Adam Meiselman, PhD

____
Committee Member: Peiwei Li, PhD

____
Committee Member: Maura Walsh, Ed.D.

____
Director of Doctoral Program in CP: Susan Gere, PhD

____
Dean of GSASS: Sandra B. Walker, MBA

May 13, 2021
Date of Final Approval

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ABSTRACT

The current placement of Hispanic level 1 and 2 English Learner students into mathematics courses has been constructed and propagated by the assumptions that these students enter school in the United States at a lower level in mathematics. This assumption, which has neither been tested nor confirmed, perpetuates the systemic injustices in public education by erroneously creating a homogeneous placement process for Hispanic English Learner students and contributes to the economic, social, and political marginalization often experienced by Hispanic immigrants. The purpose of the current project was to examine the veracity of these assumptions by exploring the mathematics placement practices that have historically excluded Hispanic level 1 and 2 students from higher-level mathematics courses and to utilize the results to start to develop more equitable mathematics placement practices. Using a multifaceted quantitative research design, including multiple regression, a two one-sided test for equivalence, and exploratory post hoc analyses, the mathematics placement practices of Hispanic level 1 and 2 students were examined. The results of the current project suggest the existence of broader, systemic assumptions surrounding immigrant students and their ability to perform academically at the same level as their native English-speaking peers. Proposed evidence-based research with the target population that is needed to make effective change in mathematics placement for Hispanic level 1 and 2 students is explored.

Keywords: English Learner, Hispanic, mathematics, language proficiency

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CHAPTER 1: INTRODUCTION

Statement of the Research Problem

As the demographics of the United States have shifted, the percentage of school-age children identified as English Learners (EL) has significantly increased (Peña & Maxwell, 2015); there are over one million more EL students now in public schools than there were 15 years ago (National Center for Education Statistics, 2017). As the numbers have increased, the EL population has appeared to split into two different groups, "traditional" EL students and students with limited or interrupted formal education (SLIFE) (WIDA, 2015). Traditional EL students may be described as those who enter the public schools with a higher level of formal schooling, reside with a parent or guardian, and seem to have a broader support network, while many of the SLIFE population lack these characteristics. Students with limited or interrupted formal education often lack background in reading and writing in their native language and demonstrate academic skills below grade level (Freeman & Freeman, 2002). Many of the students arriving in the United States from El Salvador, Guatemala, and Honduras are classified as SLIFE; the violence and poverty that many of these young people have experienced in their native countries have limited and interrupted their educational opportunities (WIDA, 2015). School districts were not prepared for the wave of changes in terms of curriculum development and delivery, social-emotional needs, and community engagement that accompanied this shift. Increases in numbers and migratory patterns have created new challenges for school districts and state and national agencies in terms of educating this diverse group of learners. These changes are happening at an exponential rate, which translates to disconnections between theory and practice as policies may no longer be applicable and effective in educating EL students.

This project was designed to explore the current mathematics placement practices that have excluded Hispanic level 1 and 2 EL students from participating in higher-level mathematics (HLM) courses. Since the ACCESS test is used as the only placement assessment tool at school registration, EL students with varying levels of math knowledge and aptitude are placed in an identical math trajectory based solely on their English proficiency. The effects of the trajectory of courses for Hispanic EL students, which are directly associated with the placement system, seem to worsen after Grade 9, creating a waterfall of issues, specifically in the math and science fields. The underlying assumption in the current placement system is that Hispanic EL students are not capable of performing in higher-level courses. This has neither been tested nor confirmed.

Significance of the Problem

The current system that places Hispanic EL students into math courses at school registration has been created and perpetuated by the assumption that Hispanic level 1 and 2 EL students enter school in the United States at a lower level in mathematics, which has not been tested or confirmed. The use of antiquated one-dimensional placement systems that solely evaluate student knowledge through the lens of English proficiency does not acknowledge the countless differences among the educational competencies and historical academic narratives of Hispanic EL students. A system that only evaluates English proficiency and then places students accordingly does not account for academic foundations, such as mathematics, and makes inaccurate assumptions about the cultural and academic homogeneity of Hispanic EL students.

Historically, Hispanic EL students have been denied entry into HLM courses despite meeting the same academic prerequisites as their native English-speaking peers due to their perceived academic inabilities related to a lack of English proficiency. Though the research indicates that high school students who complete advanced mathematics courses, like precalculus, are more likely to graduate from high school and are twice as likely to attend college compared to students who are enrolled in lower-level mathematics courses (Adelman, 2006), Hispanic EL students continue to be disproportionately underrepresented in these courses. It is assumptions about linguistic proficiency, rather than evidence, that often guide policies as they relate to the perceived abilities of Hispanic EL students to perform in HLM courses. These assumptions have long-term negative consequences for Hispanic EL students because they potentially limit their academic and career opportunities. This project focuses on secondary school mathematics placement, as students' performance in mathematics is one of the strongest indicators of high school graduation, college matriculation, and employment in the Science, Technology, Engineering, and Mathematics (STEM) fields, which are currently the fastest growing sectors of jobs (U.S. Department of Labor, 2018). The data regarding post-secondary education for EL students are indicative of the need for change; as the numbers of EL students continues to rise, the number enrolling in colleges and universities should as well. However, statistics from a study conducted by Kanno and Cromley (2015) indicate this is not occurring, perhaps due to reasons related to curricula, tracking, and homogeneous grouping that segregates EL students in a way that denies them equitable educational opportunities. The educational structure that exists for many newly arrived Hispanic EL students drives a generation of individuals into employment tracts that do not require degrees beyond high school and perpetuates the economic, social, and political marginalization often experienced by Hispanic immigrants.

Positionality

As an educated former EL student, I find myself at a crossroads in my career where I know that from an intellectual and ethical perspective, EL students are not afforded the same access to opportunities for academic success as their English-speaking peers, and I firmly believe this begins at the time of placement. The underlying assumptions that researchers hold are described by Morrow (2005), who claims that even prior to conducting a literature review, “investigators always believe something about the phenomenon in question” (p. 254). This is particularly true for me. My initial assumptions about EL placement are grounded in a combination of personal and professional experiences, in my roles as an EL student and as a school counselor working with the EL population. My early academic experiences as an EL student were not positive ones. I am of the belief that the manner in which I was educated was not conducive to the development of a solid academic foundation and that the lack of a proper English education created difficulties for me at the collegiate level. Unfortunately, I do not believe there have been significant changes in the progress of EL education in the 25 years since I was a student. I am witness to, through my current work as a Hispanic Bilingual School Counselor, the shortcomings of the way EL students are placed as it does not effectively correspond with the goal of achieving academic success. My assumptions, constructed through a combination of personal and professional experiences, regarding EL placement and its impact on future success are the foundation upon which these research studies are built. In my role as a researcher, my responsibility is to test my assumptions impartially and be ready to accept what the evidence shows as long as it is done fairly with real potential to confirm or disconfirm my theories.

Theoretical Framework

The placement of ELs upon their arrival into the public-school system is pivotal in the development of their language and skills (Conger, 2013) as well as its potential to impact both educational and social experiences at the high school level and beyond. Currently at the district, state, and national levels, EL students are placed into programs without consideration of any factors besides their language proficiency and using standard educational expectations for secondary level EL students of high school graduation (Kanno & Kangas, 2014). Although traditional EL students and SLIFE are homogeneously categorized upon entry in the school system as first-year EL students, their needs differ greatly. One of the major factors impeding academic success among members of these groups is linked to the process of evaluation and placement conducted during school registration. Findings from a study conducted by Ragan and Lesaux (2006) showed that the "lack of standardization and clarity of entry and exit criteria for ELL programs…has the potential to have pronounced effects" (p. 2) on these learners.

Vygotsky's (1978) Zone of Proximal Development (ZPD) and its role in instruction and assessment in schools provides the theoretical framework for the current project. The ZPD refers to the difference between what learners can do without help and what they are able to achieve with assistance from a skilled teacher (Vygotsky, 1978). For this to occur, students must begin their education at their individualized skill or knowledge level. Despite the extensive use of ZPD in education practices, this theory has not been integrated in the placement process of EL students, as demonstrated through the district policies related to assessment and placement. At the most basic level, each student should have the opportunity to be assessed to determine their capability of performing in HLM courses at the time of registration. However, this process does not occur. Instead, the district has determined that each EL student, regardless of potential background knowledge, has an equivalent ZPD and is placed in that manner. Construction of a protocol that assists in ZPD determination is critical in the establishment of a better system of placement that is guided on the principles of what the learner is capable of doing on their own and what the learner needs assistance with from a teacher rather than simple English language proficiency. By examining mathematics placement practices that have excluded Hispanic level 1 and 2 students from HLM courses, it may be discovered that Hispanic EL students have been denied the same opportunities as their native English-speaking peers to learn within their own ZPD. Students who have not been given the opportunity to perform academically because of their English language proficiency have not been able to develop a higher-level skill set, which is constructed through exposure to higher-level academic content and collaboration with more peers who more closely share their ZPD. This has the potential to greatly limit their future opportunities in postsecondary education and beyond.

The screening tool used by the district is composed of a language placement test, administered in English and by a staff member who is not required to be knowledgeable in EL strategies. This one-dimensional tool does not account for the student's social-emotional needs, educational history, or background knowledge gained in their country of origin. The current process of placing students solely on their English proficiency level is antiquated and should be modified, considering the heterogeneity that exists among EL students. Although educators understand the link between strong educational foundations and academic success, the placement tool does not allow or account for the level of prior education, nor is it designed to measure any background knowledge. Newly arrived EL students are categorized as level 1 or 2 in terms of English proficiency by the ACCESS test and are placed in full English immersion classrooms where they receive instruction in the major content areas as well as additional level-specific English language development support. The assumption that all EL students are academically similar across diverse subjects such as math, science, and history because of their English language proficiency has the potential to significantly impact future academic success among traditional ELs and SLIFE.

Inappropriate classification decisions, which may be caused by the screening tool used, may unnecessarily place students who are at higher levels in academic content areas, such as mathematics, into remedial programs and may deprive students of appropriate curricula (Abedi, 2008). The deprivation of appropriate curricula and its accompanying feelings of discouragement (Barajas-Lopez, 2014) initiates a series of negative events for some Hispanic EL students. Because only a only small percentage of Hispanic ELs (2%) are academically prepared, both by courses and grade point average (GPA) as indicated in their limited enrollment in college preparatory courses, to enter 4-year colleges and universities (Callahan, 2005), they continue to be underrepresented in colleges and universities as well as STEM programs (National Center for Education Statistics, 2017), which may lead to employment opportunities in one of the fastest growing career fields (U.S. Department of Labor, 2018). This pattern unfortunately begins upon registration into school in the United States and their subsequent placement into a restricted academic trajectory.

The evidence of a limited math trajectory for EL students is found in a review of both the literature and school curricula. The proportion of current ELs in the accelerated math sequence is significantly lower than the proportion of both former ELs and never ELs (Thompson, 2017). The resulting consequences are that EL students attain less math knowledge and complete less rigorous math coursework than former and never ELs (Thompson, 2017), decreasing their preparedness and potential for advanced post-secondary work, specifically in STEM-related fields. Non-EL students are provided significantly more opportunities than their EL peers to satisfy the requirements for post-secondary admission into STEM courses through enrollment into HLM courses.

The current placement system only accounts for English proficiency, which provides limited information on what Vygotsky referred to as "what is known" (1978) and may result in incorrect academic placement of students. This devalues the narrative of EL students and creates a mechanism where EL students, who may have knowledge and aptitude equivalent to their non-EL peers, are denied access to opportunities for academic achievement that may extend beyond high school. The present state of EL education, as described in the research, and the use of antiquated one-dimensional placement systems that solely evaluate student knowledge through the lens of English proficiency necessitate the construction of a new model that more appropriately accounts for additional factors that may impact an immigrant student's learning trajectory.

An updated model that has been reconstructed to better capture, in a holistic manner, the experiences of the immigrant student would incorporate additional factors, such as content knowledge, English proficiency, and social-emotional state. These factors have been traditionally used for placement for students not classified as EL (no-EL) but have yet to be extended to EL students. By expanding what is known to include English proficiency, content knowledge, and factors related to their social-emotional state and constructing an evaluation tool that more effectively measures these, it is more likely that the student will begin their U.S. educational experience at a more appropriate ZPD. The researcher acknowledges that the current project is the first step towards the development of a more holistic, comprehensive model designed to improve educational opportunities for EL students. The current project explores one facet of content knowledge, mathematical ability, with the purpose of exploring the potential of this proposed model to more appropriately place EL students.

Problem Statement

The assessment exam used at school registration places EL students into an identical math trajectory based solely on their English proficiency. The current placement of Hispanic EL students into math courses has been created and perpetuated by the assumption that Hispanic level 1 and 2 EL students are at a lower level in mathematics, which has neither been tested nor confirmed. This assumption segregates a specific group of students from HLM courses and continues to marginalize Hispanic EL students by eliminating academic opportunities both at the high school and post-secondary levels. The current project aims to explore the veracity of these assumptions. The overarching purpose of the current project was to explore the mathematics placement practices that have excluded Hispanic level 1 and 2 students from HLM courses and to utilize the results to construct more equitable mathematics placement practices. The lack of representation of Hispanic EL students in HLM, created by the historical practice of segregating Hispanic EL students with level 1 and 2 English proficiency from HLM courses, necessitated the use of a multifaceted, indirect approach to explore the issue of math placement and Hispanic EL students. This included determining if there were factors that appropriately predicted mathematical performance for level 1 and 2 Hispanic EL students and exploring, through comparison analyses of archival data, the mathematics performance of Hispanic EL and no-EL students.

Research Questions and Hypotheses

Since Hispanic EL students have not been allowed to participate in an alternate, HLM trajectory due to their language proficiency, another method to collect evidence that they may be able to do the work was constructed. Using a comparative research design, the current project incorporated three studies, which together provide a more comprehensive analysis of the mathematics placement practices that have historically excluded Hispanic level 1 and 2 students from HLM courses. All three studies utilized the district's archival database and the state department of education database, which provided detailed demographic and academic information on the participants.

Study 1 was designed to determine if there was a shared metric between EL and no-EL students that would appropriately predict mathematical performance in HLM. The study explored what relationship, if any, existed between Mathematics State Assessment (MSA) scores and/or Algebra 1, the shared metrics between Hispanic EL and no-EL students, and performance in precalculus. To meet the overall goal of the project most appropriately, which was to explore the current mathematics placement practices that have excluded Hispanic level 1 and 2 students from participating in HLM courses, a minimum cutoff grade by which to examine the final Algebra 1 grade and HLM performance was also established.

Research Question 1-1: Is there a shared metric between EL and non-EL students that would appropriately predict mathematical performance in higher-level math?

Hypothesis 1-1a: MSA will show a modest but substantial correlation with performance in precalculus courses for all students who have taken the course for at least two quarters.

Null Hypothesis 1-1a:	There is not a strong enough or significant correlation between 10th grade MSA scores and the final precalculus grade for all students who have taken the precalculus course for at least two quarters.
Hypothesis 1-1b:	Algebra 1 will show a modest but substantial correlation with performance in precalculus courses for all students
Null Hypothesis 1-1b:	There is not a strong enough or significant correlation between the final Algebra 1 grade and the final precalculus grade for all students who have taken the precalculus course for at least two quarters.
Research Question 1-2:	Are there differences in Algebra 1 performance between students who did not enroll in HLM and those who did?
Hypothesis 1-2:	A significant difference in the means between the no-EL HLM and no-EL no-HLM sample groups will emerge on this linking variable.
Null Hypothesis 1-2:	There will not be a significant difference of the means between the no-EL HLM and no-EL no-HLM sample groups on the linking variable (final grade in Algebra).
Research Question 1-3	Is there a cutoff grade in Algebra 1 that best predicts successful performance in higher-level math?
Hypothesis 1-3	A minimum cutoff grade in Algebra 1 that outperforms chance in predicting HLM performance can be obtained through cross tabs. Sensitivity will be emphasized more than specificity.

Null Hypothesis 1-3: No cutoff grade or range of grades in Algebra 1 that adequately predicts HLM performance, emphasizing sensitivity above specificity, can be obtained through cross tabs.

Study 2 was designed to explore if there are factors that may predict math potential for Hispanic EL students. The analysis, which also included an additional post hoc exploratory analysis, was conducted by examining several predictor variables and the shared metric between Hispanic EL and no-EL students that was established in Study 1. By examining predictor variables that are available when the student registers for school, it may be possible to develop a model that predicts math performance and assists with course placement.

Research Question 2-1: Does a predictive model exist that adequately delineates performance in HLM for Hispanic level 1 and 2 students?

Hypothesis 2-1: A model will emerge in Study 2 from the multiple regression with at least a modest yet significant strength to adequately predict math ability associated with precalculus performance.

Null Hypothesis 2-1: No significant model that adequately predicts Algebra 1 performance will emerge.

Research Question 2-2: If the model is strong enough, can this model be adapted into a decision protocol algorithm that outperforms chance in selecting students who will likely pass precalculus?

Hypothesis 2-2: A decision protocol using procedures that adapt significant multiple regression models into algorithms will be successfully created based on the multiple regression results.

Null Hypothesis 2-2: The models will not outperform chance in selecting students who will do well in higher-level math.

Post Hoc Exploratory Question

Research Question 2-3: Are there indicators available at the time of school registration that are associated with Algebra 1 performance for Hispanic EL level 1 and 2 students?

Hypothesis 2-3: Predictor variables will emerge from the multiple regression analysis that are associated with performance in Algebra 1 for Hispanic EL level 1 and 2 students.

Null Hypothesis 2-3: No predictor variables will emerge from the multiple regression analysis that are associated with performance in Algebra 1 for Hispanic EL level 1 and 2 students.

Study 3 was constructed to further explore the historical practice of using English proficiency to dictate a math trajectory for Hispanic EL students after an initial examination of the findings from Studies 1 and 2. There are assumptions that accompany the policy of determining English proficiency at school registration and using that proficiency to place EL students in math courses. Study 3 was designed to examine those assumptions through the use of additional post hoc analyses using specific datasets from the same overall archival database from Studies 1 and 2. These 3 additional inquiries used the a priori alpha allocated for follow-up analyses after examining the initial outcome from Studies 1 and 2. Since Research Question 3-2 was designed to explore if there are differences between Hispanic EL level 1 and 2 students and other students, it was necessary to construct additional, more specific research questions. Each of these research questions were tested with their own set of hypotheses.

Research Question 3-1: Is there substantial variation among Hispanic EL level 1 and 2 students in their performance in Algebra 1?

Hypothesis 3-1: There is a substantial variation in the distribution of the final grade in Algebra 1 among all Hispanic level 1 and 2 students.

Null Hypothesis 3-1: There is little variation in the distribution of the final grade in Algebra 1 among all Hispanic level 1 and 2 students.

Research Question 3-2: Are there differences in Algebra 1 performance between Hispanic EL level 1 and 2 students and other students?

Research Question 3-2A: Is the Algebra 1 performance of Hispanic EL level 1 and 2 students similar to all non-EL students?

Hypothesis 3-2A[1]: The Algebra 1 final grades of the Hispanic EL students will be similar to the Algebra 1 final grades in the no-EL all sample group.

Null Hypothesis 3-2A[1]: The Algebra 1 final grades of the Hispanic EL students will not be similar to the Algebra final grades of the students in the no-EL all sample group.

Research Question 3-2B: Are there differences in the Algebra 1 performance of Hispanic EL level 1 and 2 when compared to other students who did not enroll in HLM courses?

[1] The mean difference comparison between the EL and the no-EL all samples was run as a two one-sided test equivalence test, as outlined in Lakens et al. (2018), reflecting the most appropriate analysis to confirm a similarity or lack of difference. The other mean differences were hypothesized to be different consistent with the theorized model and were therefore analyzed as *t*-tests (Lakens et al., 2018).

Hypothesis 3-2B: The Hispanic EL group will show a higher mean compared to the no-EL no-HLM group.

Null Hypothesis 3-2B: The Hispanic EL group will fail to show a higher mean compared to the no-EL no-HLM group. There will be no difference when the means are compared.

Research Question 3-2C: Are there differences in the Algebra 1 performance of Hispanic EL level 1 and 2 when compared to students who enrolled in HLM courses?

Hypothesis 3-2C: The means of the final Algebra 1 grades for the no-EL HLM group will be stronger than the Hispanic EL students.

Null Hypothesis 3-2C: The means of the final Algebra 1 grades for the no-EL HLM group will fail to show a difference when compared to the Hispanic EL students.

Key Terms

ACCESS testing: The placement test used in 38 states to assess English proficiency for EL students. It is an acronym for Assessing Comprehension and Communication in English State to State.

MSA: Mathematics State Assessment designed to test student proficiency in Mathematics.

English Language student: Students for whom English is not their first language and who are unable to communicate in English. They require specialized instruction and support to meet their language needs. Their EL status is determined at registration and reevaluated yearly. Formerly referred to as English as a Second Language (ESL) student and English Language Learner (ELL).

Level 1: The English language proficiency level assigned to an EL student who knows and uses minimal social English language and minimal academic language with visual and graphic support.

Level 2: The English language proficiency level assigned to an EL student who knows and uses social and instructional words and expressions including cognates.

Hispanic or Latino: Defined by the U.S. Office of Management and Budget (1997) as "a person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin, regardless of race" (Categories and Definitions section, para. 5).

SLIFE: Students with Limited or Interrupted Formal Schooling. They have completed little formal schooling, perhaps only completing the compulsory elementary education in their native countries. They have major gaps in their educational foundations and often lack literacy skills in their native language.

Traditional EL Students: EL students who enter the school system with a higher level of formal schooling. The schooling for these students has been consistent throughout their academic history, and students possess literacy skills in their native language.

Summary

The current placement of Hispanic EL students into math courses has been created and perpetuated by the assumption that Hispanic level 1 and 2 EL students enter school in the United States at a lower level in mathematics, which has neither been tested nor confirmed. The overall purpose of the project is to explore these assumptions and to develop a more comprehensive analysis of the mathematics placement practices that have historically excluded Hispanic level 1 and 2 students from HLM courses. Chapter 2 further describes the theoretical framework, the history of EL education in the United States, the literature related to factors associated with being a Hispanic level 1 or 2 EL student, the current placement assessment tool used for EL students, and the characteristics and outcomes of the EL curriculum. Chapter 3 explains in detail the methods employed to explore assumptions and placement as it relates to Hispanic level 1 and 2 students and mathematics. Chapter 4 outlines the statistical analyses utilized in the three studies that comprise the overall project. Chapter 5 presents a summary of findings as well as implications and future directions related to mathematics placement and Hispanic level 1 and 2 students.

CHAPTER 2: LITERATURE REVIEW

The increased number of Hispanic English Learner (EL) students and the shift in immigration patterns in the United States have created new challenges for school districts and state and national agencies in relation to educating this new, diverse group of learners. Research has not maintained pace with the expedited rate of demographic shifts and influxes of EL students, forcing school districts to often use antiquated research that is not specific to the population. This translates to disconnections between theory and practice as procedures and policies may no longer be applicable and effective in educating the recent wave of EL students who began their academic careers in the United States at the secondary level.

There are several areas that are essential in the development of a comprehensive understanding of the current state of mathematics education for Hispanic EL students and the fundamental role that placement plays in academic achievement. These include historical context in terms of EL education, factors associated with being a Hispanic level 1 or 2 EL student, the current placement assessment tool used for EL students, and the characteristics and outcomes of the EL curriculum. These are explored within Vygotsky's (1978) Zone of Proximal Development. These areas, and their interrelationships, are discussed in the following sections.

Theoretical Framework

Vygotsky's (1978) Theory of the Zone of Proximal Development (ZPD) has been widely utilized in the development of education policies. At its most basic level, the ZPD refers to the difference between what a learner can do without help and what they are able to achieve with assistance from a skilled teacher. For this to occur, students must begin at their individualized skill or knowledge level; by assessing only for English proficiency, which all new immigrant students understandably lack, and not knowledge, it is impossible to clearly identify what the student’s ZPD truly is.

Academic foundations are instrumental in education, and when students possess a foundation, the process of knowledge transfer and learning is enhanced. The assumption, then, is that all EL students begin at identical starting points in all content areas, a concept that was eradicated from regular education instruction years ago. Beginning each student at identical places because of their language proficiency limits their opportunities to progress at an individualized pace, whether it be advanced or not, and ultimately may create inequities in their ability to achieve compared with their native-English speaking peers (Thompson, 2017). Instead of constructing a system that is equitable to their native-English speaking peers, in terms of opportunity for advancement, Hispanic EL students become enveloped in a tracking system (Thompson, 2017) that potentially diminishes their advancement by ignoring and disregarding their ZPD and erroneously assuming instead academic homogeneity among Hispanic EL students, despite contrary research regarding differences in Hispanic EL students (King & Bigelow, 2016). Examining the outcomes of the screening tool through the lens of denied opportunity to learn within one’s ZPD is necessary to establish equitable access to educational opportunities for Hispanic EL students by disentangling English proficiency and academic ability.

History of EL Education

The recent saturation of the media in its portrayal of surges of migrations of children into the United States from Central America would potentially mislead individuals into believing that immigrant students in the schools, technically identified as English Learners, is a novel concept. However, the process of educating EL students began over 50 years ago, with the introduction of a bill in Texas proposed to aid school districts to establish educational programs specifically for EL students, formally known as Limited-English Speaking Ability students. The bill, entitled the Bilingual Education Act, was designed specifically to ensure funding for bilingual education, encourage teaching of Spanish as a native language and English as a second language, and to provide Spanish-speaking students with an appreciation of their ancestral language and culture (Bilingual Education Act, 1968). This act, also referred to as Title VII of the Elementary and Secondary Education Act, was the first federal acknowledgement that Limited-English Speaking Ability students are a population with specific educational needs and bilingual programs that address those needs should be federally funded (Stewner-Manzanares, 1988). It was this act that provided the foundation for Lau vs. Nichols (1974), a landmark case in bilingual education.

The Supreme Court ruling in Lau v. Nichols (1974) became the cornerstone of current bilingual education by establishing a new framework, complete with regulations and policies, for districts and states to use in their education of EL students, formally referred to as bilingual students. The decision mandated, at a federal level, that public schools develop policies to ensure that EL students have access to appropriate accommodations to provide them with equitable access to an education. Although the case involved Chinese students specifically, its intentions, to ensure that linguistic status should not influence a student's ability to receive an appropriate education, were applicable to all immigrant children.

Another major act that impacted EL education was Title III of the No Child Left Behind Act (NCLB) of 2001, which required that EL students, formally referred to as English language learners (ELL), be provided with instruction for learning both English and grade-level content. No Child Left Behind also mandated that EL students meet specific targets each year that were indicative of their progress in English Proficiency. In 2015, NCLB was replaced by the Every

Student Succeeds Act, which established new requirements for educating EL students and returned decision making in terms of how schools educate and annually evaluate EL student progress in proficiency in reading, writing, listening, and speaking English to the individual states.

In fulfillment of these laws, the state in which the present project was conducted requires EL students to participate in ACCESS for ELLs tests. In addition to testing for proficiency, the State Department of Education, in collaboration with the state legislature, developed a set of guidelines and mandates for school districts to implement to ensure equal access to curricula and opportunities for ELs. One of the more recent regulations signed into law is the Language Opportunities for Our Kids. This act provides districts with more flexibility in terms of the language acquisition programs they choose to implement to meet the needs of EL, while maintaining accountability for timely and effective English Language acquisition. This law is designed to create more accountability for school districts, while providing support, based on the district needs for EL students, whose population in certain districts has augmented due to migration trends in the state. Although the Language Opportunities for Our Kids Act was developed as a more effective way to provide for support for EL students, there is no indication that ACCESS testing will be removed, despite the limitations associated with it and its lack of standardization across the state.

Hispanic EL Students

In opposition to the first laws surrounding EL, then known as Bilingual Education, which only included Spanish-speaking students, the current state of EL education incorporates all EL students, regardless of their country of origin, immigration status, or nativity. Similar to the country as a whole, the state in which the research was conducted has been experiencing significant changes in the demographic profile of EL students due to an influx of Hispanic immigrant children from not only Central America (Amuedo-Dorantes & Puttitanun, 2016) but also the Caribbean and South America. According to the National Center of Educational Statistics (2017), Hispanic students are the largest ethnic group enrolled in public schools; the percentage of public-school students in the United States who were ELs in the fall of 2015 was 9.5% or 4.8 million, a 1-million-student increase from the fall of 2000. In the district in which the study was conducted, 61.6% of students are categorized as Hispanics, and over one fifth of the population (21.8%) are ELs.

Type of EL Student

The diversity among Hispanic EL students is great in terms of emotional, academic, and family needs (Suárez-Orozco, Suárez-Orozco, & Todorova, 2008; Yip, 2017). English Learners are further categorized beyond language proficiency into two different groups, "traditional" EL students and Students with Limited or Interrupted Formal Education (SLIFE) (Freeman & Freeman, 2002; WIDA, 2015). "Traditional" EL students may be described as those who enter the public schools with a higher level of formal schooling, reside with a parent or guardian, and seem to have a broader support network, while many of the SLIFE population lack these characteristics. The latter group presents a new set of challenges to educators and school systems due to a variety of factors including their academic backgrounds, emotional and psychological needs, lack of adult support, and immigration status (Storlie & Jach, 2012; WIDA, 2015). The difference between traditional EL and SLIFE students is apparent in their acculturation to school settings and their lack of background knowledge in academic subjects. Traditional EL students enter high school with a degree of knowledge in their own native language that enables them to transition, academically, socially, and emotionally, more seamlessly and their background content knowledge and skills assist them in propelling linguistically at a higher rate than SLIFE students. Traditional EL students tend to have more protective factors that counterbalance the risk factors associated with immigration and English proficiency than do SLIFE, graduating at a higher rate than SLIFE (Freeman & Freeman, 2002; Yip, 2017). It is plausible that many students categorized as SLIFE have not been enrolled in schools for several years, as compulsory education laws in their country of origin are limited. Additionally, many in this group of students travel to the United States unaccompanied, without their parents or guardians, and upon apprehension are placed with sponsors, who often are distant family relatives or friends (Amuedo-Dorantes & Puttitanun, 2016)**.** The emotional needs of these students may be great, as they have experienced trauma in their native countries and during their border crossing as well as issues associated with undocumented status and may not be understood by school districts (Infante, Idrovo, Sánchez-Domínguez, Vinhas, & González-Vázquez, 2012; Perreira & Ornelas, 2013).

Economic Factors

There are multiple economic factors that may influence the ability of some Hispanic EL students to perform academically, including unaccompanied status, debt repayment, and remittance. Students who are under age 18, have no lawful immigration status in the United States, and are without a parent or legal guardian in the United States who is available to provide care and physical custody may be categorized as unaccompanied youth (Homeland Security Act, 2002). Their independent status often requires that they work extensive hours to sustain themselves, which, research has demonstrated, has a negative impact on students' ability to achieve academically (Perez, Espinosa, Ramos, Coronado, & Cortes, 2009). It is possible that students who have not lawfully immigrated to the United States students may also be working to repay the debt to the *coyotajes* or *polleros*, the individuals who facilitated their migration to the United States (Heidbrink, 2018; Izcara Palacios, 2015). This debt, in the thousands of dollars plus interest (Heidbrink, 2018), must be repaid in a timely manner or retribution to the student's family members who remain in the country of origin is threatened. Students may also be working to send money to their country of origin, a process formally referred to as remittance (Park, Amparo Cruz-Saco, & Lopez Anuarbe, 2017). Remittance is a relatively common practice among non-U.S.-born migrants (Park et al., 2017) who have emigrated from countries with high levels of poverty and is reflective of the cultural expectation that all individuals of a certain age contribute financially to the family (Heidbrink, 2018). The need to work to sustain themselves, to repay debt, and to contribute to their families who have remained in their country of origin may force students to work more than 20 hours a week, which, research shows, is the demarcation point where employment begins to negatively impact the academic achievement of students (Perez et al., 2009).

Gender

There are differences between male and female students that may influence their ability to perform in mathematics. Embedded within the economic factors discussed above are the norms and expectations related to gender found within patriarchal countries. In these countries, there is a heightened expectation for males to work and provide financially for their families (Galanti, 2003). Remittance behaviors among Hispanic migrants from Latin American countries are more prevalent in males than females (Park et al., 2007) and may be representative of the cultural expectations and values found within the countries that individuals immigrated from (Heidbrink, 2018).

Gender also influences the types of employment opportunities available for males and females, which may impact a student’s capacity for academic engagement. According to the American Community Survey conducted by the U.S. Census Bureau (2018), two percent of immigrant women 16 years and older were employed in maintenance and construction occupations, compared to 21% of immigrant men 16 years and older (2018). Thirty one percent of immigrant women aged 16 years and older were employed in service occupations, such as grocery stores, compared to 17% of immigrant men aged 16 years and older. Although the survey is designed to categorize immigrant employment, it may not fully capture the employment patterns of undocumented workers, as fear of deportation often forces them to go unaccounted for in research (Jeffries, 2014).

Research also suggests there are gender-related differences in relation to academic performance. Recent studies have rejected the notion that math and science differences between genders are biologically based; in fact, they have found no difference in brain processes and neural engagement related to gender (Kersey, Csumitta, & Cantlon, 2019) in early childhood. Rather, the underrepresentation of women in majors and careers related to Science, Technology, Engineering, and Math (STEM) may be attributed to sociocultural ones often displaying themselves after early childhood (Van Mier, Schleepen, & Van den Berg, 2018; Wang & Degol, 2017). Current research conducted among male and female students in Caribbean and Latin American countries have found a different pattern than that found in the United States in relation to gender-related differences in academic performance (DeRose, Huarcaya, & Salazar-Arango, 2018; Duraya, Galiani, Nopo, & Piras, 2007). In Caribbean and Latin American countries, even in areas with poor educational progress, a reverse gender gap exists, which favors females over males (DeRose et al., 2018; Duraya et al., 2007). Since current research indicates there is no biological basis for gender differences in math and sciences, the results of studies conducted in Caribbean and Latin American countries suggest that there may be different sociocultural influences impacting female and male academic performance in these countries.

Academic Readiness

Research indicates that only a small percentage of Hispanic ELs (2%) are academically prepared, both by courses and grade point average (GPA), as indicated in their enrollment in college preparatory courses, to enter 4-year colleges and universities (Callahan, 2005), which impacts Hispanic EL participation in higher education. These trends in the GPAs of Hispanic students are supported by research, including the Longitudinal Immigrant Student Adaptation Study, which used a mixed methods approach to examine the academic patterns of 407 immigrant students from various countries over a 5-year period (Suarez-Orozco et al., 2008). The study found differences in the GPAs among students of varying racial and ethnic backgrounds; Hispanic students, regardless of country of origin, tended to have lower GPAs than their Asian immigrant peers (Suarez-Orozco et al., 2008). Although the mean starting age of participants is 11.6 years, which would place students in middle school, its use of bicultural and bilingual research assistants and inclusion of newly arrived immigrant youth (Suarez-Orozco et al., 2008) allows for its applicability to Hispanic EL students.

ACCESS Testing for EL Students

In response to NCLB regulations in which states, or a consortium of states, were mandated to create their own standards for monitoring and supporting EL students, the Assessing Comprehension and Communication in English State to State for ELLs (ACCESS for ELLs) was developed. The entity responsible for the development of ACCESS is the World Class Instructional Design and Assessment (WIDA), an agency formed in 2003 through the United

States Department of Education by the states of Wisconsin, Delaware, and Arkansas. The idea behind the development of this assessment was to provide continuing support for the development of English language and to satisfy accountability as part of NCLB. However, the opposite effect may be occurring as the lack of standardization of entry criteria for EL programs, which ACCESS is used for, has the potential to have profound consequences for EL students (Ragan & Lesaux, 2006). Although it is currently used in 39 states and territories nationwide as a screening tool for initial placement of entering EL students and to assess growth in proficiency levels each academic year, each state is free to set its own guidance regarding testing accommodations and use of results, which impacts the standardization of EL education across states. The test assesses four major domains of the English language—reading, speaking, listening, and writing—as well as some aspects of the English language used in the four content academic areas, ELA, math, science, and social studies. The test is administered annually to students from K–12 and produces three types of scores: (a) raw scores, (b) psychometrically derived scale scores, and (c) proficiency level followed by a decimal to tenth. These scores are then constructed into the following categories: Entering (Level 1), Beginning (Level 2), Developing (Level 3), Expanding (Level 4), Bridging (Level 5), and Reaching (Level 6). The students of most concern to many educators are level 1 students, who, according to WIDA proficiency levels, know and use minimal social language and minimal academic language with visual and graphic supports (Fox & Fairbairn, 2011).

There is a one-dimensionality to ACCESS testing as its focus is on accessing English proficiency; its inability to account for academic foundations, such as mathematics, which may be more appropriate for placement, may contribute to negative academic outcomes (Fox & Fairbairn, 2011). Not accounting for the student’s educational history or background knowledge gained in their country of origin makes assumptions about the cultural and academic homogeneity of all Hispanic EL students, which, research has illustrated, is inaccurate (Suárez-Orozco et al., 2010; Yip, 2017). As previously mentioned, there are countless differences among the educational competencies of EL students (King & Bigelow, 2016), as there are among students whose native language is English, which supports the need for inclusion of historical academic narratives into the placement of students. Assumptions are made that countries and international educational systems mirror that of the United States and that all students educated in the same country have parallel academic experiences. This is not necessarily true.

There are significant differences in the education profiles of students even from the same country, which may be due, in part, to whether they attended public or private school, as each educates them at pedagogically different levels. Public education in developing countries is subject to not only the funding but also the functioning of the government. In some countries, issues such as public-school teachers going on strike for months, military coups disrupting the government functioning, and natural disasters that cause schooling to be disrupted for extensive periods of time all create gaps in learning for students (WIDA, 2015). Also, the curriculum delivered at public institutions does not appear to be as rigorous as the instruction in private schools. This dichotomy between public and private education creates a dilemma in terms of determining academic placement because it is uncertain as to how much actual time spent on learning the student has received, regardless of what the transcript states. This places both students at higher levels and students who may be lacking an academic foundation at risk of not achieving their full academic potential.

It is uncertain, after a review of the research, why all 50 states do not use ACCESS testing, and it is especially concerning that California, which houses one third of the nation's EL students (California Department of Education, 2018; Callahan, 2013), has yet to adopt this tool. The state of California instead utilizes the English Language Proficiency Assessments for California, which is the required state test for English language proficiency that must be given to students whose primary language is a language other than English. The English Language Proficiency Assessments for California aligns with the 2012 California English Language Development Standards and consists of two separate English language proficiency assessments: one for the initial identification of students as English learners (ELs) and a second for the annual summative assessment to measure a student's progress in learning English and to identify the student's level of English language proficiency (California Department of Education, 2018).

In addition to the one-dimensionality of ACCESS in terms of academic measurement and lack of standardization among states, there may be issues related to the screening process itself that impacts academic outcomes for students. Unfortunately, in many districts, the process of testing of EL students is not standardized, and factors related to implementation may impact testing (King & Bigelow, 2016; Solano-Flores, 2008), including screening by individuals lacking in bilingual and bicultural skills and in an environment not conducive to testing. This means that some EL students are placed by their response to testing conditions rather than their actual English proficiency.

The most significant factor in the utilization of ACCESS to screen entering EL students for placement is in its potential long-term outcomes for academic opportunities and achievement for all EL students. It is contended that inappropriate classification decisions, which may be caused by the screening tools used, may unnecessarily place students who are at a higher level of English proficiency into remedial programs (Abedi, 2008) and may deprive students of appropriate curricula. A recent qualitative study conducted by King and Bigelow (2016) provides additional evidence that the evaluation tool utilized by school districts in the United States is ineffective in the placement of students for whom English is not their first language and that these tests potentially mislead educators about students' abilities. This study found a student who was categorized as a long-term English language learner had the same score as some SLIFE (King & Bigelow, 2016), indicating the inability of the test to account for different educational and background experiences of the students. Despite the lack of test sensitivity and inability to account for prior knowledge, it continues to be the primary source of assessment for EL students. Researchers discovered that in some cases, the underestimating of capabilities, masked by a lack of linguistic proficiency, has led to ELs being disproportionately placed into special education (King & Bigelow, 2016).

Placement and Curriculum

Currently at the district, state, and national levels, EL students are placed into programs based solely on their English proficiency and using standard educational expectations for secondary level EL students' high school graduation (Kanno & Kangas, 2014). Once screened, students are placed into an EL curriculum in which there are inherently several issues, including its assumptions and potential outcomes for EL students. There is evidence, supported through research (Callahan, 2005; King & Bigelow, 2016; Palardy, Rumberger, & Butler, 2015), that placement exams whose focus is solely on English proficiency have the potential to produce a tracking system, defined as "the assignment of students to differentiated coursework with varying levels of academic content" (Callahan, 2005, p. 307), that linguistically segregates students within schools and decreases their exposure to opportunities to increase their language fluency (Palardy et al., 2015). There are specific consequences to the tracking of EL students in terms of long-term outcomes and its potential to limit academic achievement, especially in mathematics, for Hispanic EL students.

Homogeneous Grouping

The education of EL students is guided by the assumption that all students arrive in the United States with the same background knowledge. The administration of a language proficiency exam that places students according to their language domains and not their abilities supports these assumptions. There are different first languages, migration histories, and levels of exposure to formal instruction that contribute to the notion that EL populations are heterogenous (Solano-Flores, 2008; Suárez-Orozco et al., 2010), not homogeneous, as other studies have indicated through their grouping of Hispanic populations. Although students are recognized for having linguistic differences, academic gaps, varied learning experiences, and diversity, they are categorized homogeneously without individualized considerations that may be helpful in learning the curriculum (Debossu, 2015). The assumption in this placement is that all EL students are socially and culturally homogeneous and do not possess the cognitive and social assets necessary for classroom learning (Levinson et al., 2007). Since there are multiple factors, including linguistic and cognitive difficulties, sociocultural differences, and psychological/emotional concerns (Lin, 2015), that affect student performance, when EL students are unilaterally placed with disregard to background education and social factors, the process of language acquisition is delayed. This method perpetuates marginalization by providing inequitable opportunities for different groups of students to learn on the basis of their race/ethnicity rather than on their abilities (Kanno & Cromley, 2015).

For example, a recent study conducted by Kanno and Cromley (2015) investigated the college pathways for English Language Learners (ELL), who, despite being the fastest growing segment of K–12 students, remain underrepresented in higher education. Using a quantitative method with 2,000 ELL students, researchers analyzed which of the five stages of college planning presents the greatest difficulties to ELLs and why. The study found that ELLs lagged behind Native speakers and English proficiency minority students in 4-year college enrollment, with only 19.0% of ELLs enrolled in 4-year colleges. Racial/ethnic minority ELLs are particularly vulnerable and need more targeted support in the early stages of college planning, which may increase their application and enrollment in 4-year colleges. The study is limited in its exploration of other variables, such as legal status and amount of time in the United States, which may impact the college planning process.

Research conducted among not-classified or reclassified ELs provides further support for the negative impact that EL education may have (Conger, 2015) on students' academic opportunities. In a recent quantitative study conducted by Conger (2015), it was found that immigrant youth with some command of English have the ability to outperform native-born youth from similar race and class backgrounds, while those immigrants who are designated by the school system as EL tend to underperform in similar academic measures. This study, conducted with almost 600,000 ninth grade students in Florida Public Schools, indicates that the designation of EL status, and its subsequent placement, has the potential to have a negative effect on academic achievement. The findings are further supported by a quantitative study conducted by Hass, Tran, and Huang (2016), which examined the relationship between the English language proficiency level of EL students in Arizona and Nevada and the students' subsequent performance on English language arts and math content tests. Although the participants were not high-school-age, the conclusions, that students who are reclassified as fluent English proficient are likely to succeed in mainstream English-only classes and that proficiency thresholds are not necessarily indicative of student ability (Hass et al., 2016), are applicable to all Hispanic EL students.

Research has found that the placement of first-year ELs and SLIFE is pivotal in the development of their language and skills (Conger, 2013) and that background knowledge and previous schooling plays a fundamental role in the development and achievement of ELs. In fact, recent immigrants with background knowledge and a high degree of schooling outperform long-term ELs in content area classes (Callahan, 2005). However, despite these and other findings supporting the importance of prior academic knowledge (Mosqueda & Maldonado, 2013), the practice of one-dimensional placement has not been adjusted, and the education of ELs, using a homogeneous lens, continues to follow the trajectory of curricular tracking, deemed inappropriate for native-English speaking students years ago. The EL curriculum is designed with the idea of helping ELs “succeed” and advance at the same rate as their non-English speaking peers or former ELs with the idea that increased EL instruction will guarantee equitable success across all content areas. The curriculum for ELs is designed around the same frameworks as the regular education curriculum, the only difference being the idea of differentiation and the utilization of different EL teaching approaches and techniques. Unfortunately, as illustrated in the research, this instruction exists more in theory than in practice and instead reinforces linguistic segregation and its associated outcomes (Callahan, 2005; Conger, 2013; Kanno & Cromley, 2015). The resounding question that remains in EL education is how to separate two seemingly interwoven concepts, English proficiency and academic ability. One possible solution to disentanglement of these concepts is to focus on EL student placement to determine if a multifaceted placement tool will address this problem.

Homogeneous grouping creates issues that follow students throughout the entire educational experience, and even for students who have exited EL services in middle or high school, there is a long-term impact on academic achievement (Thompson, 2017). Tracking, created by having a linguistically segregated system for EL students, reinforces educational inequalities and further widens the achievement gap between native and foreign-born students (Palardy et al., 2015). Despite the knowledge in education regarding the link between strong educational foundations and academic success, one-dimensional placement tools do not allow or account for the level of prior education, nor is it designed to measure any background knowledge. It only determines the level of English proficiency, and unfortunately, most students entering the United States are at the same level of English proficiency despite their educational history.

EL Curriculum

After students are screened to determine English proficiency, traditional EL and SLIFE are placed together in full English immersion classrooms where they receive instruction in the major content areas as well as additional level-specific English language development support. There are implications to this; students placed in EL coursework exit high school with significantly less academic content knowledge due to the concentration on English proficiency (Callahan, Wilkinson, & Muller, 2010). Once students are placed in EL courses where one or two periods of the schedule are consumed by EL instruction, there is no room left for electives, including upper-level science and social science coursework, which would increase students' academic knowledge (Callahan et al., 2010). This presents a dilemma for high-achieving, potentially college-bound EL students as they will have limited linguistic and content exposure as well as opportunities to practice language because they are in class with students who have limited fluency (Conger, 2015; Palardy et al., 2015).

Due to potentially extensive variation in the students' knowledge base, particularly in classes designed specifically for EL students where traditional EL students and SLIFE learn together, teachers must slow the pace of the curriculum to accommodate students with limited or formal schooling or run the risk of disengagement. Unfortunately, this leaves behind higher-achieving students as those with greater academic needs require different attention from the teacher. For these students with more of an educational background, there are limited opportunities for high-level academic curricula within the EL classroom (Kanno & Cromley, 2015). The placement of students by a combination of language and aptitude would benefit students at the higher end of the academic spectrum because when students are with peers that practice and operate with a higher level of critical thinking skills, such as asking advanced questions, the rigor of the class, as well as learning opportunities, is increased (Conger, 2015b). Challenges remain even once students move out of EL courses, as often they have not received the foundation they need to achieve success as they transition into regular education courses and the post-secondary arena in terms of both content and higher-order thinking skills. Some, because of this placement, may have adjusted their learning expectations and lost their level of motivation, decreasing their future potential for academic achievement (Kanno & Kangas, 2014). This motivation may also be impacted by teacher expectations, which, research has shown, are extremely low for first- and second-year EL students (Callahan, 2005). This shift from low expectations to higher expectations as students begin to participate in mainstream courses may also contribute to the poor academic performance among advanced English learners (Callahan, 2005).

The lack of preparation, discouragement, and differences in teacher expectations creates a snowball effect where students are forced to enroll in community colleges because they do not have the opportunity to apply to a 4-year institution as a freshman or are denied admission into their desired major for lack of prerequisite courses (Callahan, 2005). For some students, being required to participate in remedial courses or not studying in the major of choice is so discouraging that they choose to not complete school (Gonzalez, 2009). Due to the tracking system that is created with placement based solely on English language proficiency, ELs are forced to remain in one “educational lane,” regardless of their academic abilities, rather than move ahead.

Not having equal access to proper instruction creates a disadvantage for students, especially when they are required to perform on high-stakes college entrance exams such as the SATs, ACTs, and Accuplacer exam. Being denied access to higher-level classes severely compromises their content and vocabulary knowledge in the subject and creates a disparity in terms of GPA, which is weighed by the academic rigor of classes. The current tracking of ELs may contribute to the fact that only a small percentage of ELs are academically prepared to enter 4-year college institutions as they have not taken enough college preparatory courses to be eligible to apply for admission (Callahan, 2005). A review of the College Board (2018) website, which includes indicators for college readiness, illustrates that students from other racial/ethnic groups, such as White, are more appropriately prepared for and attend colleges and universities at a much higher rate than their Hispanic EL peers. This is exemplified in the next section, which outlines the math sequences for students categorized as level 1 and 2 EL students and those that are not.

EL math course sequence. The challenge of disentangling English proficiency from academic ability remains one of the foundational issues of EL education (Callahan, 2013). Findings from a study provide evidence that current ELs obtained less math knowledge and completed less rigorous math coursework than former ELs and never ELs (Thompson, 2017). More current research has focused on math as an area of interest since the language of math is more universal and requires less English proficiency than other content areas, such as History (Thompson, 2017). This corresponds directly with the state policy in terms of testing EL students; Hispanic immigrants who have been in the country for less than 3 years are permitted to complete the mathematics examination in Spanish. Unfortunately, math learning, unlike English or History, occurs only in the school setting (Conger, 2013), and students lack the ability to supplement it at home, making school-based math courses fundamental to learning.

Often, traditional ELs and SLIFE, since they are categorized as level 1 in terms of proficiency by the ACCESS test, are placed together in full English immersion classrooms where they receive instruction in the major content areas as well as additional level-specific English language development support. These courses, which are conducted in classrooms separate from regular education students, are designed for first- and second-year EL students who have earned levels 1 and 2 English proficiency. Regular courses are the courses that general education students as well as higher proficiency EL students are enrolled in. Although the course number is the same, the classification and placement of EL students in separate classes creates a tracking mechanism where students are all forced to take the same sequence of courses regardless of their previous academic backgrounds. The effects of the tracking system seem to worsen, after Grade 9, specifically in the math and science fields where foundational knowledge is essential for participation and success. The imposed sequence of EL courses does not provide EL students with the same prerequisite knowledge and coursework as the regular education students, limiting their opportunities to enroll in upper-level courses such as physics and precalculus. Their ability to enter these types of courses was potentially predetermined at registration, when only their English proficiency, rather than their prior math and science knowledge, was measured and factored into their course placement.

The math sequence currently used in many EL programs disproportionately segregates EL students from advanced-level courses, which impacts their capacity to apply to math-related post-secondary programs, such as engineering and nursing. Research has shown that high school students who complete advanced mathematics courses, like precalculus, are more likely to graduate from high school and are twice as likely to attend college compared to students who are enrolled in lower-level mathematics courses (Adelman, 2006). Table 1 depicts an example of a math sequence for a level 1 EL student in a high school in the district where the project was conducted.

Table 1

Sample Math Sequence for a Level 1 EL Student

Grade 9	Grade 10	Grade 11	Grade 12
Algebra 1*	Geometry*	Algebra 2	Probability & Statistics

*MSA requirement course

Students who enter the district as 11th and 12th graders are required to enroll in both Algebra and Geometry to acquire the necessary content for the Mathematics State Assessment (MSA) exam. The assumption is that students, because no testing has been completed to indicate otherwise, lack the prerequisite knowledge in mathematics to pass the exam, despite it being presented in their native language and them having the required number of credits in content areas to be placed in a grade other than 9. This sequence does not correspond to the required sequence for many public and private universities and colleges, making EL students ineligible to apply. The current trajectory and sequence for students who are not categorized as level 1 or 2 ELs differ greatly and provide an opportunity to participate in higher-level mathematics (HLM) courses. These courses range from College Preparatory courses to Advanced Placement (AP) courses. Table 2 provides the potential courses for students who are not designated as level 1 or 2 ELs.

Table 2

Sample Potential Courses for Students Not Designated as English Learners (no-EL)

Grade 9	Grade 10	Grade 11	Grade 12
Algebra I	Geometry	Algebra II	Financial Literacy
Honors Algebra I	Honors Geometry	Honors Algebra II	Probability & Statistics
Honors Geometry	Algebra II	Honors Algebra II	Honors Calculus
	Honors Algebra II	Pre-Calculus	AP Calculus
		Honors Pre-Calculus	AP Statistics
		AP Statistics	

Tables 1 and 2 illustrate the historical practice of limiting mathematical opportunities for EL students due to their English proficiency. These practices are based on assumptions related to EL students as opposed to evidence-based research. Research conducted among EL students contradicts these assumptions and provides support for the notion that the lack of access to rigorous content is a principal factor contributing to achievement inequities (de Araujo, Roberts, Willey, & Zahner, 2018; Mosqueda, 2010; Mosqueda & Maldonado, 2013) on students' academic opportunities. A quantitative study by Mosqueda and Maldonado (2013), conducted with over 2,000 Latinas/os from different schools, found that students' linguistic proficiencies should not be used solely as a course placement determinant and that students' linguistic proficiencies need to be reconceptualized as indicators for the types of required resources necessary to ensure achievement in rigorous mathematics courses. The issues related to mathematical placement by English proficiency for Hispanic EL students are highlighted in a current literature review conducted by de Araujo et al. (2018), which focused on teaching and learning in which K–12 students were simultaneously learning mathematics in English and English in school. The review concluded that there are harmful effects of tracking and course placements and identified persistent inequities in everyday schooling experiences that affect ELs in mathematics.

Summary

Extensive research has been conducted in relation to EL students and academic achievement. However, there are fundamental issues with the available research in relation to high school-level Hispanic EL students. Much of the research has focused on students at the elementary level and often does not disentangle English proficiency from academic abilities and background knowledge, which is a significant concern for secondary-level EL students transferring into high schools in the United States. English Learners are often erroneously homogeneously grouped together in research without consideration for their country of origin, cultural differences, and educational foundation, all of which may influence their academic success in the United States (King & Bigelow, 2016; Suárez-Orozco et al., 2010; Yip, 2017). Additionally, the research has not maintained pace with the shift in demographics of EL students, often forcing school districts to use antiquated research that is not specific to the population to construct policies.

It is not only the paucity of literature as it relates to secondary-level Hispanic EL students and mathematics education but also the assumptions related to the abilities of Hispanic EL students to perform in HLM that create challenges in conducting a research project in this field. Although current research that indicates Hispanic EL students, despite their English proficiency, have diverse math skills that would allow them to perform in rigorous coursework (de Araujo et al., 2018; Mosqueda & Maldonado, 2013), they have been, and continue to be, disproportionately underrepresented in HLM courses. Their exclusion from advanced mathematics courses, which is based only on assumptions related to English proficiency as opposed to evidence-based research, makes it difficult to directly study their performance in HLM.

Despite the challenges associated with studying Hispanic EL students and HLM placement and performance, it is an area of high relevance as evidence generated may assist in breaking the cycle of social, political, and economic marginalization that Hispanic immigrant students often become entangled in. The concepts described above, including the history of EL education, factors associated with being a Hispanic level 1 or 2 EL student, the current placement assessment tool used for EL students, and the characteristics and outcomes of the EL curriculum, have been framed within the context of the research questions developed for this project. The lack of representation of Hispanic EL students in HLM necessitated the use of a multifaceted, indirect approach to explore the issue of math placement and Hispanic EL students for this project. The methods included three separate studies connected by a shared metric and aligned directly with the ultimate goal of the project: to create more equitable opportunities in mathematics for Hispanic EL students. The first study focused on determining the most appropriate shared metric between students categorized as level 1 and 2 Hispanic EL students and students not categorized as ELs. Once the shared metric was established, it was able to be utilized in Study 2 to find a model that would predict the future performance of Hispanic EL students in an HLM course. Lastly, Study 3 used the shared metric established in Study 1 to explore if there were academic differences between students categorized as level 1 and 2

Hispanic ELs and students not categorized as ELs that support the historical practice of excluding Hispanic EL students from HLM courses. The utilization of alternative methods to explore Hispanic EL performance in HLM courses highlights how assumptions about linguistic proficiency, rather than evidence, have guided policies and procedures related to the perceived mathematical abilities of Hispanic EL students.

CHAPTER 3: METHODS

The research design for the current project incorporated three studies, which together provide a more comprehensive analysis of the Mathematics State Assessment (MSA) and Algebra 1 in terms of the predictor variables that may influence it and its connection to performance in HLM courses, in relation to Hispanic English Learner (EL) level 1 and 2 students. All three studies utilized the district's archival database and the state department of education database, which provided detailed demographic and academic information on the participants. A comparative research design was chosen to best meet the overarching purpose of the current project, which was to explore the mathematics placement practices that have excluded Hispanic level 1 and 2 students from HLM courses and to utilize the results to start to construct more equitable mathematics placement practices. The purpose of the studies was three-fold. First, it was to examine, through quantitative analyses, if the MSA exam and/or Algebra 1 appropriately predicts mathematical performance in HLM. Secondly, to explore if there are additional factors that may predict mathematical potential, and lastly, to examine the potential differences and similarities between non-Hispanic EL students who participate in higher-level mathematics (HLM), non-Hispanic EL students who do not participate in HLM, and Hispanic EL students using the metric of the linking variable.

Students with significantly different academic abilities and background knowledge are homogeneously grouped into the same course trajectory, which is determined only by English proficiency. Since Hispanic EL students are not allowed to participate in an alternate, HLM trajectory due to their language proficiency, it was necessary to explore the potential differences in math knowledge using a metric shared across all students, referred to herein as a linking variable. The purpose of Study 1 was to establish a linking variable that is considered to be predictive of performance in an HLM course. Study 2 used a multiple regression analysis to determine which indicators best predict performance in the linking variable and thus are predictive of HLM for level 1 and 2 Hispanic EL students. Study 3 included additional analyses on the differences and similarities between non-Hispanic EL students who participate in HLM, non-Hispanic EL students who do not participate in HLM, and Hispanic EL students using the metric of the linking variable established in Study 1. It was constructed to assess whether there is additional evidence to demonstrate an overlapping distribution of performance in each student group, which would suggest that inequities for Hispanic EL students exist in the current system.

The questions and hypotheses were designed to examine the potential negative academic trajectory that a one-dimensional placement system creates for Hispanic EL level 1 and 2 students, as it relates to mathematics. Different datasets and subpopulations were chosen and then harvested from archival records at the district and state level. The studies included four different samples of students, which represent different subpopulations of students. The students in sample groups 1, 2, and 4 were all members of the general school population. The general school population includes students who were never identified as EL students, former English Learner (FEL) students, students who were identified as having level 3, 4, or 5 English proficiency in Grade 9, and students receiving instructional supports in the form of inclusion services through an Individualized Education Plan. The general school population for this project did not include students who participated in special education self-contained mathematics classrooms. Sample group 3 was part of a separate population of students who were identified as having level 1 or 2 English proficiency in Grade 9. These students are not considered to be part of the general school population for this project since all of their academic courses are taken in separate cohorts. A full description of the students and which subgroup they represent, and the selection criteria utilized for placement into each of these subgroups, is discussed in detail for each study. By analyzing one facet in depth, mathematical ability, and placement across different subpopulations, it was determined if the current placement system should be restructured and whether research should be continued to further explore the potential benefit of this model.

Study 1

Participants

The data from Study 1 were harvested from the district's archival database and the state department of education database. Together, the two databases provided detailed demographic and academic information on the subjects. This also included the grades earned in Algebra 1 and precalculus, as well as the raw score earned on the MSA. The inclusion criteria for subjects in Study 1 included participation in the MSA in Grade 10, an Algebra 1 course in Grade 9, and a no-EL math course in Grade 12. All three criteria must have occurred at the study site between September 2012 and June 2019.

Study 1 consisted of two sample groups harvested from the no-EL school population. The designation no-EL means that regardless of whether the sample group is no-EL HLM or no-EL no-HLM, the student group was from the general school population, as previously described, and then further partitioned based on their interest in and skills for HLM. All students in the district are required to participate in Algebra 1 as well as a Grade 12 math course. Between 2012 and 2019, students who were not identified as Hispanic level 1 or 2 ELs in Grade 9 had the option to participate in the HLM course in Grade 12. The no-EL HLM group refers to the students who participated in an HLM course, and the no-EL no-HLM group refers to the students who participated in a no-EL math course in Grade 12. During the time period from which the data were harvested, there were no Hispanic EL students enrolled in the no-EL HLM or no-EL no-

HLM courses in Grade 12 due to the placement policies. All Hispanic EL students who were identified as level 1 or 2 in Grade 9 were required to participate in a separate, no-HLM course for EL students in Grade 12.

Sample group 1, no-EL HLM, participated in an Algebra 1 course in Grade 9 and a no-EL HLM course in Grade 12 between September 2012 and June 2019. Sample group 1 included all students who participated in a specific HLM course, precalculus, regardless of race and ethnicity, EL designation, and language proficiency; there were 536 students in the sample. The no-EL HLM sample group did not include any students who were identified as Hispanic level 1 and 2 EL students in Grade 9. Because Hispanic EL students who were identified as level 1 and 2 EL students in Grade 9 were prevented from taking upper-level math courses, the student group did not include this group of students. However, it still provided a general sense of how MSA and Algebra 1 are associated with performance in HLM (precalculus). Participation was defined as enrolling in the course at the school and earning a minimum of two quarters of grades for the course, which verified that the study was measuring the main group of precalculus students. Additionally, students must also have taken the MSA examination in Grade 10 and have earned grades in Algebra 1 prior to taking the MSA; both must have been completed in the district. Students who transferred Algebra grades from other districts were excluded to control for differences in grading approaches and methodologies of teaching. To reduce bias by the researcher, all students in the study must have exited the district; all students had left the school by the end of school year 2019. An outline of Sample group 1, no-EL HLM, is presented in Table 3.

Sample group 2, no-EL no-HLM, participated in an Algebra 1 course in Grade 9 and a no-EL no-HLM course in Grade 12 between September 2012 and June 2019. Sample group 2 included all students who did not participate in an HLM course in Grade 12 regardless of race and ethnicity, EL designation, and language proficiency. There were 663 students in the sample. The no-EL no-HLM sample group did not include any students who were identified as Hispanic level 1 and 2 EL students in Grade 9. Because the Hispanic students who were identified as level 1 or 2 EL students in Grade 9 had not yet earned the proficiency score on ACCESS to be reclassified as a FEL and therefore were prevented from taking no-EL mathematics courses in Grade 12, the sample group did not include these students. Participation was defined as enrolling in the course at the school and earning a minimum of two quarters of grades for the course, which verified that the study was measuring the main group of non-HLM students. Additionally, students must also have taken the MSA examination in Grade 10 and have earned grades in Algebra 1 prior to or in the same year as taking the MSA; both must have been completed in the district. Students who transferred Algebra grades from other districts were excluded to control for differences in grading approaches and methodologies of teaching in different schools. To reduce bias by the researcher, all students in the study must have exited the district; all students left the school by the end of school year 2019. An outline of Sample group 2, no-EL no-HLM, and the sample size (N) is presented in Table 3.

Table 3

Study 1 Sample Groups

	Sample Groups	Description	Label	*N*
1	Higher-level math students	*Sample of students who participated by selection or choice in HLM course in Grade 12 *Participated in an Algebra 1 course in Grade 9 *None of the students in the sample were identified as Hispanic level 1 and 2 EL students in Grade 9	no-EL HLM	536
2	Not higher-level math students	*Sample of students who did not participate by selection or choice in any higher HLM course in Grade 12 *Participated in an Algebra 1 course in Grade 9 *None of the students in the sample were identified as Hispanic level 1 and 2 students in Grade 9	no-EL no-HLM	663

A priori sample size calculations. Based on a review of this issue by the sponsoring faculty (A. Meiselman, personal communication, 2020), the sample size was calculated considering both classical Type I error correction methods and the newer multilevel, statistical power options reviewed by Gelman, Hill, and Yajima (2013) and Benjamini and Hochberg (1995), as well as more exploratory methods as suggested by Rubin (2017) and Matsunaga (2007). The issue of family-wise error rate (FWER) was considered in two methods across the first two studies and adding three additional tests for follow-up analyses. For more detail on these issues, please see the subsection within this chapter entitled “A Priori Sample Size Calculation Considerations within the Context of FWER” near the end of this chapter.

Measures

Since the study was designed to explore if there was a correlation between MSA and/or Algebra 1 and performance in an HLM, precalculus course, there were three different measures utilized in this study. The measures included the raw score on the MSA, the final grade earned in Algebra 1, and the final grade earned in the precalculus course. Both sets of grades were measured using a 4.0 scale.

Grade 10 MSA scores. The MSA scores for all students who meet the inclusion criteria for the study were utilized to explore if there was a relationship associated with precalculus math performance. For this study, raw scores from the Grade 10 MSA, rather than scaled scores, were used for analysis. Although students have the opportunity to participate in MSA testing in 11th and 12th grade if they have arrived in the state in these grades and/or did not pass it in the 10th grade, the 10th grade exam has been chosen as a variable for several reasons. The first is because the scoring system is different; the maximum score for the 10th grade exam is 280, while the maximum score for the 11th and 12th grade exam is only 240. Also, all students who enter a public school in the state in Grades 9 or 10 are required to participate in the MSA Grade 10 examination regardless of linguistic level. Students who score below a 220 failed the exam and must retake it. Those who score 220–238 passed the MSA but are placed in the category of “needs improvement,” meaning that they must pass their 11th and 12th grade math courses to meet the graduation requirements. Students who score 240–258 are considered proficient, meaning that they have met the graduation requirements, and those who score 260–280 are considered to be advanced, making them eligible for certain scholarships and accolades. These scores, which are reported to the student, are scaled and derived through the conversion of raw scores. The raw scores, available from the state department of education, were used instead of scaled scores, as they provide a more appropriate measurement for data analysis.

The state department of education requires that all students who are seeking to earn a high school diploma, including students educated at public expense in educational collaborative and approved and unapproved private special education schools within and outside the state, meet the state designated competence determination in addition to meeting all local graduation requirements. If EL students are placed homogeneously, indicating similar math skills, their MSA scores should follow a similar trajectory. The MSA was chosen as a measurement because students, regardless of their language level, are required to pass it to obtain their high school diploma and therefore quantifies, in a way, academic achievement. This study focused specifically on raw scores from the math exam, since there is an opportunity for students who have been in the country for less than 3 years to take the exam in Spanish. Taking the exam in their native language may provide insight into students' true mathematical abilities, which are not tested upon registration.

Although most of the participants in Study 1 took the 10^{th} grade MSA exam in English because they are not current EL students, for potential EL students included in Study 1, there are relevant validity issues. While MSA scores were not a prerequisite for entry into precalculus, those who have not passed the Grade 10 exam may not have chosen to enroll based on perceived mathematical weaknesses and ability, thus creating a more homogeneous sample for Study 1. Excluding students who may be weaker in math, as indicated by their MSA scores, created a potential sampling issue that may have limited the strength of the correlation by decreasing the potential range of MSA scores and increasing the homogeneity of the sample.

Algebra 1 grade. The Algebra 1 grades for all students who met the inclusion criteria for the study were utilized to explore if there was a relationship associated with precalculus math performance. Algebra 1 is the introductory math course that all students, both EL and no-EL, are required to take. The course outlines major mathematical concepts including linear and exponential relationships, quadratic functions, exponents, and linear models, prepares students for the MSA, and builds the foundation necessary for Grade 11 and 12 math courses. The participants were assigned grades using the system outlined in Table 4, which are recorded in the district wide database. The grades used were final grades, collected by a review of student transcripts. The grade point average (GPA), as calculated by the district, was not used, as the GPA weighting system for EL courses are different from that of regular courses, which may have impacted the results. Instead, the final grades were assigned a numerical value using the grade conversions used by the state department of education. These grades are standardized, and the letter grades are not weighted by class or number of credits. Table 4 illustrates the current grading system of the district and the GPA conversions utilized by the state. Using the conversions presented in Table 4, the Algebra 1 grades for all participants were converted from a letter to a numerical GPA. The grades that the participants earned in Algebra 1 were measured as an interval indicator ranging from 0.4 to 4.0, which represents the average grades received in the Algebra 1 course. While there remains some controversy in the statistics community, GPA is considered here to be in the interval scale. This is consistent with the vast educational and social sciences literature that uses GPA as a measure in the interval scale.

Table 4

District Grading System and GPA Conversions

Grade	GPA	Range	Student Mastery Level
A	4.0	93–100	Excellent/Superior
A-	3.7	90–92	Excellent/Superior
B+	3.3	87–89	Very good/Above average
B	3.0	83–86	Very good/Above average
B-	2.7	80–82	Very good/Above average
C+	2.3	77–79	Good/Satisfactory
C	2.0	73–76	Good/Satisfactory
C-	1.7	70–72	Good/Satisfactory
D+	1.3	67–69	Minimally Satisfactory
D	1.0	63–67	Minimally Satisfactory
D-	.7	60–62	Minimally Satisfactory
F	.4	Below 60	Unsatisfactory / No credit is granted

Performance in precalculus math course. The precalculus variable was defined by the performance in the first two quarters of the precalculus course, and the correlation was explored for all students who completed Algebra 1, participated in MSA in Grade 10 and were enrolled in precalculus. Algebra 1, precalculus, and MSA were completed at the study site. The precalculus course was chosen because it is the “gatekeeper” into other HLM courses, as indicated in the course sequence described in Chapter 2. Data were collected using class lists of all students enrolled in the specific course, as indicated by a unique course code, and then reviewing the appropriate transcripts for the students who meet the inclusion criteria. A composite grade was calculated using the same method previously described for the Algebra 1 GPA.

Procedure

The data from Study 1 were harvested from the district's archival database and the state department of education database. All school data on the students are archival and standard information mandated by state and local law policies. Rather than the student's name, the district-assigned student ID number was used to link the different datasets and create a full data case for each student included in the studies. A subject ID number was then assigned to each student, and the district-assigned student ID number was removed.

Research Design and Data Analytics

Since Hispanic EL students have historically been segregated from HLM courses, it was necessary to employ indirect methods to study their potential performance in HLM. As described in the research questions presented in Chapter 1, Study 1 was constructed to explore if there was a shared metric between EL and no-EL students that would appropriately predict mathematical performance in HLM. Applying a shared metric to each of the studies assisted in developing an understanding of the factors associated with level 1 Hispanic EL students and students' performance in HLM courses, specifically precalculus. To establish a connection between predictive variables and precalculus performance, it was necessary to first explore if MSA and/or Algebra 1 is a better predictor of successful performance in an HLM course. Study 1 utilized correlation analyses and multiple independent sample *t*-tests to explore the relationship between two potential linking variables, MSA and Algebra 1, and grades earned in precalculus for all students enrolled in the course. Due to the lack of enrollment of Hispanic EL students in precalculus courses, the first study included only no-EL students, as they were the ones who were allowed to participate in the precalculus course. This demonstrated whether, in general, a relationship exists between the MSA scores and/or Algebra 1 and performance in precalculus.

To most appropriately meet the overall goal of the project, which was to explore the current mathematics placement practices that have excluded Hispanic level 1 and 2 students from participating in HLM courses, it was also necessary to determine a minimum cutoff grade by which to examine Algebra 1 grades and HLM performance. This was done through the use of cross tabulations. This minimum cutoff grade was later utilized in Study 3 to explore what, if any, mathematical limitations exist for Hispanic level 1 and 2 EL students in terms of their ability to succeed in HLM. It was necessary to use this approach since the exclusion of Hispanic EL students from HLM eliminated the collection of any possible data regarding their performance in HLM.

Using the Premium GradPack of SPSS, Pearson correlation analyses were conducted to determine if there was a relationship between either linking variable, the raw MSA scores of students enrolled in a precalculus course and the final Algebra 1 grade, and their performance in precalculus. To address Research Question 1-1, which was described in Chapter 1, the researcher first determined whether the Pearson correlation coefficient demonstrated a more significant correlation between 10th grade mathematics MSA raw scores or the final grade in Algebra 1 and the final grade in precalculus. It is important to note that the effect size in the correlation was expected to be an underrepresentation of the true relationship between MSA and/or Algebra 1 and precalculus. This was due to the removal of the weaker students in the sample who performed in the lower range of the MSA-Math and/or Algebra who decided not to pursue precalculus because of their difficulties with math. Had these students been required to participate in precalculus, it is likely their low MSA scores and/or Algebra 1 would have correlated strongly with their low precalculus performance. This sampling confound of the precalculus students attenuates the effect size of this relationship. Therefore, a significant but modest correlation between these variables would be a strong support that the MSA and/or Algebra 1 can be used as a linking variable for this current research project. To address Research Question 1-2, which was presented in Chapter 1, and further examine if the correlation between the final Algebra 1 grade and the final HLM grade had been weakened by the selection process of students allowed to participate in the HLM course, an independent samples *t*-test was conducted. This test compared the final Algebra 1 grade of students who participated in HLM to those students who did not.

To best address Research Question 1-3, as described in Chapter 1, and to meet the overall goal of the project, which was to explore the current mathematics placement practices that have excluded Hispanic level 1 and 2 students from participating in HLM courses, it was necessary to determine a minimum cutoff grade in Algebra 1 that best predicted HLM performance. This was done through the use of cross tabulations where, based on comparisons between the final grade in Algebra 1 and HLM performance, metrics were calculated for four different outcomes—true negative, false positive, true positive, and false negatives—at various minimum cutoff grades in Algebra 1 and HLM performance at a minimum of a 1.7 (C-). It is important to note that determining these cutoffs had no inferential effect on considerations of FWER for Study 1 nor across the entire project (see the FWER section in this chapter for more details). This minimum cutoff grade was later utilized in Study 3 to explore if there were academic differences between students categorized as level 1 and 2 Hispanic ELs and students not categorized as ELs that support the historical practice of excluding Hispanic EL students from HLM courses. It was necessary to use this approach since the exclusion of Hispanic EL students from HLM eliminated the collection of any possible data regarding their performance in HLM.

Study 2

Participants

The data from Study 2 were harvested from the district's archival database and the state department of education database. Together, the two databases provided detailed demographic and academic information on the subjects. This also included the grades earned in Algebra 1 and the raw score earned on the MSA. The inclusion criteria for subjects in Study 2 included identification as Hispanic and Spanish-speaking and entrance into the school in Grade 9 or 10 with level 1 or 2 English proficiency. All the subjects in Study 2 participated in the Spanish version of the MSA in Grade 10, an EL Algebra 1 course in Grade 9, and an EL math course in Grade 12 at the study site between September 2012 and June 2019.

The sample for Study 2, Sample Group 3, consisted exclusively of the data set of Hispanic students who entered the district in Grade 9 or 10 with level 1or 2 English proficiency. Sample group 3 included all level 1 and 2 Hispanic EL students who participated in an Algebra 1 course in Grade 9 for EL students and an additional math course for EL students in Grade 12 between 2012 and 2019; this sample group is referred to as EL. The sample group is part of a separate population of students who are not considered to be part of the general school population for this project since all of their academic courses are taken in separate cohorts, designed to provide intensive support for English language development and grade-level academic content (see FWER section in this chapter for details on how this affected FWER calculations). The district uses the U.S. Office of Management and Budget (1997) definition for Hispanic, which includes "persons of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin regardless of race" (Categories and Definitions section, para. 5). All data related to race and ethnicity are self-reported through a questionnaire, entitled the Home Language Survey, at the time of registration and then entered into a district level database.

All students in Study 2 were categorized as having level 1or 2 English language proficiency upon arrival in the district and placed into their respective EL curriculum. This designation was determined by the ACCESS exam, a screening test developed by WIDA, which assesses student proficiency in the English language in reading, speaking, listening, and writing, as well as language used in language arts, mathematics, science, and social studies (Fox & Fairbairn, 2011). This test, administered to all new students in Grades K–12 born outside of the country, is used as the only mechanism to place students into courses and does not account for past academic history or knowledge of content areas such as math or science. The participants in this study were all administered the paper-and-pencil version of the ACCESS exam, which has different psychometric properties than the currently used computer-based exam.

Since the purpose of the project was to further explore the historical practice of using English proficiency to dictate a math trajectory for Hispanic EL students, the linking variables from Study 1, MSA, and Algebra 1 were also used as inclusion criteria for Study 2. All participants must have completed an Algebra 1 course in Grade 9 or 10 for EL students and taken the 10^{th} grade MSA in Spanish; both must have been taken at the study site. English Learner content courses are designed to provide intensive support for English language development and grade-level academic content. In this study, as in Study 1, the final grade in the Algebra 1 course was used, with the same parameters, in terms of descriptions and conversion, outlined in Study 1. This was appropriate because although the inclusion criteria have been narrowed to only include Hispanic level 1 and 2 EL students, the Algebra 1 variable is the same as in Study 1. Because the sample of Hispanic EL students had not earned the proficiency score on ACCESS to be reclassified as a FEL, they also participated in a Grade 12 math course for EL students. An outline of the sample group for Study 2, EL, and the sample size (N) is presented in Table 5.

Table 5

Study 2 Sample Group

	Sample Group	Description	Label	*N*
3	Hispanic level 1 and 2 English Learners	*Sample of students who were identified as Hispanic level 1 and 2 English Learners in Grade 9 or 10 *Participated in an Algebra 1 course in Grade 9 or 10 for EL students *Participated in a math course for EL students in Grade 12	EL	193

A priori sample size calculations. As explained above, based on a review of this issue by the sponsoring faculty (A. Meiselman, personal communication, 2020), the sample size was calculated considering both classical Type I error correction methods and the newer multilevel, statistical power options reviewed by Gelman et al. (2013) and Benjamini and Hochberg (1995) as well as more exploratory methods as suggested by Rubin (2017) and Matsunaga (2007). The issue of FWER was considered in two methods across the first two studies and adding three additional tests for follow-up analyses. For more detail on these issues, please see the subsection within this chapter entitled “A Priori Sample Size Calculation Considerations within the Context of FWER” towards the end of the chapter.

Procedure

The data from Study 2 were harvested from the district’s archival database and the state department of education database. All school data on the students is are and standard information mandated by state and local law policies. Rather than the student’s name, the district-assigned student ID number was used to link the different datasets and create a full data case for each student included in the studies. A subject ID number was then assigned to each student and the district-assigned student ID number was removed.

Research Design and Data Analytics

Study 2 was designed to explore if there are factors that may predict math potential for Hispanic EL students. By examining predictor variables that are available when the student registers for school, it may be possible to develop a model that predicts math performance and assists with course placement. A multiple linear regression was calculated to predict the final grade in Algebra 1, the shared metric established in Study 1, based on several predictor variables that were harvested from the state- and district-level databases and are available at the time of student registration. The results of the multiple regression analysis were then utilized to construct a predictive algorithm. The purpose of this algorithm was to establish a protocol that would be used by the district at registration to place students into the appropriate math courses. An additional post hoc exploratory analysis was conducted in Study 2 to examine the three strongest predictor variables that emerged from the multiple regression analysis.

Multiple regression analysis. Study 2 examined several independent variables that were predictive of academic potential in terms of HLM course placement for Hispanic level 1 and 2 EL students, as measured by MSA and/or Algebra 1. To address Research Question 2-1, which was presented in Chapter 1, the researcher conducted a multiple linear regression that would predict the final grade in Algebra 1 based on several predictor variables. The potential predictive variables included student designation as a traditional student or Students with Limited or Interrupted Formal Education (SLIFE), student participation in public or private education in their country of origin, age of entry into the school setting, living with a parent or guardian, gender, educational ranking of country of origin, and grade of entry. The independent and dependent variables and their definitions are presented in Table 6. Through the use of a shared metric, if a relationship was found to exist in both studies between the variables mentioned, then it was reasonable to predict that the variables found predictive of Algebra 1 might be predictive of performance in the precalculus courses that Hispanic EL level 1 and 2 students are often prevented from participating in.

Independent variables. The independent variables were harvested from the state and district level databases and were available at the time of student registration. All independent variables were either in continuous interval/ratio scale or a dichotomous binary scale (0, 1). These potential predictor variables provide individual, demographic and school characteristics of Hispanic level 1 and 2 EL students from September 2012 through June 2019.

Table 6

Study 2 Variables and Definitions

Variable	Type of Variable	Definition
Type of EL student	Independent	Traditional students have followed an academic trajectory in their country of origin that parallels that of a student in the United States SLIFE are students with limited and interrupted formal education
Public or private schooling	Independent	Students attended a public or private school in their country of origin
Parent or Guardian	Independent	Students reported living or residing with a parent or guardian at registration
Age of entry	Independent	Chronological age of the student reported by parent or guardian at the time of school registration.
Mean years of school	Independent	Rank number of the student's country of origin by the average number of completed years of education of the country's population
Grade of entry	Independent	Refers to whether a student began schooling in the district in middle school or high school
Gender	Independent	Self-identification of male or female at time of school registration
Final Algebra 1 grade	Dependent	The introductory math course that all students, both EL and no-EL, are required to take

Type of EL student. This variable is a dichotomous indicator of the categorization of EL students, which is made during initial placement at the time of registration (SLIFE = 0, traditional = 1). Despite students being homogeneously grouped by language proficiency, there are relevant differences in the educational background of Hispanic EL students. Hispanic EL students include both traditional Hispanic EL and SLIFE, which designate the students as either traditional or SLIFE. Traditional Hispanic EL students are described as those who enter the school system with a higher level of formal schooling, reside with a parent/guardian, and seem to have a broader support network. Students with limited or interrupted formal education often have completed little formal schooling, only completing the compulsory elementary education in their native countries, are undocumented, and are unaccompanied or living here without parents or guardians, which requires them to work to support themselves. They are categorized as SLIFE at the time of registration using self-reported data from the Home Language Survey, and then these data are put into the district database. This is a relatively new demographic for educational systems, who are still struggling to find appropriate methods to meet their needs.

Public or private education. The variable was a dichotomous indicator of students' participation in public or private schooling before entering the district (public schooling = 0, private schooling = 1). Whether students received a public or private education in their country of origin was examined as an independent variable. This data potentially provided an additional degree of measurement as to the type and educational level of students entering the district. The data were retrieved from a review of transcripts, which contained the school name, from the student's country of origin and research into the specific school that the transcript was from.

Age of entry. Age was measured as an interval indicator where age of entry is defined as the age of a student when they enter the school system. It was included to explore whether there is a relationship between the age of a student and their performance in MSA and/or Algebra 1. This information is self-reported at the time of registration and collected and recorded as part of the student demographic data.

Living with a parent/guardian. Family composition was measured as a dichotomous, independent indicator that identifies if a participant is living with a parent or guardian (not living with a parent or guardian = 0, living with a parent or guardian = 1). A parent or guardian is defined as a person who has assumed responsibility for the student at the time of registration. For school registration and this study, a guardian is not necessarily defined by legal custody determined by family court. This information is self-reported at the time of registration and collected and recorded as part of the student demographic data.

Gender. In accordance with the classifications used at school registration, the gender variable was categorized as a dichotomous indicator of gender identification (male = 0, female = 1). This information is self-reported at the time of registration and collected and recorded as part of the student demographic data.

Mean years of schooling in a student's country of origin. This variable was measured using an interval scale found within the International Education Index published by the United Nations Development Programme. It measures the education systems of member nations of the United Nations across various indicators, including the mean years of school completed by students in the country. This provided an additional external indicator by which to measure the quality of a student’s education in their country of origin, which may be beneficial when exploring academic potential.

*Grade of entry***.** This variable is a dichotomous indicator of students’ academic placement at registration (middle school = 0, high school = 1). Grade of entry refers to the grade that the student is placed in at the time of registration into the district school. This determination is completed by school counselors during the entry meeting and includes both discussion with the student and record review. The transcript, or academic record, is reviewed, and the courses taken in the prior country are converted using a standardized process, and credit, when appropriate, is given. It is important to note that although students may have entered the school district in middle school, they have not progressed past level 1 or 2 proficiency and so are in the same math trajectory.

Dependent variable. The dependent variable that the independent variables listed above predicted was academic achievement in mathematics, as measured by the final grade in Algebra 1. Algebra 1 is the introductory math course that all students, both EL and no-EL, are required to take. The course outlines major mathematical concepts including linear and exponential relationships, quadratic functions, exponents, and linear models, prepares students for the MSA, and builds the foundation necessary for Grade 11 and 12 math courses. The participants were assigned grades using the system outlined in Table 4, which are recorded in the district-wide database. The grades used were final grades, collected by a review of student transcripts. The GPA, as calculated by the district, was not used, as the GPA weighting system for EL courses are different from that of regular courses, which may have impacted the results. Instead, the final grades were assigned a numerical value using the grade conversions used by the state department of education. These grades are standardized, and the letter grades are not weighted by class or number of credits. Table 4 illustrates the current grading system of the district and the GPA conversions utilized by the state. Using the conversions presented in Table 4, the Algebra 1 grades for all participants were converted from a letter to a numerical GPA. The grades that the participants earned in Algebra 1 were measured as an interval indicator ranging from 0.4 to 4.0, which represents the average grades received in the Algebra 1 course. While there remains some controversy in the statistics community, GPA is considered here to be in the interval scale. This is consistent with vast educational and social sciences literature that uses GPA as a measure in the interval scale.

Algorithm derived from multiple regression analysis. To address Research Question 2-2, which was described in Chapter 1, the results of the multiple regression analysis were utilized to construct a predictive algorithm for teaching purposes only. The weak to modest MR model found in answering Research Question 2-1, coupled with the modest correlation between Algebra and HLM, made such an exercise superfluous in terms of restricting alpha inflation across the overall project. However, as part of a dissertation and training of techniques, this additional step was completed but not considered in terms of additional inferential alpha inflation as its results were not actually considered. The inferential aspect to this exercise came from the correlation between the predicted Algebra score and the actual algebra score. A metric highly related to R^2 was already calculated in the initial multiple regression model.

Post hoc exploratory analysis. To address Research Question 2-3, an additional post hoc exploratory analysis was conducted to examine the predictor variables from the multiple regression analysis and yielded three worthy of further consideration (Rubin, 2017). In an effort to conserve alpha across the project, this was conducted as an exploratory analysis (Rubin, 2017). The exploratory analysis allowed for further examination of the predictor variables that are associated with Algebra 1 performance for Hispanic level 1 and 2 students, which was especially relevant considering the lack of research pertaining to secondary level Hispanic EL students transferring into high schools in the United States.

The research questions for Study 2, which were presented in Chapter 1, were developed to explore if there are factors that may predict mathematics potential for Hispanic EL students, which would then be utilized to construct a predictive algorithm from the MR model. From this predictive algorithm, it may be possible to develop a model that predicts math performance and assists with course placement for EL students.

The data were analyzed using the Premium GradPack of SPSS. A multiple regression analysis was utilized to address Research Question 2-1, if a predictive model exists that adequately delineates performance in HLM for Hispanic level 1 and 2 students. Multiple regression was chosen because of the variety and multitude of individual, societal, and academic variables associated with placement and student achievement. The use of a multiple regression model determined which indicators would predict a higher final grade in Algebra 1 and, in conjunction with the results of the first study, would provide the rationale for the construction of a more appropriate protocol for EL placement. Different entry methods were considered to both build the best predictive model and also identify all of the independent variables that are associated with the Algebra 1 grade. Thus, within the confines of statistical power and the FWER, analyses first prioritized the overall predictive model to later be used to form a protocol. Then through an exploratory method (Rubin, 2017), all the main independent variables, or potential predictors, that contributed to perform better in Algebra 1 were analyzed.

The original plan was to construct an algorithm from the multiple regression analysis that would establish a protocol to be used by the district at registration to place students into the appropriate math courses. The rationale to construct a registration placement protocol based on mathematical performance stems from the historical practice of forcing Hispanic EL students into a lower-level mathematical trajectory due to their language proficiency. However, the plan was abandoned after the results from the multiple regression and correlation analyses emerged (see Chapter 4 for details on the results). At this point, the algorithm was done solely as a teaching and learning opportunity as part of the dissertation experience.

Using the results of the multiple regression analysis, a post hoc question, Research Question 2-3, was developed. This question was presented in Chapter 1. The additional post hoc analysis was conducted using an exploratory approach (Rubin, 2017) to examine the three strongest predictor variables that emerged from the multiple regression analysis. Both the magnitude and direction of the standardized regression coefficient were used to explore Algebra

1 performance among Hispanic level 1 and 2 EL students. Variables with negative standardized regression coefficients are considered to be negatively associated with Algebra 1 performance, while variables with positive standardized regression coefficients are considered to be positively associated with Algebra 1 performance.

Study 3

Participants

Study 3 utilized the sample groups and data from Study 1 and 2, which were both harvested from the district's archival database and the state department of education's database. Sample group 1, no-EL HLM, included students who participated in an Algebra 1 in Grade 9 and who participated by selection or choice in HLM during 12th grade. None of the students in sample group 1 were identified as Hispanic level 1 and 2 EL students in Grade 9. Sample group 2 included students who participated in Algebra 1 in Grade 9 and who did not participate by selection or choice in any HLM during 12th grade. None of the students in the sample were identified as Hispanic level 1 and 2 EL students in Grade 9. The students in sample group 4 were members of sample groups 1 and 2; this sample group is referred to as no-EL all. They were part of the general school population, which includes all students except for students identified as level 1 and 2 EL students in Grade 9 and special education students in self-contained mathematics classrooms. These students participated in a no-EL Algebra 1 course in Grade 9 and a no-EL mathematics course in Grade 12. The designation no-EL means that regardless of whether the sample group is no-EL HLM or no-EL no-HLM, the no-EL indicates that the student group was from the general school population and then further partitioned based on their interest and skills for HLM. Since the sample groups are the same for Study 3, all four sample groups meet the same inclusion criteria as those in Studies 1 and 2.

Sample group 3, EL, included all students who were identified as Hispanic level 1 and 2 English Learners in Grade 9 or 10 and participated in an Algebra 1 course in Grade 9 or 10 for EL students. Since the sample of Hispanic EL students had not earned the proficiency score on ACCESS to be reclassified as a FEL, they also participated in a Grade 12 math course for EL students. English Learner content courses are designed to provide intensive support for English language development and grade-level academic content. The four sample groups and the sizes of each sample (*N*) are outlined in Table 7.

Table 7

Sample Groups Included in Study 3

	Sample Groups	Description	Label	*N*
1	HLM students	*Sample of students who participated by selection or choice in non-EL HLM course during 12th grade *Participated in an Algebra 1 course in Grade 9 *None of the students in the sample were identified as Hispanic level 1 and 2 EL students in Grade 9	no-EL HLM	536
2	Not HLM students	*Sample of students who did not participate by selection or choice in any non-EL HLM course during 12th grade *Participated in an Algebra 1 course in Grade 9 *None of the students in the sample were identified as Hispanic level 1 and 2 EL students in Grade 9	no-EL no-HLM	663
3	Hispanic level 1 and 2 English Learners (EL)	*Sample of students who were identified as Hispanic level 1 and 2 English Learners in Grade 9 or 10 *Participated in an Algebra 1 course in Grade 9 or 10 for EL students *Participated in a math course for EL students in Grade 12	EL	193
4	All non-EL college preparatory students	*Sample of all students who were not identified as Hispanic level 1 and 2 English Learners in Grade 9 *Participated in an Algebra 1 course in Grade 9 *Sample includes all students who enrolled in either a non-EL HLM or non-EL, non-HLM course in Grade 12	no-EL all	1199

A Post Hoc Power and Sample Size Calculation

Since these samples had already been used in Studies 1 and 2, the sample size needed for the different comparisons had already been calculated except for *t*-tests for Study 2 with the EL sample, as only MR considerations were used before this post hoc follow-up analysis. Still employing the overall general approach that combined both classical Type I error correction methods, the newer multilevel, statistical power options reviewed by Gelman et al. (2013) and Benjamini and Hochberg (1995), and exploratory methods reviewed by Rubin (2017) and Matuski (2007), a post hoc power analysis for the independent *t*-tests involving Hispanic EL students was considered and is discussed in detail in Chapter 4. Considering Studies 1 and 2 as different population samples was also considered for follow-up analyses conducted in Study 3. It is important to point out, however, that Study 3 was not considered directly a priori at the initial time of research design planning. Instead, some FWER alpha had been retained to be used for additional post hoc follow-up analyses, and Study 3 utilized this pre-allocated alpha. It is important to note that the two one-sided test (TOST) equivalence procedure used only one alpha unit of .007 despite actually being two one-sided tests. This is considered the appropriate way of calculating alpha for TOST procedures (Lakens, Scheel, and Isager, 2018)

Measures

Algebra 1 grade. The final grade earned in Algebra 1 for all students who meet the inclusion criteria for the study was utilized to explore if there was a relationship associated with precalculus math performance. Algebra 1 is the introductory math course that all students, both EL and no-EL, are required to take. The course outlines major mathematical concepts including linear and exponential relationships, quadratic functions, exponents, and linear models, prepares students for the MSA, and builds the foundation necessary for Grade 11 and 12 math courses.

The grades used were final grades, collected by a review of student transcripts. The participants were assigned grades using the system outlined in Table 4, which are recorded in the district-wide database. The GPA, as calculated by the district, was not used, as the GPA weighting system for EL courses is different from that of regular courses, which may have impacted the results. Instead, the final grades were converted onto the same scale metric from the state department of education for the purpose of direct comparison. Table 4 illustrates the current grading system of the district and the GPA conversions utilized by the state. Using the conversions presented in Table 4, the Algebra 1 grades for all participants were converted from a letter to a numerical GPA. The grades that the participants earned in Algebra 1 were measured as an interval indicator ranging from 0.4 to 4.0, which represents the average grades received in the Algebra 1 course. While there remains some controversy in the statistics community, GPA is considered here to be in the interval scale. This is consistent with vast educational and social sciences literature that uses GPA as a measure in the interval scale (Huang, 2014).

Procedure

The data from Study 3 were harvested from the district's archival database and the state department of education database. All school data on the students are archival and standard information mandated by state and local law policies. Rather than the student's name, the district-assigned student ID number was used to link the different datasets and create a full data case for each student included in the studies. A subject ID number was then assigned to each student, and the district-assigned student ID number was removed.

Research Design and Data Analytics

Using the set of research questions presented in Chapter 1, Study 3 further explored the historical practice of using English proficiency to dictate math trajectory for Hispanic EL students through the use of additional analyses including the distribution of final grades in Algebra 1 among level 1 and 2 Hispanic EL students, frequency histograms, and independent samples *t*-tests. There are assumptions that accompany the policy of determining English proficiency at school registration and using that proficiency to place EL students in math courses. Study 3 was designed to examine those assumptions through the use of additional analyses using specific datasets from the same overall archival database used in Study 1 and 2. The goal was to test the theoretical model that the Algebra 1 performance of EL students had not been further selected into stronger and weaker Algebra performance on average compared to the no-EL-all group, which splits into the no-EL no-HLM and the no-EL HLM groups.

To address Research Question 3-1, if there was substantial variation in Algebra 1 performance among level 1 and 2 Hispanic EL students, a frequency distribution histogram was constructed utilizing the sample group 3 from Study 2. Once it was established that there was substantial variation in the distribution of the final Algebra 1 grades among all Hispanic level 1 and 2 students, it was possible to address Research Question 3-2, which included subquestions 3-2A, 3-2B, and 3-2C, to examine if there were differences between the mathematical abilities of Hispanic EL students and other non-EL student groups. These research questions were presented in Chapter 1. Research Question 3-2A made use of the no-EL all sample group, which included two subsamples, no-EL no-HLM and no-EL HLM. Each of the subsamples, no-EL no-HLM and no-EL HLM, were utilized separately to address Research Questions 3-2B and 3-2C, respectively. The tests included independent samples *t*-tests, analyses of the distribution of Algebra 1 grades among Hispanic EL students and no-EL students through frequency distributions, and cross tabulations to explore how Algebra 1 grades predict performance in

HLM for no-EL students. The performance of Hispanic EL students in HLM was not examined directly because they historically have not been allowed entrance into HLM.

The data were analyzed using the Premium GradPack of SPSS, with the exception of the TOST equivalence procedure, which was analyzed using Jamovi 1.8.1.0. To address Research Question 3-1, if there was substantial heterogeneity in Algebra 1 performance among all Hispanic level 1 and 2 EL students, the data were analyzed descriptively using a frequency distribution. Once it was established that there was substantial variation in the distribution of the final grades in Algebra 1 among all Hispanic level 1 and 2 students, it was possible to explore the three subcomponents of Research Question 3-2 (3-2A, 3-2B, and 3-2C), which examined if there were differences in the mathematical abilities of Hispanic EL students and the no-EL student groups. Using Algebra 1, which emerged as the linking variable that was associated with HLM performance in Study 1 and was further analyzed in Study 2, an additional set of tests were conducted to revisit the concept of Algebra 1 as a predictor of success in HLM. Research Questions 3-2A, 3-2B, and 3-2C utilized different analyses, including the TOST equivalence procedure (Jamovi, 2010; Lakens et al., 2018) and independent *t*-tests to analyze the mean differences and/or equivalence between the final grades in Algebra 1 among Hispanic EL students and their no-EL peers. Frequency distributions were used to analyze the distribution of the final grades in Algebra 1 among Hispanic EL students and no-EL students. Research Questions 3-2A, 3-2B, and 3-2C also used the cutoffs determined in Study 1 to compare the final grades in Algebra 1 among Hispanic EL, no-EL HLM and no-EL, no-HLM students. These tests allowed for the exploration of the assumptions associated with using English proficiency as the only indicator and placement tool for mathematics. The performance of Hispanic EL students in

HLM was not examined directly because they historically have not been allowed entrance into HLM.

Additional Issues Related to the Overall Project

A Priori Sample Size Calculation Considerations Within the Context of FWER

Based on a review of this issue by the sponsoring faculty (A. Meiselman, personal communication, 2020), the a priori sample sizes for each specific statistical analysis within each study were calculated considering both classical Type I error correction methods and newer multilevel, modern approaches as reviewed by White et al. (2019), Gelman et al. (2013), and Benjamini and Hochberg (1995). Additional post hoc analyses consistent with the exploratory methods as outlined by Rubin (2017) and Matsunaga (2007) were also considered during the a priori research design phase of the overall project to be carried out in the multiple regression model for Study 2. If data presented itself, it was decided that this level of exploratory follow-up would be considered under Rubin's (2017) approach and not counted as part of the a priori FWER alpha correction issue used across the three studies.

Sample size calculations were determined for bivariate correlations, *t*-tests, and multiple regression R^2 using the classical and often-considered overly conservative Bonferroni method (correction for type I error) to create an upper/maximum sample size estimate and lowest possible alpha threshold needed for each dataset and study. Creating the upper bound based on the FWER of the overall project helped the researcher estimate the correct sample size needs under the most conservative and stringent statistical approach, although the researcher and sponsoring faculty considered less stringent approaches more accurate.

By combining a classical and more modern approach, the researcher aimed to balance the issues of FWER, false discovery rate (Benjamini & Hochberg, 1995; Gelman et al., 2013; White et al., 2019), and the general problems experienced with overcorrection, especially when working with exploratory data (Rubin, 2017). As outlined in American Statistical Association (1997) guidelines, the researcher aimed to create a transparent accounting of how alpha was considered so that any researcher would have the information available to make their own decision on how they would have adjusted alpha considering the current project's complex setup with different datasets derived from different populations, each often measuring different variables.

Utilizing a transparent approach, the researcher created two different alpha correction methods to contend with the issue of two studies, each with their own populations and sample estimates. As each study had different datasets, it was conceivable that the alpha should be reset for each study (American Statistical Association, 1997). However, a more conservative project-wide alpha correction was also created, and sample size was ultimately based on this overly restrictive FWER approach across the first two studies with three additional test slots added for post hoc follow up analysis, as suggested as standard practice by the American Statistical Association (1997).

The most conservative method yielded an alpha of .00714 per test, which included three additional tests for follow-up post hoc analyses. These three tests were then used to create Study 3, which was not pre-planned but later realized after completing Study 1 and 2. It is important to note that the TOST equivalence procedure uses only one alpha unit (.007) despite performing two analyses (Lakens et al., 2018). An alpha level corrected to .007 is an extreme correction in the social sciences, as there are many reasons one could argue that the alpha should be considered higher while still contending with reasonable corrections for type 1 error (Benjamini & Hochberg, 1995; Gelman et al., 2013; Rubin, 2017; White, 2019). The researcher calculated this alpha to demonstrate the absolute maximum correction that would suffice the most conservative and careful alpha corrections in the social sciences. The breakdown of the alpha corrections followed by a priori sample size calculations for various alpha levels one might consider for such a project is presented in Appendix A and B. Chapter 4 outlines how these different methods of correction could influence the researcher's decision to accept or reject the null hypothesis. It should be noted that Research Question 2-3 was added as a set of post hoc exploratory analyses to the overall project after the plan and is considered solely as an exploratory examination without factoring in its implications to FWER as outlined by Rubin (2017). The researcher and sponsoring faculty decided to add Research Question 2-3 into Study 2 and designated it as a post hoc research question (PH) because the question is a follow-up to the multiple regression model initially created as part of a decision algorithm. Here, the researcher analyzes the specific predictor variables and beta coefficients to utilize the information from the second approach one can use with multiple regression. This was done partially as a learning exercise and because the data were available for additional exploration as outlined in Rubin (2017). The results in RQ 2-3 (PH) should therefore be considered exploratory in nature (Matsunaga, 2007; Rubin, 2017) with an explicit and transparent need to replicate and verify such findings in future research. Due to the research approach utilized in in Research Question 2-3 (PH), alpha was not calculated and factored into the FWER process, explained above and further examined for the entire project in Appendix B.

All a priori sample size calculations were determined through G* Power 3.1.9.4. The different sample size requirements using two-tailed tests with various alphas and a power of .8 are outlined in Appendix A. The alpha of .007 was included in this exercise because of the reasoning explained above. Different alpha levels were calculated to demonstrate a range of samples sizes for FWER issues across the pre-planned studies 1 and 2. Many statisticians argue that when using a different data set, one should restart their FWER calculations (American Statistical Association, 1997; A. Meiselman, personal communication, 2020; Rubin, 2017). The different alpha levels provided a range of possible sample size needs. All sample size calculations were less than the number of students available in the data set. The researcher could therefore proceed with confidence that the results would have enough statistical power and appropriate FWER due to alpha correction methods including the TOST procedure (Lakens et al., 2018), which examined whether there was an equivalence between the EL and no-EL all groups.

Validity

The issues associated with validity span across the entire project. The most significant concerns with validity are related to the MSA and the Algebra 1 course. First, while it is possible that the MSA exam does not appropriately measure background knowledge but rather English proficiency, it is even more likely that the MSA is measuring a complex interaction of the two. To mitigate the issue of measuring English proficiency instead of mathematics knowledge, only data from the MSA were collected from the participants. Students with less than 3 years in the United States are permitted to take the MSA in Spanish, which differs from the other state assessments that students, regardless of time in the country, are required to take in English. The use of the MSA also pinpointed the focus on their mathematical ability, which may be very different from their skills in language or science. By only using the MSA, which incorporates less English-based language than other instruments, there were decreased concerns around validity that stem from a language artifact.

Secondly, there may be issues related to the parallel delivery of content related to Algebra 1. Algebra 1 is the first course in the sequence of mathematics courses that all college preparatory students are required to enroll in. Although all content courses, including Algebra 1, are expected to use a standardized curriculum that follows the state frameworks and a district-wide universal grading system, the heterogeneity of students and teachers may create variations in the delivery of instruction and grade patterns. These potential differences across classes means that the grades earned by students may not be consistent indicators of ability. There is also an issue of reliability that may affect validity, which involves the consistency of the delivery of the curriculum across classrooms. There may be differences not only between each classroom but also between the non-EL and EL Algebra courses. This would be a reliability issue that then affects validity because it could be so unreliable and inconsistent that it becomes invalid as a real measure of Algebra 1 performance across each classroom. The issue related to validity was fundamental to the overarching intention of the studies; because there is no protocol in place to measure math ability at registration, the integrity of the delivery of the Algebra 1 curriculum schoolwide may be compromised.

Ethical Considerations

The district-assigned student ID number was used to link the different datasets and create a full data case for each student included in the studies. A subject ID number was assigned to each student to replace the district-assigned student ID number. The master file, which included the district-assigned student ID number and linked subject ID number, was kept separate from the other data set information on a different device. The master list was password encrypted and stored on a different device than the datasets. The datasets only have subject numbers, making it impossible for anyone to identify or associate specific subject information with specific students in the school system. The researcher was the sole person with access to the devices, passwords, and datasets that contained identifying student information.

Summary

Historically, Hispanic EL students have been denied entry into HLM courses despite meeting the same academic prerequisites as their native English-speaking peers because of their perceived academic inabilities due to a lack of English proficiency. The lack of representation of Hispanic EL students in HLM necessitated the use of a multifaceted, indirect approach to explore the issue of math placement and Hispanic EL students for this project. The methods included three separate studies connected by a shared metric and aligned directly with the ultimate goal of the project: to explore the current mathematics placement practices that have excluded Hispanic level 1 and 2 EL students from participating in HLM courses. Study 1 was constructed to explore if there was a shared metric between EL and no-EL students that would appropriately predict mathematical performance in HLM. Once the shared metric was established in Study 1, it was able to be used in Study 2 to find a model that would predict the future performance of Hispanic EL students in an HLM course. Utilizing the linking variable that was associated with HLM performance in Study 1 and was further analyzed in Study 2, an additional set of tests were conducted to revisit the concept of Algebra 1 as a predictor of success in HLM in Study 3. The necessity of using alternative methods to explore Hispanic EL performance in HLM courses highlights how assumptions about linguistic proficiency, rather than evidence, have guided policies and procedures related to the perceived mathematical abilities of Hispanic EL students.

CHAPTER 4: ANALYSES AND RESULTS

This chapter outlines the results of three studies that were developed to explore the profound effects of the trajectory of courses associated with the current mathematics placement system for the Hispanic English Learner (EL) student population and to develop, if possible, a feasible protocol for student placement at registration. Study 1 was designed to examine if a linking variable could be established that was shared by both precalculus students and Hispanic EL students and associated with performance in a higher-level mathematics (HLM) course. This was done through use of correlation analyses, multiple independent sample *t*-tests, and cross tabulations. Study 2 utilized a multiple regression analysis to explore if there are factors that may predict mathematics potential for Hispanic EL students, which would then be utilized to construct a predictive algorithm from the multiple regression model. From this predictive algorithm, it may be possible to develop a model that predicts math performance and assists with course placement for EL students. Study 3 used additional analyses, including the two one-sided test (TOST) equivalence procedure and independent sample *t*-tests, to further explore the historical practice of using English proficiency to dictate math trajectory for Hispanic EL students by examining if there were differences between the mathematical abilities of Hispanic EL students and students in the no-EL groups. Although all three studies used data harvested from the district's archival database and the state department of education's database, the various tests utilized in the three studies involve different samples of students. The four sample groups are detailed in Chapter 3 and Appendix D.

Study 1

Since Hispanic EL students have historically been segregated from HLM courses, it was impossible to directly study their performance in HLM. Using three research questions, 1-1, 1-2, and 1-3, and their associated hypotheses, which were presented in Chapter 1, Study 1 was constructed to explore if there was a shared metric between EL and no-EL students that would appropriately predict mathematical performance in HLM and to establish a minimum cutoff grade by which to examine the final Algebra 1 grade and HLM performance. The study was designed to demonstrate what relationship, if any, existed between Mathematics State Assessment (MSA) scores and/or Algebra, the shared metrics between EL and no-EL students, and performance in precalculus. Pearson correlation analyses were conducted to determine if there were relationships between either linking variable, the raw MSA scores of students enrolled in a precalculus course and the final Algebra 1 grade, and their performance in precalculus. The effect size in the correlation was expected to be an underrepresentation of the true relationship between MSA and/or Algebra 1 and precalculus due to many of the weaker students performing in the lower range of the MSA-Math and/or Algebra 1 and deciding not to pursue precalculus because of their difficulty with math. This sampling confound of the precalculus students attenuates the effect size of this relationship. Therefore, a significant but modest correlation between these variables would be a strong support that the MSA and/or Algebra 1 can be used as a linking variable for this current research project. To most appropriately meet the overall goal of the project, which was to explore the current mathematics placement practices that have excluded Hispanic level 1 and 2 students from participating in HLM courses, it was also necessary to determine a minimum cutoff grade by which to examine the final Algebra 1 grade and HLM performance. This was done through the use of cross tabulations. This minimum cutoff grade point average (GPA) was later utilized in Study 3 to explore what, if any, mathematical limitations exist for Hispanic level 1 and 2 EL students in terms of their ability to succeed in HLM.

Correlation Between HLM Final Grade and MSA Scores

In order to determine if the MSA was the most appropriate linking variable, a Pearson correlation was performed between the HLM course grade and the Grade 10 MSA raw scores for no-EL students. The HLM variable that measures HLM performance will from now on be referred to as "HLM." The data set for this test included all no-EL students who participated in the Grade 10 MSA assessment and completed HLM between the school years 2012 to 2019. To answer Research Question 1-1, whether a linking variable that is also available for Hispanic EL students is associated with performance of students in precalculus, a Pearson *r* correlation coefficient was used to measure the degree of association between MSA and student performance in HLM. An HLM course refers to a mathematics course with restricted enrollment based on performance in earlier-level math courses and MSA performance. The same set of prerequisites does not exist for level 1 and 2 EL students. During the time period from which the data were harvested, there were no Hispanic EL level 1 and 2 students who completed the EL Algebra 1 course who were then allowed entry into HLM, despite meeting the same academic prerequisites as no-EL students enrolled in HLM. The descriptive statistics for the sample of students who completed both MSA and HLM are presented in Table 8. The raw scores from the Grade 10 mathematics Massachusetts Comprehensive Assessment System range from 0 to 60 and are considered to be continuous. The raw scores, unlike the scaled scores, are consistent for each test year administration and therefore directly comparable across years. Student performance in HLM was measured using the final grade earned in the course, which was converted into a GPA using the state education conversion system. For the purpose of this analysis, the GPA is treated as a continuous variable.

Table 8

Descriptive Statistics for MSA and HLM Sample

	Mean	Standard Deviation (*SD*)	*N*
MSA Score	39.3	1.0817	529
HLM GPA	2.7	7.769	515

The Pearson *r* correlation coefficient ($r = .158$) is presented in Table 9. The results show a statistically significant ($p < .001$) but modest positive association between MSA scores and HLM GPA.

Table 9

Correlation Between HLM Final Grade and MSA Score

		HLM GPA	MSA Score
HLM GPA	Pearson Correlation	1	.158
	p (2-tailed)		3.22×10^{-4}
	N	515	514
MSA Score			
	Pearson Correlation	.158	1
	p (2-tailed)	3.22×10^{-4}	

These results indicate that student performance in HLM is only modestly associated with MSA scores. Only 2.496% ($.158^2$) of the variation of HLM is accounted for by MSA scores, yielding a small yet statistically significant effect size. It is clear that the selection process of students in the HLM courses minimizes the effect of the association between these two variables. Removing the lower-level math students, as they do not participate in HLM, reduces the overall range of math ability and performance, resulting in reduced variance in both MSA and HLM scores. If all students were required to take HLM, then the majority of weaker math students would perform at a lower level in the class on average, greatly increasing the magnitude of the association. Thus, it is highly likely that this sampling selection bias mitigates a truer measure of the actual relationship between MSA and HLM.

Correlation Between HLM Final Grade and Final Algebra 1 Grade

To gather additional evidence to answer Research Question 1-1, whether a linking variable that is also available for EL students is associated with performance of students in precalculus, a second Pearson correlation was conducted to identify which linking variable would be a better predictor for HLM placement for Hispanic EL students. The data set for this correlation included all students who completed both Algebra 1 and the HLM course between the school years 2012 to 2019. During the time period from which the data were harvested, there were no Hispanic EL students enrolled in HLM**.**

In order to determine the best available linking variable, the final Algebra 1 grade was considered next as a possible replacement for MSA given the modest but significant correlation between MSA and the HLM grade. The weak association between MSA scores and the HLM grade raised the possibility that a more appropriate predictor of success in HLM courses exists. Since both MSA and Algebra 1 grades have historically been the gateway to participation in HLM courses, a second correlation was performed to determine the relationship between HLM grades and Algebra 1 grades. The descriptive statistics for the sample are presented in Table 10. Student performance in the HLM and Algebra 1 courses was measured using the final grade earned in each course, which was converted into a GPA using the state education conversion system. As described by Huang (2014), GPAs are considered to be continuous variables.

Table 10

Descriptive Statistics for Algebra 1 and HLM Sample

	Mean	Standard Deviation	*N*
HLM GPA	2.7	1.0817	515
Final Algebra Grade	2.3	.9953	536

The Pearson *r* correlation coefficient ($r = .353$) is presented in Table 11. The results show a statistically significant ($p < .000$) moderate positive association between final algebra grade and HLM GPA, indicating that Algebra 1 is a stronger predictor of student performance in HLM than MSA.

Table 11

Correlation Between HLM Final Grade and Algebra 1 Final Grade

		HLM GPA	Algebra GPA
HLM GPA	Pearson Correlation	1	.353
	p (2-tailed)		1.4665×10^{-16}
	N	515	514
Algebra I GPA			
	Pearson Correlation	.353	1
	p (2-tailed)	1.4665×10^{-16}	

As demonstrated in Table 11, there is a statistically significant positive association between the final Algebra 1 grade and HLM GPA ($r = .353$, $p < .001$), which is stronger than the association between MSA scores and HLM GPA ($r = .158$, $p < .001$). The difference in the effect sizes of the final Algebra 1 grade ($r = .353$) and MSA ($r = .158$) indicates the final Algebra 1 grade is more strongly associated with performance in HLM than MSA. The moderate correlation found in the above test and the differences in effect size indicate that Algebra 1 is a stronger predictor for success in HLM courses than MSA.

As was the case with the MSA and HLM correlation, it is possible that the selection process of students in the HLM courses reduces the effect of the association between these two variables by removing the lower-level math students. The selection process that places no-EL students into HLM courses minimizes the effect of the association between Algebra 1 and HLM by removing no-EL students with lower Algebra 1 grades from participating in HLM courses. Their non-participation in HLM reduces the range of the overall math ability being tested, thus reducing the degree of variation in the final Algebra 1 grade and HLM scores. If it were mandatory for all students to participate in the HLM course, the findings may have demonstrated a stronger relationship between HLM and Algebra 1. Therefore, it is reasonable to assume that the relationship between the final Algebra 1 grade and HLM GPA is even stronger than measured because all students across all math abilities are not being included.

To address Research Question 1-2 and further examine if the correlation between the final Algebra 1 grade and the final HLM grade had been weakened by the selection process of students allowed to participate in the HLM course, an independent samples *t*-test was conducted. This test compared the final Algebra 1 grade of students who participated in HLM to those students who did not. All students in the no-EL HLM and the no-EL no-HLM sample groups were part of the general school population and were enrolled in a no-EL Grade 9 Algebra class and a no-EL Grade 12 mathematics course between September 2012 and June 2019. For a complete description of Sample Groups 1 and 2, see Table 3.

An independent samples *t*-test was performed to measure the mean difference of the final Algebra 1 grade between no-EL HLM students and no-EL no-HLM students to help provide an explanation for the modest correlation between the final Algebra 1 grade and HLM GPA. Table 12 presents the results of an independent samples *t*-test. With the Levene's Test revealing that homogeneity of variance could not be assumed, the unequal variance independent samples *t*-test revealed a significantly lower final Algebra 1 grade mean score (M = 1.152, SD = .955, N =663) for the no-EL no-HLM group when compared to the no-EL HLM group (*M* = 2.341, *SD* = .9958, *N* = 536); *t(df* = 1124.8) = -20.94, *p* <.001; effects size Cohen's *d* = 1.219, Hedges's *g* = 1.22).

Table 12

Independent Samples t-test Summary Table: Final Algebra 1 Final Grade by Math Group

Sample Group	*N*	Mean	*SD*	*t*	*p*
no-EL HLM	536	2.341	.9558	-20.9	$1.745\text{x}10^{-82}$
no-EL no-HLM	663	1.152	.995		

The test provided evidence that many students who did not participate in an HLM course performed significantly lower in Algebra 1 as compared to those students who did participate in an HLM course. The findings help explain why the correlation is weakened between the final Algebra 1 grade and HLM GPA for HLM students. Because the true relationship in the population has been attenuated by the sampling selection and consequential decrease in the variables' variances, it seems appropriate to use the final Algebra 1 grade as a predictor for performing adequately in an HLM course. The results indicate that students who took HLM (no-EL HLM) averaged a C+ (2.7 GPA) in Algebra, while the students who did not go on to take HLM (no-EL no-HLM) averaged a D (1.0 GPA). Further investigation reveals that 56.9% of students who took HLM (no-EL HLM) received a B or greater in Algebra, while only 8.9% received a B or greater for those students who decided not to pursue HLM (no-EL no-HLM). Of the no-EL students who did not participate in HLM (no-EL no-HLM), 81.7% achieved a grade of C or lower, while 27.8% of the students who took HLM (no-EL HLM) received a C or below. When these results are taken together, the students who took HLM (no-EL HLM), on average, represent stronger math performers in Algebra 1, further supporting the premise that Algebra 1 has some predictive strength and association to performance in HLM.

Minimum Cutoff Determination

To address Research Question 1-3 and to most appropriately meet the overall goal of the project—to explore the current mathematics placement practices that have excluded Hispanic level 1 and 2 students from participating in HLM courses—it was necessary to determine a minimum cutoff grade by which to examine the final Algebra 1 grade and HLM performance. This minimum cutoff GPA was later utilized in Study 3 to explore what, if any, mathematical limitations exist for Hispanic level 1 and 2 EL students in terms of their ability to succeed in HLM. It was necessary to use this approach since the exclusion of Hispanic EL students from HLM eliminated the direct collection of any possible data regarding their performance in HLM.

To conduct this comparison, a minimum cutoff for the final Algebra 1 grade had to first be determined, which was done by evaluating the final Algebra 1 grade as a predictive measure of HLM performance. This was done using cross tabulations where, based on comparisons between the final Algebra 1 grade and HLM performance, metrics were calculated for four different outcomes, true negative, false positive, true positive, and false negatives at various minimum cutoff grades in Algebra 1 and HLM at a minimum of a 1.7 (C-). The minimum performance level for HLM was set at 1.7, or a C-, as this is considered to be a minimum passing grade for many courses. The final Algebra grade cutoffs were set at various levels, including .7 (D-), 1.0 (D), 1.3 (D+), 1.7 (C-), 2.0 (C), 2.3 (C+), 2.7 (B-), and 3.0 (B). By using a range of minimum cutoff levels for Algebra 1, it was possible to determine the most appropriate final Algebra 1 grade to utilize in both Study 2 and 3. In this context, a true negative occurs when a student earns an Algebra 1 grade that is below a minimum cutoff and scores below a minimum performance level of 1.7 in HLM. A false negative occurs when a student earns an Algebra 1 grade that is below the minimum cutoff and scores above the minimum performance level of 1.7

in HLM. A true positive occurs when a student earns an Algebra 1 grade that is above a minimum cutoff and scores above a minimum performance level of 1.7 in HLM. A false positive occurs when a student earns an Algebra 1 grade that is above the minimum cutoff and scores below the minimum performance level of 1.7 in HLM. The cross tabulations for each minimum cutoff Algebra 1 and HLM grades have been consolidated into Table 13, where the letter to the left of each bolded vertical line corresponds to a specific Algebra 1 grade.

Table 13

Minimum Performance Levels for the Algebra 1 and HLM Final Grades

Algebra 1 Final Grade													
		A	B	C	D	E	F	G	H				
		0.4	0.7	1.0	1.3	1.7	2.0	2.3	2.7	3.0	3.3	3.7	4.0
HLM Final Grade	0.4	2	3	4	4	6	4	0	2	3	0	0	0
	0.7	1	1	2	1	5	3	1	2	1	0	0	0
	1.0	0	0	0	2	1	4	0	2	1	1	2	0
	1.3	0	1	1	1	1	3	3	1	2	0	1	0
	1.7	2	5	9	3	3	4	0	0	0	4	0	1
	2.0	2	4	2	1	7	5	4	7	3	1	3	1
	2.3	1	1	3	3	2	1	4	4	5	3	3	0
	2.7	1	3	3	3	6	9	0	11	6	1	4	2
	3.0	4	4	3	3	8	4	3	14	10	6	2	0
	3.3	0	0	3	2	6	3	5	8	9	6	9	1
	3.7	0	3	7	1	7	8	8	10	13	10	14	5
	4.0	2	1	2	4	7	11	6	8	13	10	21	9

The first cross tabulation was done using the lowest possible final Algebra grade cutoff, .7 (D-). For this metric, any student who earned above a .4 or an F in Algebra 1 was considered to have met the minimum grade required to meet the minimum threshold performance of 1.7 in HLM. The results of the cross tabulation are presented in Table 13; Column A corresponds to the final Algebra 1 grade cutoff of 0.7. After the four outcomes were established for the minimum final Algebra 1 grade cutoff of .7 and the minimum HLM performance threshold of 1.7, the totals and percentages of each outcome were determined. In order to construct an appropriate comparison for all the minimum final Algebra grade cutoffs, sensitivity and specificity were calculated using the data from Table 13. Sensitivity was calculated using the formula TP/TP+FN, and specificity was calculated using the formula TN/TN+FP. For both sensitivity and specificity, TN is the number of true negatives, TP is the number of true positives, FN is the number of false negatives, and FP is the number of false positives. The metrics for the Algebra 1 grade cutoff of .7 at a minimum HLM grade of 1.7 are presented in Table 14.

Table 14

Metrics for Final Algebra 1 Grade Cutoff of .7 and HLM Grade of 1.7

	Total	Percentages	Sensitivity	Specificity
True Negatives (TN)	3	0.58		
False Negatives (FN)	12	2.29		
False Positives (FP)	69	13.40		
True Positives (TP)	431	83.69		
Overall			99.50%	4.17%

The second cross tabulation was done using the next possible final algebra grade cutoff, 1.0 (D). For this metric, any student who earned above a .7 or a D- in Algebra 1 was considered to have met the minimum grade required to meet the minimum threshold performance of 1.7 in HLM. The results of the cross tabulation are presented in Table 13; Column B corresponds to the final Algebra 1 grade cutoff of 1.0. After the four outcomes were established for the minimum final Algebra 1 grade cutoff of 1.0 and the minimum HLM performance threshold of 1.7, the totals and percentages of each outcome were determined. In order to construct an appropriate comparison for all the minimum final Algebra 1 grade cutoffs, sensitivity and specificity were calculated for this final Algebra 1 grade cutoff using the methods previously described for the final Algebra 1 grade cutoff of .7 and the data from Table 13. The metrics for an Algebra 1 grade cutoff of 1.0 and a minimum HLM grade of 1.7 are presented in Table 15.

Table 15

Metrics for Final Algebra 1 Grade Cutoff of 1.0 and HLM Grade of 1.7

	Total	Percent	Sensitivity	Specificity
True Negatives (TN)	8	1.55		
False Negatives (TP)	33	6.41		
False Positives (FP)	64	12.43		
True Positives (TP)	410	79.61		
Overall			92.50%	11.10%

The third cross tabulation was done using the next possible final Algebra 1 grade cutoff, 1.3 (D+). For this metric, any student who earned above a 1.0 or a D in Algebra 1 was considered to have met the minimum grade required to meet the minimum threshold performance of 1.7 in HLM. The results of the cross tabulation are presented in Table 13; Column C corresponds to the final Algebra 1 grade cutoff of 1.3. After the four outcomes were established for the minimum final Algebra 1 grade cutoff of 1.3 and the minimum HLM performance threshold of 1.7, the totals and percentages of each outcome were determined. In order to construct an appropriate comparison for all the minimum final Algebra 1 grade cutoffs, sensitivity and specificity were calculated for this final Algebra 1 grade cutoff using the methods previously described for the final Algebra 1 grade cutoff of .7 and the data from Table 13. The metrics for an Algebra 1 grade cutoff of 1.3 and a minimum HLM grade of 1.7 are presented in Table 16.

Table 16

Metrics for Final Algebra 1 Grade Cutoff of 1.3 and HLM Grade of 1.7

	Total	Percentages	Sensitivity	Specificity
True Negatives (TP)	15	2.91		
False Negatives (FN)	65	12.62		
False Positives (FP)	57	11.07		
True Positives (TN)	378	73.40		
Overall			85.30%	20.83%

The fourth cross tabulation was done using the next possible final Algebra 1 grade cutoff, 1.7 (C-). For this metric, any student who earned above a 1.3 or a D+ in Algebra 1 was considered to have met the minimum grade required to meet the minimum threshold performance of 1.7 in HLM. The results of the cross tabulation are presented in Table 13; Column D corresponds to the final Algebra 1 grade cutoff of 1.7. After the four outcomes were established for the minimum final Algebra 1 grade cutoff of 1.7 and the minimum HLM performance threshold of 1.7, the totals and percentages of each outcome were determined. In order to construct an appropriate comparison for all the minimum final Algebra 1 grade cutoffs, sensitivity and specificity were calculated for this final Algebra 1 grade cutoff using the methods previously described for the final Algebra 1 grade cutoff of .7 and the data from Table 13. The metrics for an Algebra 1 grade cutoff of 1.7 and a minimum HLM grade of 1.7 are presented in Table 17.

Table 17

Metrics for Final Algebra 1 Grade Cutoff of 1.7 and HLM Grade of 1.7

	Total	Percentages	Sensitivity	Specificity
True Negatives (TN)	23	4.47%		
False Negatives (FN)	85	16.50%		
False Positives (FP)	49	9.51%		
True Positives (TP)	358	69.51%		
Overall			80.81%	31.90%

The fifth cross tabulation was done using the next possible final Algebra 1 grade cutoff, 2.0 (C). For this metric, any student who earned above a 1.7 or a C- in Algebra 1 was considered to have met the minimum grade required to meet the minimum threshold performance of 1.7 in HLM. The results of the cross tabulation are presented in Table 13; Column E corresponds to the final Algebra 1 grade cutoff of 2.0. After the four outcomes were established for the minimum final Algebra 1 grade cutoff of 2.0 and the minimum HLM performance threshold of 1.7, the totals and percentages of each outcome were determined. In order to construct an appropriate comparison for all the minimum final Algebra 1 grade cutoffs, sensitivity and specificity were calculated for this final Algebra 1 grade cutoff using the methods previously described for the final Algebra 1 grade cutoff of .7 and the data from Table 13. The metrics for the final Algebra 1 grade cutoff of 2.0 and a minimum HLM grade of 1.7 are presented in Table 18.

Table 18

Metrics for Final Algebra 1 Grade Cutoff of 2.0 and HLM Grade of 1.7

	Total	Percentages	Sensitivity	Specificity
True Negatives (TN)	36	6.99%		
False Negatives (FN)	131	25.44%		
False Positives (FP)	36	6.99%		
True Positives (TP)	312	60.58%		
Overall			80.81%	31.90%

The sixth cross tabulation was done using the next possible final Algebra 1 grade cutoff, 2.3 (C+). For this metric, any student who earned above a 2.0 or a C in Algebra 1 was considered to have met the minimum grade required to meet the minimum threshold performance of 1.7 in HLM. The results of the cross tabulation are presented in Table 13; Column F corresponds to the final Algebra 1 grade cutoff of 2.3. After the four outcomes were established for the minimum final Algebra 1 grade cutoff of 2.3 and the minimum HLM performance threshold of 1.7, the totals and percentages of each outcome were determined. In order to construct an appropriate comparison for all the minimum final Algebra 1 grade cutoffs, sensitivity and specificity were calculated for this final Algebra 1 grade cutoff using the methods previously described for the final Algebra 1 grade cutoff of .7 and the data from Table 13. The metrics for an Algebra 1 grade cutoff of 2.3 and a minimum HLM grade of 1.7 are presented in Table 19.

Table 19

Metrics for Final Algebra 1 Grade Cutoff of 2.3 and HLM Grade of 1.7

	Total	Percentages	Sensitivity	Specificity
True Negatives (TN)	50	9.71%		
False Negatives (FN)	176	34.17%		
False Positives (FP)	22	4.27%		
True Positives (TP)	267	51.84%		
Overall			60.27%	69.44%

The seventh cross tabulation was done using the next possible final Algebra 1 grade cutoff, 2.7 (B-). For this metric, any student who earned above a 2.3 or a C+ in Algebra 1 was considered to have met the minimum grade required to meet the minimum threshold performance of 1.7 in HLM. The results of the cross tabulation are presented in Table 13; Column G corresponds to the final Algebra 1 grade cutoff of 2.7. After the four outcomes were established for the minimum final Algebra 1 grade cutoff of 2.7 and the minimum HLM performance threshold of 1.7, the totals and percentages of each outcome were determined. In order to construct an appropriate comparison for all the minimum final Algebra 1 grade cutoffs, sensitivity and specificity were calculated for this final Algebra 1 grade cutoff using the methods previously described for the final Algebra 1 grade cutoff of .7 and the data from Table 13. The metrics for an Algebra 1 grade cutoff of 2.7 and a minimum HLM grade of 1.7 are presented in Table 20.

Table 20

Metrics for Final Algebra 1 Grade Cutoff of 2.7 and HLM Grade of 1.7

	Total	Percentages	Sensitivity	Specificity
True Negatives (TN)	54	10.49%		
False Negatives (FN)	206	40.00%		
False Positives (FP)	18	3.50%		
True Positives (TP)	237	46.02%		
Overall			53.49%	75%

The last cross tabulation was done using the next possible final Algebra 1 grade cutoff, 3.0 (B). For this metric, any student who earned above a 2.7 or a B- in Algebra 1 was considered to have met the minimum grade required to meet the minimum threshold performance of 1.7 in HLM. The results of the cross tabulation are presented in Table 13; Column H corresponds to the final Algebra 1 grade cutoff of 3.0. After the four outcomes were established for the minimum final Algebra 1 grade cutoff of 3.0 and the minimum HLM performance threshold of 1.7, the totals and percentages of each outcome were determined. In order to construct an appropriate comparison for all the minimum final Algebra 1 grade cutoffs, sensitivity and specificity were calculated for this final Algebra 1 grade cutoff using the methods previously described for the final Algebra 1 grade cutoff of .7 and the data from Table 13. The metrics for the final Algebra 1 grade cutoff of 3.0 and a minimum HLM GPA of 1.7 are presented in Table 21.

Table 21

Metrics for Final Algebra 1 Grade Cutoff of 3.0 and HLM Grade of 1.7

	Total	Percentages	Sensitivity	Specificity
True Negatives (TN)	61	11.84%		
False Negatives (FN)	268	52.04%		
False Positives (FP)	11	2.14%		
True Positives (TP)	175	33.98%		
Overall			39.50%	84.72%

After the metrics were established for each of the minimum Algebra 1 cutoffs and a minimum performance threshold of 1.7 in HLM, it was necessary to determine which final Algebra 1 grade was the most appropriate cutoff for HLM performance. This was done by comparing the metrics calculated for each minimum Algebra 1 grade. These are presented in Table 22.

Table 22

Percentage of Sample, Sensitivity, and Specificity for HLM Outcome by Algebra 1 Grade Cutoff

		Minimum Final Algebra 1 Grade Cutoff							
		.7	1.0	1.3	1.7	2.0	2.3	2.7	3.0
HLM Membership Outcome (%)	True Negative	0.58	1.55	2.91	4.47	6.69	9.71	10.49	11.84
	False Negative	2.29	6.41	12.62	16.50	25.44	34.17	40.0	52.04
	False Positive	13.40	12.43	11.07	9.51	6.99	4.27	3.50	2.14
	True Positive	83.69	79.61	73.40	69.51	60.58	51.84	46.02	33.98
	Sensitivity	99.50	92.50`	85.30	80.81	70.42	60.27	53.49	39.50
	Specificity	4.17	11.10	20.83	31.90	50.0	69.44	75.0	84.72

After these values were calculated, a determination was made regarding the most appropriate minimum final Algebra 1 grade cutoff to use for Study 3 by comparing sensitivities and specificities of the final Algebra 1 grade cutoffs. As previously discussed, sensitivity measures the percentage of positives correctly identified by the predictor test, while specificity measures the percentages of negatives correctly identified by the predictor test. For this study, final Algebra 1 grade was used as the tool to predict success in HLM. It was determined that sensitivity, which measures true positives, would be emphasized above specificity, which measures true negatives. By utilizing sensitivity, it was possible to measure the strength of the Algebra 1final algebra grade to appropriately identify those students who were able to perform at a level of 1.7 (C-) or higher in HLM. The researcher chose an 80% sensitivity rate as the minimum for the final Algebra 1 grade cutoffs as an acceptable percentage of correctly identified positive outcomes. Four Algebra 1 grades met this criterion—0.7, 1.0, 1.3, and 1.7—and then among these four Algebra 1 grades, the one with the highest specificity was selected. Based on the results of Table 20 and the criteria set forth by the researcher, it was determined that the most appropriate minimum final Algebra 1 grade to use for Studies 2 and 3 was 1.7. Interestingly, this grade is consistent with the minimum prerequisite grade for most HLM courses in the district.

Study 2

Study 2 was designed to explore if there are factors that may predict math potential for Hispanic EL students. The research questions for Study 2, and their associated hypotheses, which were presented in Chapter 1, were developed to explore if there are factors that may predict mathematics potential for Hispanic EL students, which would then be utilized to construct a predictive algorithm. From this predictive algorithm, it may be possible to develop a model that predicts math performance and assists with course placement for EL students. This analysis was conducted by examining several predictor variables and the shared metric between Hispanic EL and no-EL students that was established in Study 1. By examining predictor variables that are available when the student registers for school, it may be possible to develop a model that predicts math performance and assists with course placement. Within the confines of statistical power, analyses first prioritized the overall predictive model to later be used to form a protocol and then, as statistical power provided, further identified all the main independent variables, or potential predictors, that contributed to perform better in Algebra 1. An additional post hoc exploratory analysis was conducted in Study 2 to examine the three strongest predictor variables that emerged from the multiple regression analysis.

A multiple regression analysis was conducted to address Research Question 2-1, if a protocol can be created using a group of variables available at the time of student registration. A multiple linear regression was calculated to predict the final Algebra I grade based on several predictor variables, which were harvested from the state- and district-level databases. These include type of EL student, public or private schooling in the student's country of origin, living with a parent or guardian, age of entry, mean years of schooling completed in a student's country of origin, grade of entry, and gender. Gender was dummy coded into the female variable, and for the purpose of the study, not being a female student is the equivalent of being a male student. Nonbinary gender is not addressed in the study because during the period in which the data used in the study were harvested, students were required to identify as either male or female at the time of registration. Although there are other possible predictor variables, these variables were chosen because they would potentially assist in the development of a protocol used at registration. The study had limited statistical power, which restricted the number of variables to be in line with the power. The predictor variables, variable code names, and definitions, as well as the associated coding for SPSS, are included in Table 23. For a complete description of each predictor variable, see Table 6 in Chapter 3.

Table 23

Summary of Predictor Variables in Study 2

Variable	Variable Coded	Type of Variable	Code
type of EL	type_EL	Dichotomous	SLIFE = 0 Traditional = 1
public or private school	pubpriv_school	Dichotomous	Public = 0 Private = 1
parent or guardian	parent_guard	Dichotomous	No = 0 Yes = 1
age of entry	age_entry	Continuous	
mean years of schooling	mean_school	Continuous	
grade of entry	grade_entry	Dichotomous	High School = 0 Middle School = 1
gender	female	Dichotomous	Not Female = 0 Female = 1

Using the Enter method, a multiple regression analysis was conducted to establish which variables were the best predictors of math performance as measured by the final Algebra I grade point average. The regression equation and explanation of variables for the model are provide below:

$Y_{pred} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + e_n$, where:

Y_{pred} = predicted value for Algebra 1
β_0 = Y axis intercept
β_1 = regression coefficient for type of EL
X_1 = Value for type of EL
β_2 = regression coefficient for Public or Private education in country of origin
X_2 = Value for Public or Private education in country of origin
β_3 = regression coefficient for living with a parent or guardian
X_3 = Value for living with a parent or guardian
β_4 = regression coefficient for gender, coded for female
X_4 = Value for gender, coded for female

β_5 = regression coefficient for age of entry
X_5 = Value for age of entry
β_6 = regression coefficient for Mean Years of School by Country of Origin
X_6 = Value for Mean Years of School by Country of Origin
β_7 = regression coefficient for age of entry
X_7 = Value for age of entry

As illustrated in Table 23, the multiple regression included variables that were both dichotomous and continuous. The descriptive statistics for the continuous variables in the study are presented in Table 24.

Table 24

Descriptive Statistics for Continuous Variables

Variable	Mean	Standard Deviation *(SD)*	*N*
public or private school	.1290	.33614	186
age of entry	15.742	1.6842	186
mean years of schooling	114.96	15.975	186

Tolerance statistics and variance inflation factors (VIF) were assessed to detect the presence of multicollinearity between the predictor variables, which occurs when two variables are highly correlated with each other. Tolerance levels lower than .2 and VIFs greater than 5 indicate multicollinearity. Table 25 presents the tolerance statistics and VIF for each predictor variable. All the variables in the model have tolerance statistics of greater than .2 and VIFs of less than five, supporting that there is no evidence of multicollinearity.

Table 25

Tolerance and VIF for Variables

Variable	Tolerance	VIF
type of EL	.730	1.370
public or private school	.874	1.145
parent or guardian	.660	1.516
gender	.991	1.009
age of entry	.933	1.071
mean years of schooling	.665	1.504
grade of entry	.822	1.217

A significant regression equation was found ((F (7,178) = 2.956, $p < .01$, $R = .323$, $R^2 = .104$) using seven predictor variables. Table 23 presents the regression coefficients and summary for the model. The unstandardized regression coefficients are represented with the letter B, the standardized regression coefficients are represented by the symbol β, the t statistics are represented by the letter *t*, and the significance levels are represented by the letter *p*.

Table 26

Regression Coefficients and Summary for Multiple Regression

Variable	B	β	*t*	*p*
Constant	1.245		.544	.587
type of EL*	-0.357	-.147	-1.768	0.079
public or private school	0.095	.030	.399	.690
parent or guardian	0.286	0.128	1.468	.144
gender**	0.379	.179	2.512	0.013
age of entry	-0.008	-.013	-.175	.861
mean years of schooling	0.008	.124	1.423	.156
grade of entry**	-.0.435	.166	2.121	.035

*p < .10 **p < .05

Research Question 2-3 was addressed using a post hoc exploratory analysis that examined the strongest predictor variables that emerged from the multiple regression analysis. There were three predictor variables with statistically significant beta coefficients (Rubin, 2017) with p value threshold of under .1, including type of EL, female, and grade of entry. Female (β = .179, p = .013) was positively associated with performance in Algebra 1, which suggests that when compared to males, females perform better in Algebra 1. Type of EL student (β = -.147, p = .079), which is defined as the categorization of EL students into traditional EL—those who have followed an academic trajectory in their country of origin that parallels that of a student in the United States—and Students with Limited or Interrupted Formal Education (SLIFE), was negatively associated with performance in Algebra 1. Grade of entry (β = -.166, p = .035), defined as the original grade level of placement during student registration, was also found to be negatively associated with performance in Algebra 1. The results suggest that Hispanic EL students who entered the school system in middle school performed better in Algebra 1 than students who entered the school system in Grades 9 or 10.

The results of the multiple regression analysis were then utilized to address Research Question 2-2, the construction of a predictive algorithm. The purpose of this algorithm was to establish a protocol that would be used by the district at registration to place students into the appropriate math courses. The rationale to construct a registration placement protocol based on mathematical performance stems from the historical practice of forcing Hispanic EL students into a lower-level mathematical trajectory due to their language proficiency. By using a protocol at registration, EL students who were able to demonstrate HLM skills would be provided the opportunity to enter a more advanced math trajectory rather than simply be placed by language proficiency. Below is the algorithm that was constructed using the results of the multiple regression analysis:

$$= \text{constant} + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + B_5X_5 + B_6X_6 + B_7X_7$$

$$= 1.245 - .357(\text{type\_EL}) + .095(\text{pubpriv\_school}) + .286(\text{parent\_guard}) + .379(\text{female}) - .008(\text{age\_entry}) + .008(\text{mean\_school}) - .435\ (\text{grade\_entry})$$

B is the unstandardized regression coefficient for each predictor variable.

As reflected in the modest R^2 for the overall model, the algorithm predicts the actual Algebra 1 scores at a similar correlational rate of .313 versus .323. When one considers that Algebra 1 is only modestly associated with HLM, the protocol decision algorithm would only predict at .313, which in turn would predict HLM by .353. Taken together, this would likely have a predictive *r* of .313 x .353, which would equal .11. For these reasons, the algorithm was only conducted for educational purposes since the R^2 and the correlation obtained in Study 1 of .353 both were too modest to be combined for an actual protocol system.

In real terms, the algorithm plan was abandoned at the R^2 model stage so that the researcher could retain more family-wise error rate (FWER) alpha for Study 3, which was a follow-up post hoc examination of the linking variable across the different student populations involved in the overall project.

Study 3

The research questions for Study 3, and their associated hypotheses, which were presented in Chapter 1, were constructed to further explore the historical practice of using English proficiency to dictate a math trajectory for Hispanic EL students. There are assumptions that have accompanied the policy of determining English proficiency at school registration, and language proficiency has historically been utilized as the sole criteria to place EL students in math courses. Study 3 aimed to explore the Algebra performance of each sample group, as this had been shown in Study 1 to be moderately predictive of HLM performance. Study 3 was designed by using the a priori allocated alpha reserved for follow-up inquiries. Using specific datasets from the same overall archival database from Study 1 and 2, the goal was to test out the researcher's developing theoretical model. The model hypothesized that the EL students were similar in Algebra performance to students from the general school population (no-EL all) prior to the students with stronger math skills opting to pursue HLM and students with weaker math skills declining to pursue HLM (see Appendix D). For a complete description of the different sample groups—EL, no-EL no-HLM, no-EL HLM, and no-EL all—see Table 7. The descriptive statistics for the four sample groups are presented in Table 27.

Table 27

Descriptive Statistics for Sample Groups

	Sample Group			
	1 Hispanic EL	2 no-EL no-HLM	3 no-EL HLM	4 no-EL all
Sample Size (N)	193	663	536	1199
Mean	1.826	1.152	2.341	1.684
Median	2	0.7	2.3	1.7
Mode	.7	.4	2.7	.4

Study 3 was designed to confirm or disconfirm whether the data supported that the Hispanic EL students were similar in their Algebra 1 performance to students from the general school population (no-EL-all) because, at this point, neither group had been further selected into subgroups of stronger and weaker Algebra 1 performance. As was already demonstrated in Study 1, the HLM students should have higher Algebra grades on average compared to the students from the general school population who did not participate in HLM (no-EL no-HLM). The performance of Hispanic EL students in HLM was not examined directly because they historically have not been allowed entrance into HLM, and therefore the EL students have not further homogenized into stronger and weaker math student subgroups.

To address Research Question 3-1, if there was substantial variation in Algebra 1 performance among level 1 and 2 Hispanic EL students, a frequency distribution histogram was constructed utilizing the sample group from Study 2. Using the letter grade to GPA conversion system utilized by the state department of education from Table 4, a frequency distribution for the final Algebra 1 grade for Hispanic EL students was constructed. The Hispanic EL sample is the same sample group utilized in Study 2. As previously discussed, these students are members of a separate population of students who were identified as having level 1 or 2 English proficiency in Grade 9. These students are not considered to be part of the general school population for this project since all their academic courses are taken in separate cohorts. The sample includes all Hispanic EL students who were identified through ACCESS testing as having as a level 1 or 2 English proficiency and therefore participated in an Algebra 1 course for EL students. The results with the corresponding percent distribution of grades in Algebra 1 for Hispanic EL students are presented in Figure 1.

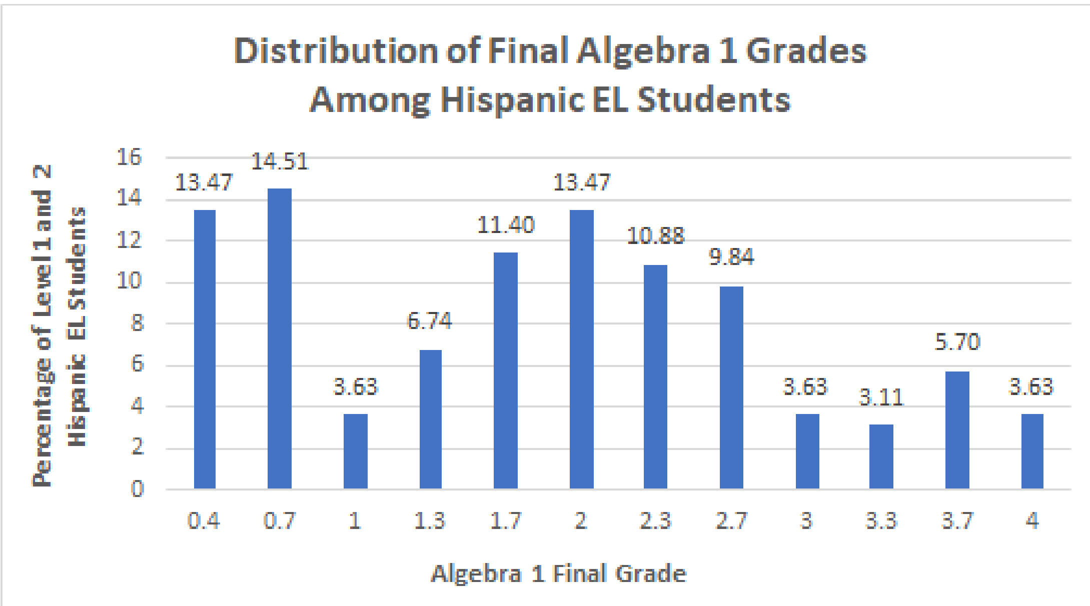

Figure 1. Distribution of Final Algebra 1 Grades for Hispanic EL Students.

Although 27.98% of the sample of Hispanic EL students earned a .7 or below in Algebra 1, according to Figure 1, there is substantial variation in the final Algebra 1 grade scores for Hispanic EL students. The variation of scores among Hispanic EL students is indicative of the heterogeneity in math performance for this sample and suggests that similar results would be found for this specific population.

Once it was established that there was substantial variation in the distribution of final Algebra 1 grades among all Hispanic level 1 and 2 students, it was possible to address Research Questions 3-2A, 3-2B, and 3-2C to examine if there were differences between the mathematical abilities of Hispanic EL students and the no-EL student groups. Research Question 3-2A was explored using the no-EL-all sample group, which included two subsamples, no-EL no-HLM and no-EL HLM. Collapsing the two no-EL groups, those who participated in HLM and those who did not, back into one group, called no-EL-all, was the most appropriate method of comparison to the Hispanic EL level 1 and 2 group as they have not yet opted in or out of HLM, making them as a collective group more similar to the Hispanic EL students with diverse math skills and interests. Each of the subsamples, no-EL no-HLM and no-EL HLM, were utilized separately to address Research Questions 3-2B and 3-2C, respectively.

The first sample group, no-EL-all, includes all students who were not categorized as Hispanic EL level 1 or 2 when they were enrolled in Algebra 1 and did not participate in HLM in Grade 12, either by choice or because they did not meet the prerequisite requirements. The second no-EL sample group, no-EL HLM, is a subsample of the no-EL all group. This group includes all students who were not categorized as Hispanic EL level 1 or 2 when they were enrolled in Algebra 1 and participated in HLM in Grade 12. All students in the two different no-EL sample groups were part of the general school population, as described in Chapter 3. The members of the no-EL-all group were not identified as having level 1 or 2 English proficiency when they participated in Algebra 1 in Grade 9. All the students in this group participated in a no-EL Algebra 1 course in Grade 9 and a no-EL mathematics course in Grade 12 (see Appendix D for a visual schematic of the different student groups differentiated by their self-selection into HLM).

Utilizing Algebra 1, which emerged as the linking variable that was associated with HLM performance in Study 1 and was further analyzed in Study 2, an additional set of tests were conducted to revisit how the various student groups compared in their Algebra 1 performance, which was found to be predictive of success in HLM. These tests allowed for an examination of the assumptions associated with using English proficiency as an indicator and placement tool for mathematics with no consideration of actual math skill and performance. This was done by exploring if Hispanic EL students were statistically different or equivalent in their math prerequisite performance than their no-EL peers through independent samples *t*-tests and one TOST equivalence procedure. Additional analyses of the distribution of Algebra 1 grades and the use of crosstabs to predict performance in HLM for non-EL students were also examined. The performance of Hispanic EL students in HLM was not examined directly because they historically have not been allowed entrance into HLM. Through the aggregate of these follow-up analyses, Study 3 aimed to examine the developing theoretical model of the researcher, which hypothesized the EL students were similar in Algebra math performance to their peers from the general school population (no-EL all) before stronger students decided to pursue HLM and weaker students declined to pursue HLM. This model would support the notion that the EL students are also heterogeneous in math skills and that the stronger math students were likely able to succeed in HLM if they were allowed to participate.

Independent Samples *t*-test 1: Algebra 1 Grade by EL and no-EL all

Through different independent samples *t*-tests and one TOST equivalence procedure, the mean differences and similarities of the final Algebra 1 grade of Hispanic EL students and no-EL students were compared to test out the proposed model. The Hispanic EL sample included all Hispanic EL students who participated in an EL Algebra 1 course as a level 1 or 2 student, as determined by ACCESS. As previously described, the no-EL all sample was composed of two subgroups that were later separated by interest and skill for HLM. The first no-EL student group, no-EL no-HLM, included all students who were not categorized as Hispanic EL level 1 or 2 when they were enrolled in Algebra 1 and did not participate in HLM in Grade 12, either by choice or because they did not meet the prerequisite requirements. The second no-EL group, no-EL HLM, included all students who were not categorized as Hispanic EL level 1 or 2 when they were enrolled in Algebra 1 and participated in HLM in Grade 12. These two sample groups were collapsed back into one group, no-EL all, representing the general student population before any demarcation or change to membership occurred, based on being allowed to take HLM. This was done to reconstruct a group that best mirrors the Hispanic EL sample, which includes all students who completed Algebra 1. Unlike the other independent samples *t*-tests, the TOST equivalence procedure was hypothesized to show a statistical equivalence or similarity within the upper and lower bounds of a Cohen *d* of under +/- 0.4. Based on an effect size with meaning regarding a reasonable grade difference as well as a standard effect size confidence interval (CI) utilized for such a TOST procedure (Lakens et al., 2018), the equivalence procedure was run to test out whether the two groups were indeed similar and statistically considered equivalent. It was hypothesized that the two groups should be statistically equivalent within the Cohen *d* of +/-. 4 because theoretically both samples should be similar before the stronger math students are self-selected out of the no-EL all general student population and enter HLM.

Table 28 presents the results of the TOST equivalence procedure, as described by Lakens et al. (2018) and Anderson Cook et al. (2016). Utilizing a Hedges's *g* and/or Cohen's *d* of .4 for the effect size bands, with a 98.6% CI, the lower and upper bounds of the effect size were determined to be within the +/- .4 effect size threshold. The 98.6% CI is a precise interval based on the .007 alpha left for this specific analysis, which was doubled due to the TOST procedure per Lakens et al. (2018). Even with these strict parameters, the comparison yielded statistically equivalent groups in terms of their mean similarity of Algebra performance (p<.001).

It is important to note that the means (*M*) and standard deviations (*SD*) show a slight edge to the EL group (M = 1.826, SD = 1.0496) when compared to the no-EL-all group (M = 1.685, SD = 1.1388). As reported in Table 28, if a mean difference *t*-test for the two groups had been performed, the outcome would not be significant and the effect size of difference would be extremely small ($t(df$ = 270.173) = -1.712, p=.088, EL students > no-EL all; Cohen's d = 0.129, Hedges's g = 0.125). At .088, the *p* value would be approaching a standard .05 alpha threshold. However, this *p* value is heavily influenced by the very large sample size of one of the two groups, while the effect size of any difference is extremely small. It is also important to consider the real world meaning of such a small effect size. Using the standard deviations of the two groups and considering an effect size of .4 as a reasonable threshold with some meaning in terms of grade differences, the current effect size of difference is well within this interval. It is interesting to note that the insignificant difference is in the direction benefiting the EL student group. The mean of the EL group is slightly higher than the mean of the overall no-EL all group.

Table 28

Independent Samples TOST and t-test Summary Table: Algebra 1 Grade by Student Group

				98.6% CI Lower ES Bound > -0.4	98.6% CI Upper ES Bound < +0.4
		Results within 98.6% CI		-.345	+.0627
Sample	*N*	Mean (*SD*)	*df*	*t*	*p*
no-EL all	1198	1.685 (1.1388)	270	-1.712	.088
EL	193	1.826 (1.0496)			
TOST Upper			270	-7.03	< .001
TOST Lower			270	3.6	< .001

Independent Samples *t*-test: Algebra 1 Final Grade by EL and no-EL no-HLM

To further examine if there were differences between the mathematical abilities of Hispanic EL students and the no-EL student groups, the no-EL all student group was divided by participation in HLM into two groups, no-EL no-HLM and no-EL HLM. To address Research Question 3-2B, if the final Algebra 1 grades of the Hispanic EL students differ from the final Algebra 1 grades of the no-EL no-HLM students, an independent samples *t*-test was conducted. The EL sample group includes all Hispanic EL students who participated in an EL Algebra 1 course as a level 1 or 2 student, as determined by ACCESS. The no-EL no-HLM sample group includes all students who were not categorized as Hispanic EL level 1 or 2 when they were enrolled in Algebra 1 and did not participate in HLM in Grade 12, either by choice or because they did not meet the prerequisite requirements. Table 29 presents the results of an independent samples *t*-test conducted after a significant Levene's Test showed that homogeneity of variance could not be assumed. Results yielded a significant *t*-test ($t(df = 290.964) = 8.005$, $p = 2.87\text{x}10^{-14}$)

and a medium effect size (Cohen's *d* = 0.671, Hedges's *g* = 0.67), showing that Hispanic EL students had a significantly higher GPA compared to the no-EL no-HLM students. Due to the unequal sample size, Hedges's *g* was used instead of Cohen's *d* to calculate effect size.

Table 29

Independent Samples t-test Summary Table: Algebra 1 Final Grade by Student Groups

Sample	*N*	Mean	*SD*	*t*	*p*
no-EL no HLM	663	1.152	.9558	8.005	2.8691×10^{-14}
EL	193	1.826	1.0496		

The mean final Algebra 1 grade of the no-EL no-HLM group (*M* = 1.152, *SD* = .9558, *N* = 663) was significantly lower than the final Algebra 1 grade of the English Learner group (*M* = 1.826, *SD* = 1.0496, *N* = 193). The test showed a difference in Algebra 1 performance between the EL and no-EL no-HLM sample groups and suggests that Hispanic EL students performed significantly better in Algebra 1 than non-EL students. Hispanic EL students averaged a C- in Algebra 1 while the no-EL no-HLM students averaged a D in Algebra 1, which is two grade intervals lower.

Independent Samples *t*-test: Algebra 1 Final Grade by EL and no-EL HLM

To further examine if there were differences between the mathematical abilities of Hispanic EL students and the no-EL student groups, the no-EL-all student group was divided into two groups, no-EL no-HLM and no-EL HLM, by participation in HLM. To address Research Question 3-2C, if the final Algebra 1 grades of the Hispanic EL students differ from the final Algebra 1 grades of the no-EL HLM students, an independent samples *t*-test was conducted. The EL sample group includes all Hispanic EL students who participated in an EL Algebra 1 course as a level 1 or 2 student, as determined by ACCESS. The no-EL HLM sample group includes all students who were not categorized as Hispanic EL level 1 or 2 when they were enrolled in Algebra 1 and participated in HLM in Grade 12. Table 30 presents the results of an independent samples *t*-test conducted after a significant Levene's Test showed that homogeneity of variance could not be assumed. Results yielded a significant *t*-test (*t(df* =324.255) = 5.931, *p*= 7.74 x 10^{-9} and a small effects size (Cohen's *d* = 0.503, Hedges's *g* = 0.50), with no-EL HLM students' mean final Algebra 1 grade significantly higher than the EL students' mean final Algebra 1 grade. Due to the unequal sample size, Hedges's *g* was used instead of Cohen's *d* to calculate effects size.

Table 30.

Independent Samples t-test Summary Table: Algebra 1 Final Grade by Student Groups

Sample Group	*N*	Mean	*SD*	*t*	*p*
no-EL HLM	536	2.341	.9953	5.931	1.93 x10^{-9}
EL	193	1.826	1.0496		

The mean final Algebra 1 grade of the HLM group (*M* = 2.341, *SD* = .9953, *N* = 536) was significantly higher than the final Algebra 1 grade of the English Learner group (*M* = 1.826, *SD* = 1.0496, *N* =193). The test showed a difference in Algebra 1 performance between the EL and no-EL HLM sample groups and suggests that Hispanic EL students performed significantly lower in Algebra 1 compared to the no-EL HLM sample group. However, there are variations within the HLM group, as indicated in Study 1. It is possible that the final Algebra 1 grade of the Hispanic EL students is more closely related to the lower performing HLM math students than the non-HLM students, which would provide empirical evidence for the development of a protocol that would allow higher math-performing EL students to participate in HLM courses.

Additional Analyses

To gather additional evidence to answer Research Questions 3-2A, 3-2B, and 3-2C, whether Hispanic EL students differ in relation to math prerequisite performance from their no-EL peers, analyses of the distribution of Algebra 1 grades among Hispanic EL students and no-EL students were conducted. These included frequency distributions, cross tabulations, and comparative analyses to explore how Algebra 1 grades predict performance in HLM for no-EL students. The frequency distribution of the final Algebra 1 grades of each sample group and the entire sample, which includes Hispanic EL and no-EL students, is presented in Figure 2. As described in Study 1, a final Algebra 1 grade of 1.7 was determined to be the most appropriate minimum final Algebra 1 grade by which to explore what, if any, mathematical limitations exist for Hispanic level 1 and 2 EL students in terms of their ability to succeed in HLM. The percentage of students earning a 1.7 or above in Algebra 1, by sample group, is presented in Table 31.

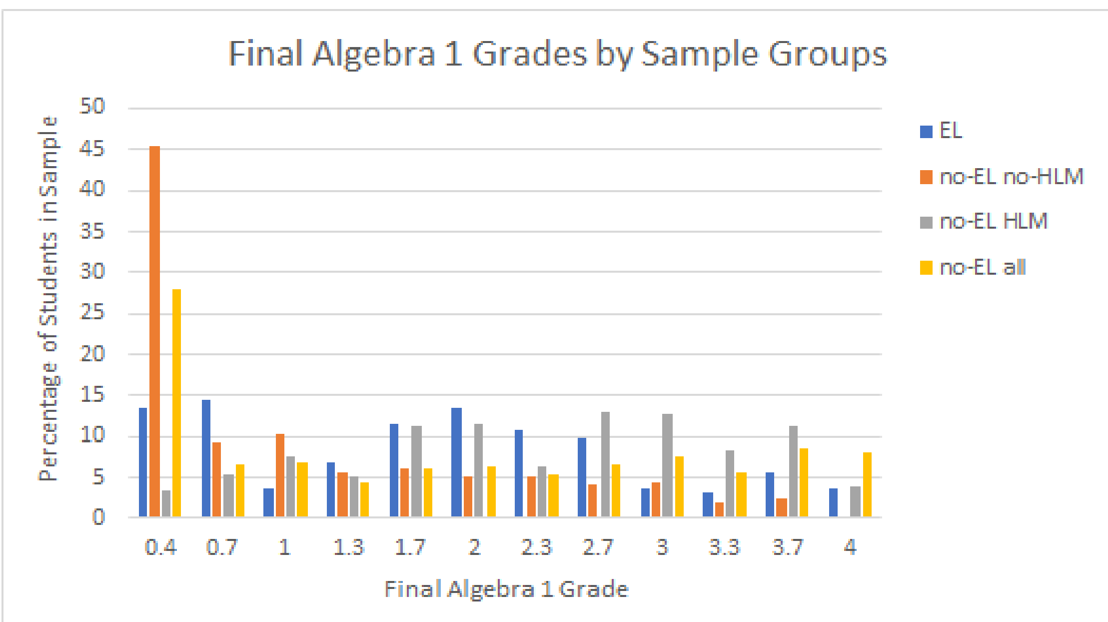

Figure 2. Frequency Distribution of Final Algebra 1 Grade by Sample Groups.

Table 31

Percentage of Students Earning a 1.7 or Above in Algebra 1 by Sample Group

	Sample Group			
	1 Hispanic EL	2 no-EL no-HLM	3 no-EL HLM	4 no-EL all
% of sample with minimum 1.7 Algebra 1 GPA	61.6	31.4	78.40	51.4
% of sample with final Algebra 1 grade below 1.7	38.4	68.6	21.6	48.6

As demonstrated in Figure 2 and Table 31, 61.6% of the Hispanic EL students scored a 1.7 or above in Algebra 1, indicating that there is significant variation in the final algebra grade among Hispanic EL students. Over a fifth (21.6%) of the students in the no-EL HLM group earned lower than a C- in Algebra, and they were still allowed to participate in HLM. However, despite having 61.6% percent of students earning a C- or better in Algebra 1, none of the students from the EL sample group were allowed to participate in HLM. Additionally, as Figure 2 and Table 31 illustrate, the final Algebra 1 grade of the Hispanic EL students clearly lies between the final Algebra 1 grade of the students who did not participate in HLM and the students who did participate in HLM (no-EL HLM) and is higher than the group of all no-EL students. Hispanic EL students might be a slightly stronger group in terms of final Algebra grade than the all no-EL students, and if some of the Hispanic EL students chose to participate in HLM, due to stronger Algebra performance and math interest, the data for the Hispanic EL HLM students would likely resemble the data for the no-EL HLM students. This self-selection and allowance into HLM, which has not historically been permitted for Hispanic EL students, results in a stronger pool of math performers in HLM. This point is even further corroborated by a closer examination of the modes for each subgroup. With a mode of .7, the no-EL no-HLM group is clearly well below all the other groups. This is reflected strongly in both the *t*-tests of mean differences and the frequency histogram in Figure 2. Depicted in orange, 50% of the no-EL no-HLM group has a score grade of .7 or below, meaning 53% of this group failed Algebra with a D- or less, with 45% receiving an F.

Since it was not possible to study the performance of Hispanic EL students in HLM directly, a comparison was made to examine the potential group of students who would have entered HLM based on their academic performance. This includes all Hispanic EL students who earned a 1.7 or higher Algebra 1 grade. This number was then compared to the subsample of no-EL HLM students who also earned a 1.7 or higher in Algebra 1. The descriptive statistics for the two samples are presented in Table 32, and the frequency distribution of the final Algebra 1 grade is presented in Figure 3. The sample size for no-EL HLM (1.7+) is less than the overall sample size of no-EL HLM since only students who earned a 1.7 or better in Algebra 1 were included in the comparison.

Table 32

Descriptive Statistics for Hispanic EL (1.7+) and HLM (1.7+) Samples

	Sample Group	
	Hispanic EL (1.7+)	no-EL HLM (1.7+)
Sample Size (*N*)	119	420
Mean	2.508	2.738
Median	2.3	2.7
Mode	2	2.7
Standard Deviation	0.7092	0.7141

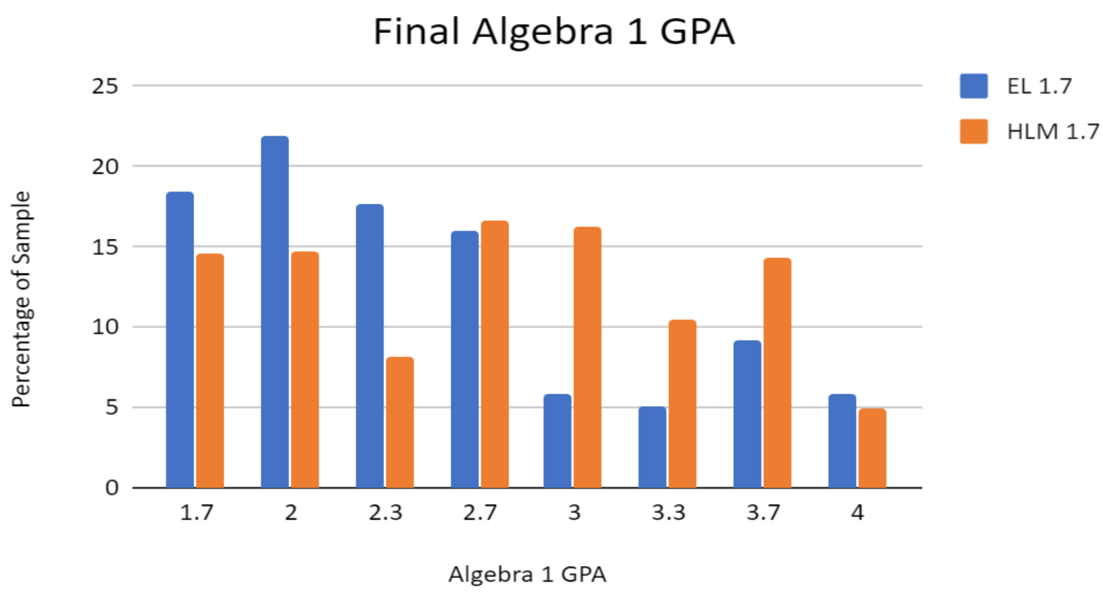

Figure 3. Frequency Distribution for Hispanic EL (1.7+) and HLM (1.7+) Samples.

Although the distribution of final Algebra 1 grade differs for the two sample groups, there is only a .4 difference between the two groups, which equates to a C+ compared to a B-. Since no HLM data exist for Hispanic ELs because of their exclusion from the course, it was necessary to include the entire sample who earned at least a 1.7 in Algebra 1, which may have negatively influenced the final Algebra 1 grade of the overall sample.

Revisiting FWER and Alpha Considerations

Appendix C shows the most conservative and moderate FWER methods utilized in the current project across all three studies. In the most extreme version where alpha is not reset for each dataset and FWER is considered across studies 1-3 as described in Chapter 3, all of the main inferential findings produced *p* values below the needed alpha, which was corrected for seven tests resulting in an alpha corrected threshold of .00714. Only R^2 from the multiple regression model came close at a *p* value of .006. It is important to remember that the analyses of the multiple regression at the individual coefficient level were conducted purely in a post hoc exploratory capacity per Rubin's (2017) and Matsunaga's (2007) suggested methods where all *p* values below .1 are considered of interest. Moreover, as two of the coefficients' *p* values were well below the standard .05 level, these independent variables should be studied more closely in future studies regarding Algebra 1 performance with Hispanic EL students.

It is important to note that regardless of whether a researcher employed the most stringent FWER corrections, which many would argue are too strong due to the interrelated properties of the variables (see Bender & Lange, 1999; Benjamini & Hochberg, 1995; Gelman et al., 2013; and White, 2019 for thorough reviews of these issues), the *p* values are well below these extremely low alpha settings (.007) including the TOST procedure conducted in Study 3 (see Appendix C for more details and a summary of the findings in the context of FWER for the project). It is also suggested that the interested statistician consider more sophisticated and modern approaches to these issues under false discovery rate models that tend to retain more statistical power. This was beyond the current expertise or need for the current study, but such approaches should be considered more for work that aims to further this line of inquiry into the mathematical trajectory of Hispanic EL level 1 and 2 students. In the current studies, all of the main findings, coupled with ample sample sizes and excellent effect sizes, produced significant results with low *p* values and very high statistical power ranging from .93 to .999.

Summary

Since Hispanic EL students have historically been denied access to HLM courses, it was necessary to use a multifaceted, indirect approach to explore the issue of math placement and Hispanic EL students for this project. The methods included three separate studies connected by a shared metric and aligned directly with the ultimate goal of the project, to explore the current mathematics placement practices that have excluded Hispanic level 1 and 2 EL students from participating in HLM courses. Algebra 1 emerged in Study 1 as the linking variable that was shared by both precalculus students and Hispanic EL students and associated with performance in an HLM course. It was also established in Study 1 that the most appropriate minimum final Algebra 1 grade to use for Studies 2 and 3 was 1.7 or a C-. The final Algebra 1 grade was then used in Study 2 to create the best model that would allow for the participation of Hispanic EL students in HLM courses based on factors known during registration. Utilizing Algebra 1, which emerged as the linking variable that was associated with HLM performance in Study 1 and was further analyzed in Study 2, an additional set of tests was conducted in Study 3 to revisit the concept of Algebra 1 as a predictor of success in HLM. The results of these analyses suggest there is a lack of evidence to support the assumptions regarding differences in mathematical performance between Hispanic EL and no-EL students. Moreover, they suggest that Hispanic EL students perform similarly to the students in the general population in relation to Algebra 1 and that if the stronger, more interested EL students were allowed to participate in HLM, the EL-HLM group would fall into a similar distribution of skills in Algebra and HLM performance as depicted in the schematic in Appendix D and demonstrated statistically in Study 3.

CHAPTER 5: DISCUSSION

The overarching purpose of the current project was to explore the mathematics placement practices that have excluded Hispanic level 1 and 2 English Learner (EL) students from higher-level mathematics (HLM) courses and to utilize the results to construct more equitable mathematics placement practices. This was done using a multifaceted approach, which included determining if there were factors that appropriately predicted mathematical performance for level 1 and 2 Hispanic EL students and exploring, through comparison analyses of archival data, the mathematics performance of Hispanic EL and no-EL students. Due to the historical practice of segregating Hispanic EL students with level 1 and 2 English proficiency from HLM courses, it was necessary to conduct the analysis indirectly, through the use of a metric shared among all students. Algebra 1 was found to have some predictive properties to HLM performance among students in the general school population, yet Hispanic EL students, with mathematical skills comparable to their non-EL peers in Algebra 1, have been refused admittance into HLM courses. This is in part because research has typically focused on the relevance of language placement as opposed to domain-specific skills such as math with minimal attention given to the profound short- and long-term effects of course placement and curricula for Hispanic level 1 and 2 EL students. The necessity to use a shared metric to study math placement for Hispanic EL students as well the diversity of Algebra scores among Hispanic EL students highlights the inequitable practice of academic placement of Hispanic level 1 and 2 students, which historically has unjustly segregated them from HLM courses based solely on their English proficiency.

Summary of Results

The data were analyzed using correlation analyses, multiple regression analysis, independent *t*-tests, a TOST equivalence procedure, and various descriptive statistical techniques to first establish a math-related metric that is shared across all student groups and then, utilizing that metric, explore the historical practice of using English proficiency to dictate a math trajectory for Hispanic EL students. Given that it was not possible to study Hispanic EL students and the associated predictors for HLM directly because they have been excluded from participation in the courses, it was necessary to design and conduct three studies across different student populations that were connected by a metric shared by all students. Utilizing this method, a relationship was established between HLM course performance and Algebra 1, a shared metric for all students. The results from Study 1 suggested that the final grade in Algebra 1 (r = .353) is more strongly associated with performance in HLM than the Mathematics State Assessment (MSA) (r = .158) and therefore is a more appropriate predictor of performance in an HLM course. Algebra 1 was then utilized in Study 2 to create the best model that would predict better Algebra performance and thus allow for the participation of Hispanic EL students in HLM courses based on factors known during registration. Utilizing the remaining family-wise error rate (FWER) alpha allocated for the project, Study 3 consisted of a set of follow-up post hoc analyses that more deeply explored the shared metric, Algebra 1, for both Hispanic EL and no-EL students to determine if there is validity or evidence to support the assumptions regarding differences in mathematical performance between the two groups. In Study 2, results from an additional exploratory post hoc analysis with generous alpha thresholds of .10 outside of the main question and focus suggest that female Hispanic EL students, who initiate their schooling in the United States in Grades 6–8 and register for school with proof of prior education from their country of origin, might perform better in Algebra 1 than other Hispanic EL level 1 students. Male students whose formal education has been limited or interrupted and initiated their schooling in the United States at the high school level do not perform as well in Algebra 1.

Analyzed under the methods proposed by Rubin (2017), these additional results in Study 2 should be viewed cautiously with a transparent call to replicate and revisit in future research. Moreover, although the additional variables—mean years of schooling in country of origin, public or private school in country or origin, living with a parent or guardian, and age of entry at arrival—did not meet the generous exploratory alpha threshold of .1, it is maintained that these variables warrant further observation through continued research.

The results from the overall project provide evidence for the need to develop and implement pilot studies to further examine the issue of mathematics placement and Hispanic EL students. The distribution of Algebra 1 scores for Hispanic EL students compared to no-EL student groups is indicative of the need to provide opportunities for Hispanic EL students to participate in additional math courses like their non-EL peers. Additionally, although Study 2 did not produce a sufficient algorithm, the identification of predictor variables that can influence Algebra performance offers future opportunities to develop a protocol that may be used at registration to more appropriately place EL students in mathematics courses. Placement based on math abilities and interest ensures that linguistic proficiency will no longer limit mathematical opportunities both in high school and beyond for EL students. Despite limitations associated with sample size, the findings from the overall project, which incorporated the linking variable found in Study 1, suggest the practice of homogeneously classifying and placing Hispanic EL students is erroneous. Study 3 provided evidence in support of the researcher's model, which hypothesized that the EL students were similar in Algebra performance to the students who were part of the general school population (no-EL all) before students with stronger math skills chose to pursue HLM and students with weaker math skills declined to pursue HLM. Taken as a whole, these findings support the need for the construction of a placement system that disrupts rather than propagates the existing cycle of marginalization in education for Hispanic EL students.

Discussion

Study 1

Two correlation analyses and one follow-up independent sample *t*-test were performed to address Research Question 1-1. This research question explored whether the MSA raw score or the final grade in Algebra 1 was a better predictor of precalculus and if the stronger variable was sufficiently strong enough to use as a predictor and linking variable for precalculus performance. Although MSA has traditionally been used as a gauge of mathematics ability, it was not strongly correlated with performance in HLM (r =.158, p <.001). One explanation is that the selection process that places students who were not identified as level 1 or 2 Hispanic EL students into HLM courses minimizes the effect of the association between MSA and HLM by removing lower scoring students who were not identified as level 1 or 2 Hispanic EL students from participating in HLM courses. If the lower-performing math students do not participate in an HLM course, then their exclusion reduces the variance of scores and thus the overall association between HLM and MSA. If it were mandatory for all students to participate in the HLM course, the findings may have demonstrated a stronger relationship between MSA and HLM. A second factor that also may have contributed to the weak correlation between MSA and HLM performance is inherent in the test itself. It is possible that, despite its widespread use as a measurement of mathematical ability, as research suggests, the test is not as appropriate of an indicator of achievement for all students (Gong, 1999).

There were several factors that contributed to the decision to use MSA as the linking variable to predict HLM performance. The raw scores are standardized, so the scores may be used across various years, and the test is available in Spanish, which decreases the potential issues associated with a lack of English proficiency. The scoring is completed at the state level, which eliminates the potential issue of variability in grading between different teachers for the same Algebra courses. Despite the perceived capability of the MSA to predict HLM performance, there are issues that are inherent in the MSA test itself. As opposed to aptitude tests, like the SAT, which measure ability in a future context, the MSA was designed to be a subject achievement test, measuring knowledge of lower-level high school math. It was not designed to be a predictive aptitude test for HLM. This may have contributed to the lack of association between MSA and HLM performance.

The lack of predictive value of MSA on performance in HLM may also be reflective of the implications of the passage of the federal No Child Left Behind Act in 2001 and the Every Student Succeeds Act in 2015, which mandated that states had the responsibility of holding school districts accountable for student achievement (Every Student Succeeds Act, 2015; No Child Left Behind Act, 2001). This was achieved, in part, through the development and implementation of statewide assessments in academic areas, including mathematics and English, beginning in the elementary grades and culminating in an exit examination required for graduation. These assessments were constructed utilizing alignment-based research to ensure that the evaluation of student performance was reflective of the state academic content standards and that school districts were meeting student performance expectations set forth by the state (Martone & Sireci, 2009). However, the concern with the use of a standardized, statewide assessment is that it does not account for differences between students and school districts and minimizes potential external influences. For urban school districts, like the one in which this project was conducted, the inability of the standardized assessment to predict performance may be related to the impact of outside influences on students as opposed to their academic aptitude.

As a result of the weak correlation found between MSA and HLM, a second correlation analysis and follow-up independent *t*-test were performed using the final grade in Algebra 1. This is an indicator that is both a prerequisite to HLM courses and a common course that all students regardless of English proficiency are required to take. Despite having the same interest and math skill sampling issues, a stronger relationship between the final grade in Algebra 1 and the final grade in HLM ($r = .353$, $p < .001$) emerged.

To address Research Question 1-2 and further examine if the correlation between the final Algebra 1 grade and the final HLM grade had been weakened by the selection process of students allowed to participate in the HLM course, an independent samples *t*-test was conducted. This independent *t*-test compared the mean of the final grade in Algebra 1 of students who participated in HLM to those students who did not and found that there were significant differences of the means of the final grade in Algebra 1 between the no-EL HLM and no-EL no-HLM sample groups in the final grade in Algebra 1 ($t = -20.9$, $p = 1.745 \times 10^{-82}$). The results of this test provided additional statistical evidence for the use of the final grade in Algebra 1 as the predictor for HLM performance rather than MSA. Although there had been a strong rationale to use MSA as a predictor for HLM performance, it is possible that because MSA was designed to be an “achievement test,” it lacks the ability to predict future contexts. Moreover, the results support the evidence that the ability of standardized testing to measure academic performance may only be applicable to a narrow range of students (Ragan & Lesaux, 2006). Although not standardized like statewide testing, classroom assessments, which are administered by a teacher with a broader perspective of the student, may be more appropriate and more indicative of performance. This is especially true for students, like those in the current project, whose external influences, both social and academic, are not accounted for by, but may influence, standardized statewide assessments.

Study 2

Since Hispanic EL students have historically been excluded from HLM courses, there were no available data to directly examine the potential predictors of HLM performance. The inability to directly study this group of students due to their segregation necessitated an alternative method, which included the use of a shared metric that was both predictive of HLM performance and available for Hispanic EL students. Through the use of temporal factors, correlation analyses, and multiple independent sample *t*-tests conducted in Study 1, Algebra 1 emerged as the most appropriate shared metric. Study 2 was then constructed with the intention of determining if a model could be found from a group of independent variables available at school registration that, when combined into a decision algorithm, significantly predicted a student's future Algebra 1 performance. A multiple linear regression was calculated to predict the final Algebra I grade based on several predictor variables, which were harvested from the state- and district-level databases. These predictor variables included the type of EL student, whether a student attended private or public school in their country or origin, the mean years of schooling in the student's country of origin, if the student was living with a parent or guardian, the age of the student at the time of registration in school, whether the student began school in the district in middle or high school, and the gender that the student identified as at the time of registration. An additional post hoc exploratory analysis was conducted in Study 2 to examine the three strongest predictor variables that emerged from the multiple regression analysis.

To address Research Question 2-1, if a protocol can be created using a group of variables available at the time of student registration, a multiple regression analysis was conducted. The results of the multiple regression analysis were then utilized to address Research Question 2-2, the construction of a predictive algorithm for teaching purposes. However, the modest correlation of Algebra to HLM coupled with the modest multiple regression model with an R of .342 did not warrant further use of family-wise alpha. Nevertheless, using the multiple regression model and the final grade in Algebra 1 as a predictor for performance in precalculus, the researcher attempted to create an actual decision algorithm that outperforms chance in selecting students who would likely pass precalculus. Had the model been stronger, the algorithm would have provided a foundation for the development of a protocol tool used at student registration. This protocol would assist in the appropriate course placement of students when they registered for school and decrease the historical practice of forcing all Hispanic EL students into the same academic trajectory because of English proficiency. In a broader sense, a protocol would provide acknowledgement and transferability of the skills and experiences that the student has acquired while living in their country of origin. This has long been afforded to native English-speaking students whose acquisition of skills from other schools in the United States is used for course placement. Lastly, the use of a protocol would assist in shifting the lens through which Hispanic EL students are viewed from one of homogeneity to one of heterogeneity.

Based on the results of the multiple regression, and its associated algorithm, it was determined that all the iterations of the protocol derived from these analyses were too weak because they created too many false negatives and false positives. The Study 2 algorithm predicted the linking variable of the final grade in Algebra 1, which had a low to modest correlation to the target variable of performance in HLM. Therefore, even if the correlation between the final grade in Algebra 1 and the final grade in HLM were higher, there would still be additional issues with the ability of the algorithm and/or multiple regression model to correctly classify Algebra performance. The results demonstrated a weak to modest algorithm that would then be modestly correlated with HLM through the linking variable. Given this weakness in both parts of the predicting protocol, the researcher determined that the decision algorithm was not strong enough for the purposes of this project.

While the main approach did not work for the development of a protocol, in an exploratory post hoc follow-up examination of the multiple regression model, factors emerged within the EL Hispanic student sample that may facilitate successful performance in Algebra, which is associated with higher performance in HLM. Although the model lacked the strength to construct a protocol for student registration, the overall model itself was statistically significant ($p < .001$) and three variables, grade of entry ($\beta = .166$, $p = .035$), type of EL student ($\beta = -.147$, $p = .079$), and female ($\beta = .179$, $p = .013$), all emerged as predictor variables from the multiple regression model worthy of further consideration because their *p* values were all below the alpha exploratory threshold of .1 (Rubin, 2017). Due to the sample size of 193 students, the study had limited statistical power, which may have influenced the results of the *p* values of the predictor variables. Below, the researcher considers the implications of these three indicators that show they might be factors in the future performance of Hispanic EL students in Algebra.

Grade of entry. The grade at which a level 1 or 2 Hispanic EL student commenced schooling in the United States was found to be a predictor for future mathematical performance. Students who initiated schooling in the United States in middle school performed better in Algebra 1 compared to those who entered the United States in high school. These results corroborate the limited research available regarding the influence of age-of-arrival of immigrant students on their academic performance. Academic performance is negatively correlated with age-of-arrival; the older students are when they begin schooling in the United States, the lower their academic performance (Diaz-Strong & Ybarra, 2016). This may be due to factors related to development, acculturation, assimilation, and language development and that high school level students have completed most of not only their education but also their maturation outside of the United States.

All EL students are required to complete a language proficiency exam, known as ACCESS testing, each academic year. If students entering Grade 9 who were enrolled in a middle school in the United States still test at an entering or beginning English proficiency (level 1 or 2), they are placed into an Algebra 1 course designed specifically for English Learners. Although this course is designed for recently arriving students, students who have not made progress in language acquisition may also be placed there. It is possible that for middle school EL students, the ACCESS test is not appropriately identifying their language skills, as it is unlikely, unless there are mitigating circumstances, that a student will make no progress in terms of language development over the course of 1 to 2 years. Their higher performance in Algebra 1 may be due to their extended time in the United States during which they may have had the opportunity to advance their language skills and increase their mathematical foundation. Similar to EL students who enter the United States in high school, it would be beneficial to measure mathematical performance prior to entering high school, despite language proficiency, and place students appropriately.

Type of EL student. Type of EL student is a designation assigned to EL students when they register for school in the district. English Learner students are classified either as Students with Limited and Interrupted Education (SLIFE) or not. Students with limited or interrupted formal education have gaps in their academic histories and, despite being age-appropriate, are not at grade level. Those who are not classified as SLIFE are considered to be traditional EL students who, because they have completed the equivalent level of schooling in their country of origin as in the United States, are grade-appropriate. The study results are consistent with the current research regarding the diversity among Hispanic EL students in terms of academic abilities, which may be due to a lack of limited years of compulsory education laws and the families' socioeconomic statuses in their countries of origins (Yip, 2017). The academic differences between these two groups of Hispanic EL students highlight the inaccuracies in the assumptions in the literature regarding cultural and academic homogeneity of all Hispanic EL students. The results of the present study help corroborate other research that emphasizes the issues associated with the use of ACCESS testing alone for student placement as it is unable to account for a student's educational history, academic foundations, and historical narrative (King & Bigelow, 2016; Suárez-Orozco, Suárez-Orozco, & Todorova, 2010; Yip, 2017). Not accounting for prior knowledge or life experiences creates an academic dichotomy in the classroom where one group of students, as indicated by the findings, is able to make more progress than another group (Suárez-Orozco et al., 2010; Yip, 2017). However, although the differences in academic performance exist, as evidenced by the results of Study 3, all Hispanic EL students remain on an identical trajectory, regardless of their math or any evidenced predictor of upper-level math performance. This trajectory, created by inappropriate placement, contributes to negative, long-term academic outcomes for both groups of students who, despite their abilities, are confined within the identical learning environment.

Female. The results do not align with the majority of the current research conducted among students in the United States that illustrates strong support for males outperforming females in science- and math-related fields (Makarova, Aeschlimann, & Herzog, 2019) as the females in Study 2 performed better in Algebra 1 when compared to their male peers. These results suggest that there are some gender-based differences that may not be supported by most of the literature but are supported by limited research on Hispanic EL students and anecdotal evidence. The contradiction in findings from the research may be due to a variety of factors, including cultural differences.

Recent studies have rejected the notion that math and science differences between genders are biologically based; in fact, they have found no difference in brain processes and neural engagement related to gender (Kelsey, Csumitta, & Cantlon, 2019) in early childhood. Rather, the differences may be attributed to sociocultural ones often displaying themselves after early childhood. Since all the students in Study 2 began their education in the United States in adolescence, it is possible that they were not exposed to the typical negative stereotypes and expectations regarding females studying mathematics in the United States. The females in Study 2 may have been influenced by different sociocultural factors than their U.S.-born peers that impact their ability to perform in mathematics. This is supported by current research conducted in Caribbean and Latin American countries, where, even in areas with poor educational progress, a reverse gender gap exists, which favors females over males (DeRose, Huarcaya, & Salazar-Arango, 2018; Duraya, Galiani, Nopo, & Piras, 2007). Although a student's specific country of origin was not measured in Study 2, it is possible that the differences in gender norms extend across each student's country of origin as well, which may further complicate the issue. For example, there may be differences in mathematics performance between females from the Dominican Republic as compared to those from El Salvador. Due to limitations associated with sample size and multiple regression, it was not possible to examine the influence of individual countries on mathematical performance. Future research would need to focus directly on factors related to country of origin to examine specific cultural influences on math performance associated with individual countries and their regions.

It is plausible that non-academic factors, including living independently, debt repayment, and employment patterns, have an even greater influence on performance in math and school in general and contribute to the differences in mathematical achievement between males and females. Embedded within these factors are the expectations and norms related to gender found within the patriarchal countries that the students have recently emigrated from, where the males are often expected to work hard and provide financially for their families (Galanti, 2003). Support is found in the limited formal research conducted with this population and in anecdotal evidence collected in over a decade of working with Hispanic EL students. In a recent study conducted within the same school district that utilized an overlapping archival database that included many of the same Hispanic EL students, gender-related differences were found in several areas related to employment and academic performance (Passanisi, 2020). These include being independent or not living with a parent or guardian, originating from the Northern Triangle countries of El Salvador, Guatemala, and Honduras, being retained in high school, and chronic absenteeism. A student is categorized as "retained" when they must repeat the grade in which they were enrolled in the prior school year. Students are considered to display chronic absenteeism when they are absent for more than 10% of the school days over the course of their high school career. The greatest gender discrepancy was found in the dropout rate; males (63.3%) did not complete high school at a rate that was almost double that of their female peers (38.9%). These results from this study (Passanisi, 2020) are presented below in Figure 4.

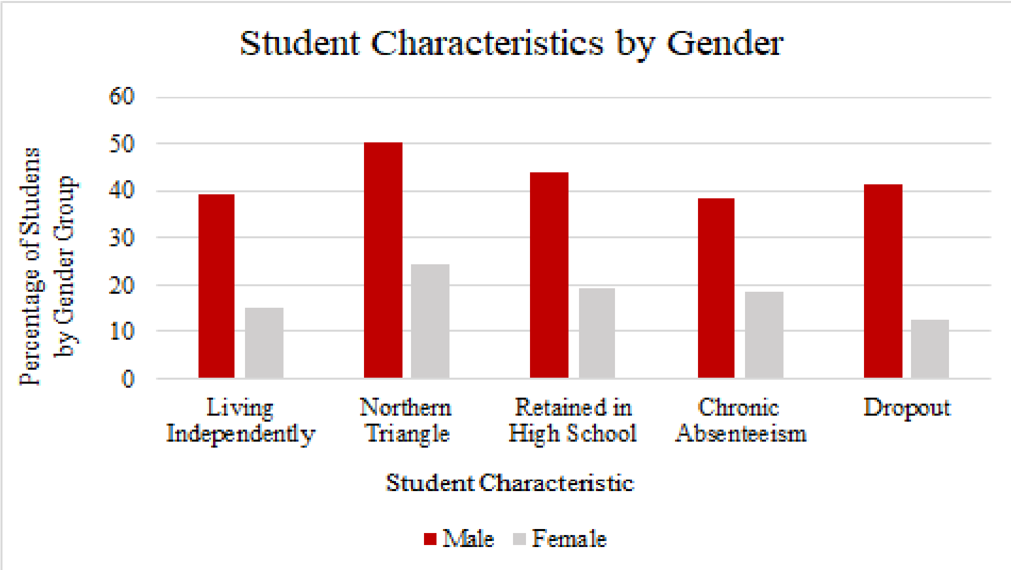

Figure 4. Student Characteristics by Gender.

The need to work extensive hours seems to be more prevalent among Hispanic males for multiple reasons, including those related to independent living, repayment of debts, and sending money to their country of origin, an act formally known as remittance (Park, Amparo Cruz-Saco, & Lopez Anuarbe, 2017). The heightened expectation for males to make financial contributions may also be reflective of the cultural values within the student population. It is the concept of *mantencion*, translated simply as “maintenance” in English, that provides some insight into the working behaviors of the male Hispanic EL students. As indicated in a recent study of newly arrived Hispanic EL students, many are living in the United States independently, meaning there is no choice but to work to sustain themselves. However, this population of students is not only working to survive in the United States but also to repay the debt to the *coyotajes* or *polleros*, the individuals who facilitated their migration to the United States from the Northern Triangle (Izcara Palacios, 2015). Retribution to the student’s family members who remain in the country of origin is threatened if the economic debt is not repaid in a timely manner. When students are forced to choose between attending school and working, physical survival and protection of one's family takes precedence over education. The extra time and effort required to maintain focus and pace in school, in addition to completing homework, are influenced by the exhaustion, stress, and time required to work to sustain themselves and to repay those who threaten their families. The pattern of behavior is illustrated in the elevated dropout rates for male Hispanic EL students that were found in a recent study, presented in Figure 4 (Passanisi, 2020).

In addition to working for self-sufficiency and debt repayment, there is pressure for Hispanic males to provide financially for their families who have remained in their countries of origin (Galanti, 2003). Migrants sending money to their country of origin, formally referred to as remittance, is a relatively common practice among non-U.S.-born migrants (Park et al., 2017) who have emigrated from countries with high levels of poverty. There is research, albeit limited, as well as anecdotal evidence, that provides support for gender and nativity differences in remittance behaviors. The practice is more prevalent in males than females among Hispanic migrants from Latin American countries, which may have foundations in cultural expectations related to gender (Park et al., 2017). Time spent working extensive hours to support families in the student's country of origin may minimize the amount of time, if any, a student has to complete assignments outside of school. The lack of time to commit to academics impacts a student's ability to perform in a class like mathematics where the iterative process of learning, practicing, receiving feedback, and making corrections is an important contributor to comprehension and understanding.

Gender also influences the types of employment opportunities available for males and females, which impacts a student's capacity for academic engagement. Although some male students are employed by grocery stores and restaurants, most are working in physically laborious jobs such as landscaping, construction, roofing, painting, and carpentry. There are few women in these positions, thus disproportionately affecting the male students in their classes. There is little oversight in terms of working hours for these types of jobs, and often male students are forced to work during the school day in order to maintain employment. A student's documentation status and their financial need to work limits their ability to self-advocate, and they become trapped in a cycle of economic exploitation and marginalization that for many often ends in school withdrawal (Palardy, Rumberger, & Butler, 2015; Suárez-Orozco et al., 2010). Females are often excluded from these types of jobs because of their physical nature and instead are employed in stores and restaurants, where there is greater flexibility for working hours as well as more oversight. Jobs that involve hard labor, like construction and landscaping, are more physically demanding and may further contribute to the gender differences in academic performance. For males, attendance and participation in school due to work-related commitments may negatively impact their ability to keep pace with course expectations. As illustrated in Figure 4, this results in higher rates of being forced to repeat grades in high school (retention) and school withdrawal compared to females (Passanisi, 2020). Future research must include non-academic barriers, including gender and specific cultural factors that Hispanic EL students encounter that have the potential to greatly influence their ability to achieve academic success in both mathematics and school in general.

Study 3

The findings from both Study 1 and Study 2, in addition to the lack of existing data for Hispanic EL students in HLM due their consistent exclusion from the course, prompted a third study. To address Research Question 3-1, if there was substantial variation in the distribution of the final grade in Algebra 1 among level 1 and 2 Hispanic EL students, a frequency distribution histogram was constructed utilizing the EL sample group from Study 2. Once it was established that there was substantial variation in the distribution of the final Algebra 1 grades among all Hispanic level 1 and 2 students, Research Question 3-2 (3-2A, 3-2B, and 3-2C), which examined if there were differences between the mathematical abilities of Hispanic EL students and the no-EL student groups, was addressed.

Research Question 3-2 was designed to specifically confirm or disconfirm the researcher's developing theoretical model, which hypothesized that the EL students were similar in Algebra performance to the students who were part of the general school population (no-EL all) before students with stronger math skills chose to pursue HLM and students with weaker math skills declined to pursue HLM. Research Question 3-2A focused on the similarity and statistical equivalence between the EL group and the general school population group. Utilizing the no-EL all sample, which included two subsamples, no-EL no-HLM and no-EL HLM, that were collapsed back together to create one sample group, no-EL all, a TOST equivalence analysis was conducted to determine if the 2 groups were similar in their mean Algebra performance. Each of the subsamples, no-EL no-HLM and no-EL HLM, were then utilized separately to address mean differences between the different groups to address Research Questions 3-2B and 3-2C, respectively.

Using Algebra 1 performance and a variety of other metrics, Study 3 further examined if mathematical differences between Hispanic EL students fit a particular pattern where HLM students would have the highest Algebra performance and students from the general school population who were not in HLM would have the lowest Algebra performance. The EL students would not differ from the students in the general school population because, at this point, neither group had been further selected into subgroups of stronger and weaker Algebra 1 performance. However, the EL group would perform stronger than the no-EL no-HLM students but weaker than the HLM students because the students with the strongest math skills would have self-selected to continue into HLM while the students with the weakest math skills would have decided not to pursue or not qualify to pursue HLM, making the no-EL no- HLM group the weakest Algebra performers across all the groups.

The results from Study 3 supported the researcher's model (see Appendix D), which hypothesized that EL students would perform similarly to the no-EL all students from the general school population but perform better than the no-EL no-HLM students and weaker than the HLM students. It is plausible that the students with the strongest math skills were concentrated in the HLM group and the students with the weakest math skills were concentrated in the no-HLM group. The findings suggest that since Algebra 1 performance among Hispanic EL students does not differ from other non-EL students, if provided the opportunity, a subset of Hispanic EL students would likely perform successfully in HLM as do a subset of the generalized general school population that enroll in HLM. Since the data show that Hispanic EL students performed at a comparable level in Algebra 1 to other non-EL students, the assumption that a subset of stronger Algebra-performing Hispanic EL students are unable to perform in HLM based on their linguistic abilities becomes questionable and worthy of further investigation that considers both strong math ability and level of English proficiency together. This type of study would be able to address the main effects of math ability and English proficiency and the interactions across both factors.

Since all students do not opt to participate in HLM, including those with Algebra 1 grade point averages (GPA) of 1.7 and higher, it is possible that there is a subset within the Hispanic EL sample who would not have enrolled in HLM. Given that no HLM data exist for Hispanic ELs because of their exclusion from the course, it was necessary to include the entire sample who earned at least a 1.7 in Algebra 1, which may have negatively influenced the final Algebra 1 grade of the overall sample. The sample of Hispanic EL students may also have been negatively influenced by factors related to the denial of opportunity for Hispanic EL students to self-select for HLM. No-EL students have the ability to self-select to participate in HLM based on Algebra performance and math interest. This sampling selection for HLM results in a more mathematically refined group of students in HLM. If Hispanic EL students were allowed into HLM with the same self-selection parameters, then it is likely that a group of Hispanic EL HLM students would emerge with similar selection sampling characteristics and performance outcomes as the no-EL HLM students. The issues associated with not allowing for sample selection do not exist for the HLM sample as the students have either already opted out of enrolling in the course and therefore are not included in the sample or have opted in, based on ability and interest, and are included in the sample.

As demonstrated visually in Appendix D, which includes the highly significant independent samples *t*-tests differentiating the EL and no-EL all groups and Table 29, the no-EL HLM group clearly shows good Algebra performance due to their skill in math but perhaps more importantly due to the removal of the very weak math students who do not go on to take HLM. The HLM group benefits both from their math skills and interest and from the removal of the underachieving students from Algebra. Nearly 53% of the no-EL no-HLM group received a D- or lower in Algebra with 45% failing with an F. In contrast, the EL students were not allowed to take the HLM option, and this leaves the very weak, moderate, and very strong math students together in the EL sample, further diluting the math performance of the group.

These findings also suggest that the default method of only using English proficiency to place Hispanic EL students at registration and the limited mathematical trajectory it forces them into for their high school career is not supported by the evidence. Math skill and performance should be considered along with English proficiency moving forward. The current system of placement and deniability of opportunity for Hispanic EL students' level 1 and 2 in HLM is solely based on assumptions that advanced English language proficiency is needed to perform in HLM courses. Prior to this project, those assumptions had not been tested in the district where this research was conducted; instead, the practice simply continued as the status quo. The assumptions have perpetuated the systemic injustices in public education by creating a homogeneous category of placement for all EL students regardless of their background knowledge and previous education. Neither their mathematical aptitude nor their skills are considered in terms of their math trajectory; they are placed solely on the English language proficiency. There is currently no evidence of how EL students who have strong math skills would perform in HLM when they still meet the EL 1 and 2 levels of English proficiency. A call to study both factors and their interaction is considered in more detail in "Future Directions."

As previously discussed, EL students may be categorized as traditional or SLIFE at the time of registration. Traditional students arrive in the district with proof of previous education in the form of transcripts from previous academic institutions, while SLIFE students are students with limited formal education and significant gaps in their education. However, all level 1 and 2 Hispanic EL students are placed in the same cohort for mathematics regardless of their educational history. The wide distribution of Algebra 1 scores among Hispanic EL students found in this project indicates that the notion of homogeneity in terms of math ability is unsupported, and in fact, there are vast differences among Hispanic EL students, just as there are among students who are not categorized as level 1 or 2 Hispanic ELs and non-EL students (Levinson et al., 1997; Solano-Flores, 2008; Suárez-Orozco et al., 2010).

The erroneous notion of homogeneity of mathematical aptitude and skill across all Hispanic EL students does not only apply to placement but also includes differences in the levels of support they may need to achieve success in HLM. Making assumptions that because a Hispanic EL student reaches a specific minimum grade cutoff, they will immediately perform at the same level as no-EL students is not realistic. The results from Study 3 do not negate the possibility that EL students whose linguistic proficiency is either at the entering (level 1) or emerging (level 2) level may require additional academic and social emotional support to perform at similar levels of other non-EL students. The complexities associated with immigration, transition, acculturation, assimilation, and language acquisition undoubtedly influence students differently. These factors must be acknowledged and ways developed to mitigate the challenges unique to this population of students. The ultimate goal in adjusting the mathematical trajectory for Hispanic EL students is not to merely allow them into HLM but to provide opportunities for them to flourish within the course, which would ultimately lead to greater opportunities in higher education and beyond.

Even the current system for movement into HLM appears to be biased against Hispanic EL students. Admission into HLM courses is, in theory, based on student performance in entry-level math courses and the state-standardized mathematics exam. The results of the study show that this is not necessarily the reality, nor are the same guidelines applicable to Hispanic EL students. Although over one-fifth (21.6%) of the non-EL HLM students did not meet the C-prerequisite for the course, they still were permitted entry into the course. In contrast, 61% of the Hispanic EL students met the prerequisite but were still denied entry into HLM. These findings provide support for the long-standing assumption used for course placement that advanced

English language proficiency is an essential prerequisite, as opposed to mathematical ability, which is ignored entirely, to perform in HLM courses.

Although the focus of the project was to explore potential inequities in math placement for Hispanic EL students, there are implications for both non-EL and EL students that emerged from the results. Algebra 1 is the first mathematics course that all ninth grade students participate in, regardless of language and background, as part of the district math trajectory and state graduation requirements. Utilizing the final grade in Algebra 1 cutoff of 1.7 established in Study 1, there is a false negative rate of 16.5% in the ability of the final grade in Algebra 1 to correctly predict HLM performance, which suggests that there are also assumptions made about the predictability of Grade 9 performance for Grade 12 performance. There was an expectation that, based on their lower performance in Algebra 1, 16.5% of HLM students would perform at a lower level in HLM than they actually did. Upon closer examination of the final grade in Algebra 1 and HLM performance, it was found that 80% of the students who were anticipated to perform poorly in HLM based on their poor performance in Algebra 1 actually earned a 1.7 (C-) or higher in HLM. The change in their mathematical grades between Grade 9 and Grade 12 may be reflective of factors that are not necessarily associated with mathematics but are more closely related to the risk factors that many Grade 9 students face. The risks associated with Grade 9 are numerous, and the transition from middle school to high school has proven challenging for many ninth-grade students at the district, state, and national levels. Since students who are able to successfully mitigate the challenges associated with Grade 9, whether they be academic, environmental, or socioemotional, are more likely to graduate from high school (Allensworth & Easton, 2007; Yip, 2017), research and practice often focus on providing appropriate and effective support for Grade 9 students. It is possible that the false negative rate is partially reflective of these ninth-grade challenges as opposed to mathematical ability and that there are additional students who have been excluded from HLM for non-mathematically related reasons. Since Hispanic EL students have historically been excluded from HLM courses, it was not possible to determine if the same patterns exist for Hispanic EL students. The non-EL group is divided, either by teacher selection or student choice, into those who enroll in HLM and those who do not. However, due to the exclusionary practices related to HLM course placement, Hispanic EL students are grouped together in one demographic representation group rather than divided into separate HLM and no-HLM groups.

Social Justice

The data regarding post-secondary education for EL students are indicative of the need for change; as the numbers of Hispanic EL students continues to rise in the United States, the number enrolling in colleges and universities should as well. However, statistics from recent studies (Callahan, 2005; Conger, 2015; Gonzalez, 2009; Kanno & Cromley, 2015) indicate this is not occurring, and for reasons related to placement, curricula, tracking, and homogeneous grouping, Hispanic EL students have been denied equitable opportunities at both the high-school and post-secondary levels. The findings from the current project provide additional support for the research related to the limited academic opportunities for early-entry Hispanic EL students. As evidenced by the absence of Hispanic EL level 1 and 2 students in HLM courses across this sample, despite having math grades that parallel their native English-speaking peers, often Hispanic EL students find themselves forced into a mathematics curriculum that does not adequately prepare them for post-secondary education and employment in fields related to science, technology, engineering, and math (STEM).

Despite the integration of social justice principles into both schools and teacher preparation programs (Hytten & Bettez, 2011), the current project suggests that there are fundamental practices in schools that perpetuate the cycle of marginalization for Hispanic EL students. These practices include using a system of placement throughout a student's high school career that is based solely on English proficiency rather than academic abilities. As suggested by the data in the current project, Hispanic EL students have been segregated from HLM courses, not due to a lack in prerequisite abilities but rather their English fluency and proficiency. Although this practice has historically been the default, there is no evidence that a lack of English proficiency presents issues for Hispanic EL students in HLM. In fact, a current review of literature on EL students and math education suggests a positive connection between ELs' use of linguistic and cultural resources to learn mathematics (de Araujo, Roberts, Willey, & William, 2018) and the ability of EL students, at any level, to achieve success in rigorous mathematics courses when necessary linguistic support is provided (Mosqueda & Maldonado, 2013). This practice of segregating students based on English proficiency only disregards the students' Zone of Proximal Development (Vygotsky, 1978) by assuming all EL students are at the same academic starting point when they register for school in the United States because of their English language proficiency. Despite its continued practice, the assumptions associated with student placement by English proficiency have never been confirmed because they have never been tested. The placement process actually contradicts the evidence in the research, which highlights the importance of the Zone of Proximal Development in learning (Vygotsky, 1978). The research also indicates that the process of determining academic suitability for higher-level coursework, based solely on proficiency in the English language as demonstrated on a standardized language assessment, leads to linguistic segregation of students within schools and a decrease in their exposure to opportunities to increase their language fluency (Palardy et al., 2015).

There are long-term consequences both at the individual and societal level created by the perpetuation of a system where Hispanic EL students, despite their abilities, are not provided the same access to academic opportunities as their native English-speaking peers. By restricting opportunities for high-achieving college-bound Hispanic EL students by forcing them into a “one-size-fits-all” EL model, students have significantly less content knowledge and post-secondary preparation than their native English-speaking peers. Denial into higher-level courses severely compromises their content and vocabulary knowledge in subject areas and creates a disparity in terms of GPA. Since the GPA is dependent upon both the grade earned in a class and the academic level of the class, EL students have been denied the opportunity to earn a GPA that is comparable to their no-EL peers. Their lack of college readiness in relation to academic preparedness, course prerequisites, and standardized testing may cause a forfeiture of the opportunity to apply to a 4-year institution or denial of admission into their desired major (Callahan, 2005). The educational structure that exists for many newly arrived Hispanic EL students drives a generation of individuals into employment tracts that do not require degrees beyond high school, thereby rendering them unable to move beyond lower economic classes. For example, according to the U.S. Bureau of Labor Statistics (2021), fields related to STEM are experiencing the greatest job growth, and it is predicted that this trend will continue. If there are no opportunities for Hispanic EL students to access the content-related coursework required for entrance into STEM majors at the post-secondary level, they will be excluded from the fastest growing fields, often with the highest paying jobs.

Perhaps the greatest challenge in creating transformative change for EL students is in altering the opinions and ideas that individuals have not only towards Hispanic EL students but towards documented and undocumented immigrants. The results of the current project suggest the existence of broader, systemic assumptions surrounding immigrant students and their ability to perform academically at the same level as their native English-speaking peers. Some Hispanic EL students enter middle and high school in the United States with requisite knowledge gained in their respective countries of origin. However, the use of an English proficiency-only assessment, administered at both registration and each year of their academic career, disregards the importance of this and ignores their aptitude, the ability to learn and develop these skills. The current system encourages social segregation between EL and native English-speaking students (Levinson et al., 2007) and mirrors the hierarchical system in society where immigrants, particularly those of Hispanic ethnicity, are forced into a lower socio-economic status simply because they are not native-born Americans. Since it is in school that often students learn the social and cultural norms and the policies in academic institutions perpetuate systemic racism, then until there is a shift at this level, the cycle of marginalization will continue.

Limitations

One of the major limitations of the overall project is embedded in the purpose of the project. The historical practice of segregating Hispanic EL students with level 1 and 2 English proficiency from HLM courses made it impossible to directly study math placement and Hispanic EL students. Indirect analyses may be more challenging to conduct than direct analyses.

Additionally, issues related to sampling may have influenced the outcomes of the studies. The parameters for study inclusion were narrow, which decreased the sample sizes. Originally, it was anticipated that the MSA would be the shared metric; this limited the number of students who met the inclusion criteria. Setting criteria that required participants to complete the MSA during Grade 10 and Algebra and Geometry prior to completing the MSA decreased the number of eligible participants in several ways.

First, students who left school prior to taking the MSA were excluded from the study, despite having enrolled in and potentially completing Algebra 1. Since the district has a high dropout rate among Hispanic EL students, it is possible that by not including this group of students, the findings from the project may not represent the entire sample of Hispanic EL students in the school. It is also possible that different predictor variables may have emerged in Study 2 had inactive students been included in the project. Second, since only level 1 and 2 Hispanic EL students were included in the project, Hispanic EL students with more advanced English proficiency, who may have also been denied access to HLM, were excluded. Since only a limited group of Hispanic EL students were included, it is possible that the findings from the project are an underrepresentation of the overall issue of Hispanic EL participation in HLM courses. Lastly, although there are Hispanic EL students enrolled in schools across the district, only students from the one school in the district with the largest population of Hispanic EL students were included.

There are limitations associated with the use of Algebra 1 as the shared metric and linking variable for the overall project since it assumes that Algebra 1 is the same and interchangeable across different teachers and classrooms and between the non-EL and EL versions of the course. This is not necessarily correct. Despite the expectation that all content courses, including Algebra 1, use a standardized curriculum that follows the state frameworks and a district-wide universal grading system, the heterogeneity of students and teachers may create variations in the delivery of instruction and grade patterns. These potential differences across classes means that the grades earned by students may not be consistent indicators of ability. There may be differences not only between each classroom but also between the no-EL and EL Algebra courses. Students who are categorized as level 1 or 2 in terms of proficiency by the ACCESS test are placed together in full English immersion classrooms where they receive instruction in the major content areas as well as additional level-specific English language development support. Time spent by the teachers on English language development support may decrease the amount of academic content delivered to the EL students, thus creating a disparity in the content-related instruction provided in the EL and non-EL classrooms.

It is also important to note that Algebra was shown to be a predictor of HLM within the context of English proficiency that the students from the general school population have on average. It is possible that Algebra would not predict success in HLM among the EL level 1 and 2 students. Future research is needed to fully understand the complex influences that both language proficiency and strong math ability and interest have on HLM performance. The issue is not addressed by ignoring either factor. Stronger math performing EL students need to be given access to HLM courses and then studied with research designed to examine the influences of both math ability and English proficiency.

The use of archival data was an effective mechanism for harvesting data for the project. However, it did not allow for any type of follow-up data collection, in terms of post-secondary education and employment, which may have provided additional information for the project. The use of archival data also limited the time frame in which data collection was able to occur. Since the number of Hispanic EL students have steadily increased since 2010, with the greatest population of level 1 and 2 Hispanic EL students in 2020, only utilizing data from students who were enrolled from September 2012 through June 2019 also decreased the sample size of students available for the project.

Since there is the potential that there are additional risk factors rooted within the predictor variables, it is possible that the variables were measuring factors other than the final grade in Algebra 1. For example, a low educational ranking for a country may be indicative of issues that are not directly related to education, such as socioeconomic status, and not necessarily predictive of academic achievement. In this project, the country with the lowest educational ranking has also experienced increased levels of poverty, violence, and political instability (Congressional Research Service, 2019). These factors, in combination with research that has repeatedly demonstrated the profound influence that poverty has on students' ability to perform academically (Li, Allen, & Casillas, 2017; Thacker-King, 2019), illustrate the possibility that outside factors not considered in this project may indirectly affect Algebra performance.

Recommendations

The results of the current project demonstrate the need for the development of a comprehensive mathematics placement tool for EL students that accounts for math aptitude as well as other factors that eventually prove to be predictive of math trajectory and success for mathematics placement. Historically, Hispanic EL students have been denied entry into HLM courses despite meeting the same academic prerequisites as their native English-speaking peers because of their perceived academic inabilities due to a lack of English proficiency. There is a lack of evidence to support the assumptions that Hispanic EL students are unable to successfully participate and perform in HLM due to their language proficiency. In fact, a current review of literature on EL students and math education suggests a positive connection between ELs' use of linguistic and cultural resources to learn mathematics (de Araujo et al., 2018) and the ability of

EL students, at any level, to achieve success in rigorous mathematics courses when necessary linguistic support is provided (Mosqueda & Maldonado, 2013).

The same prerequisites that are utilized for course placement for non-EL students should be applicable to Hispanic EL students as well. Not allowing Hispanic EL students to be placed in the same track as their native English-speaking peers limits their opportunities at the secondary level as well as their future opportunities beyond high school. A universal application of the prerequisites, regardless of language proficiency, would initiate the process of adjusting the traditional mathematical trajectory for Hispanic EL students. Once EL students are allowed into HLM courses, comprehensive studies need to be conducted to understand how both math ability and English proficiency affect the performance in HLM for EL students. If EL students with lower English proficiency experience difficulty, are there appropriate supports that can be added to increase the EL students' success in HLM?

The recommendations that have emerged from this project are focused on creating equitable academic learning opportunities for Hispanic EL students in mathematics. They revolve around the need for districts to account for the multidimensionality that may impact learning, as it relates specifically to Hispanic EL students. As indicated by the literature (King & Bigelow, 2016; Levinson et al., 1997; Solano-Flores, 2008; Suárez-Orozco et al., 2010; Yip, 2017) and the results of the project, there are differences between Hispanic EL students that may account for their ability to perform in one of the major building blocks of learning, mathematics. One of the major issues that has arisen by aggregating all Hispanic EL students together, regardless of mathematical skills and backgrounds, is that the students who should be able to move into HLM are not able to. Placing students by mathematical abilities rather than language proficiency would ensure that those Hispanic EL students who have the potential to enroll and succeed in HLM courses in the upper grades would be able to do so. It is necessary that districts find a way to assess Hispanic EL students, using a multifaceted approach that includes both academic and social emotional factors, in order to best meet the needs of students and facilitate their success. This approach must include the construction of a mathematics assessment, implementation of pilot studies with cohorts of students selected through an appropriate assessment, and ultimately the development of an instrument for math placement that shows predictive validity. It would also include robust and continued research to determine the level of influence that English proficiency has on EL student success in HLM and whether any additional reasonable supports help address any difficulties.

Mathematics Placement

The current placement system that the district utilizes has its roots in the belief that English language proficiency is predictive of mathematical ability and has been designed in a way that creates a significant educational gap for Hispanic EL students. Although Hispanic EL students enter the United States with different cultural, socioeconomic, and educational backgrounds, there is an underlying assumption of Hispanic homogeneity. Research does not suggest that English proficiency is an indicator of mathematical ability. However, this has historically been the default system for math placement for Hispanic EL students. Rather than assessing the mathematical abilities of each student as they enter the district, the student is only evaluated on English proficiency and then placed accordingly. The continued use of a system that is focused on linguistic proficiency as opposed to content-based skills has forced all Hispanic EL students out of an HLM trajectory. This is supported by the project data in which, from September 2012 through June 2019, there were no Hispanic EL students who began at the 1 or 2 level enrolled in HLM courses. The practice continues, despite contradictory evidence in the research (de Araujo et al., 2018; Mosqueda, 2010; Mosqueda & Maldonado, 2013) to support its usage. The current placement is designed to promote academic segregation and has created a cycle of exclusion for Hispanic EL students. Hispanic EL students are placed on an identical academic trajectory, without the utilization of metrics or evaluation of background knowledge, and denied opportunities to exhibit their mathematical abilities. The lack of opportunity to demonstrate these skills is then used to support their assumed inability to perform.

Although utilizing English proficiency has been the default mechanism by which to permit entrance into HLM courses, the results suggest that there are differences in the mathematical ability of Hispanic EL students just as there are differences for non-EL students. However, the current process of registration does not account for background knowledge of EL students, and they are placed solely through language proficiency assessment. They are not even afforded a mathematically based assessment, which would allow them to enroll in HLM courses with their non-EL peers, despite showing a similar distribution of mathematical abilities as demonstrated in Study 3. The erroneous notion of homogeneously grouping traditional Hispanic EL students and SLIFE, who have significant gaps in their educational trajectory, creates issues within the classroom setting. It is necessary to find the strengths and gaps in mathematics for each student and meet the student where they are at, rather than ignoring the skill set they have brought because it may be in another language.

Assessments

The use of a mathematics assessment or protocol at the time of student registration would identify the mathematical gaps and strengths among Hispanic EL students and place students in classes based on their mathematical abilities. Both the assessments and protocol would ensure that SLIFE students are grouped with students who have similar mathematical deficiencies and allow teachers to target the specific mathematical concepts that this group of students is missing and provide the additional necessary support. The purpose is not to further segregate or marginalize SLIFE students but rather to provide the opportunities to construct the mathematical foundation they are missing. The use of a mathematical assessment would also benefit the group of Hispanic EL students who enter the district with a strong mathematical foundation but have long been placed with mathematically dissimilar students. As the results of the current study demonstrate, there are diverse scores across math abilities and performance ranges, which often forces teachers to slow the pace of the course, limiting the opportunities to teach concepts needed for HLM courses to the large subset of Hispanic EL students who could easily develop these skills if only given the opportunity. Placing students by mathematical abilities, in addition to language proficiency, would ensure that those Hispanic EL students who have the potential to enroll and succeed in HLM courses in the upper grades would be able to do so. Permitting the EL students with stronger math skills into a higher math trajectory would allow school districts to study the main and interaction effects of both math performance and English proficiency. However, this cannot be done without allowing EL students with stronger math skills with a range of English proficiency to progress into a higher math trajectory.

Although the results from the study support the need for change in placement, there is a paucity of data available to construct the protocol for placement due to the historical practice of segregating Hispanic EL students from HLM courses. In order to collect and analyze data to develop an effective placement assessment for mathematics, Hispanic EL students must first be provided access into HLM courses. For school districts committed to equitable academic opportunities in mathematics for Hispanic EL students, there are methods by which to construct more appropriate short- and long-term academic pathways for Hispanic EL students. A systematic approach to the development of these pathways includes the development and implementation of a standardized, formative, grade-appropriate math assessment that incorporates state standards and is *in the student's preferred language*, which would provide Hispanic EL students access to HLM courses and the use of pilot studies to collect direct data on the math performance of Hispanic EL students. This data would assist in the development of an instrument for math placement that shows predictive validity for all students.

Since the purpose of the initial mathematical assessment is to measure a student's prior knowledge, as it relates to the district's academic expectations, it is necessary to use the appropriate tool. The recommended tool for the initial assessment would be an eighth grade Pre-Algebra final exam created at the district level. This exam is standardized and approved for all eighth graders in the district and therefore would provide an accurate picture of the mathematics abilities and aptitudes of the incoming Grade 9 Hispanic EL level 1 and 2 students, as they relate to the district's expectations. The assessment would be given to students at registration, which would ensure that enrolling students' background knowledge is accounted for as early as possible. This type of assessment may also be implemented at the end of the student's first year of high school to ensure that students are moving on their own individualized and appropriate academic trajectory.

The use of a mathematics assessment would not only initiate the process of transferring students' skill sets and appropriately placing them into mathematics courses but also allow for the construction of cohorts to implement several pilot studies related to mathematics. Data collected from the performance of Hispanic EL students in HLM courses would ultimately lead to the development of a standardized tool that would be utilized at registration to assess students in not only language proficiency but also math proficiency and place them accordingly. Once

Hispanic EL students are allowed entrance into HLM courses, it would be possible to develop an accurate predictive tool using criterion key item analysis methods. The item analysis would be constructed by first giving students a robust dataset of math questions at both the beginning and end of Grade 9. After the students complete the HLM course, the items that helped differentiate those who did well in HLM, those who did not do well in HLM, and those who did poorly in Algebra and did not want to pursue HLM would be identified. By giving students a large pool of math questions at the start, it would be possible to develop, through criterion key item analysis techniques, a psychometrically and educationally valid assessment tool that effectively predicts HLM performance based on early high school math items that are statistically found to differentiate HLM high performers, HLM low performers, and students who did not have enough earlier success in mathematics success to participate in HLM. Since the results suggest that Algebra 1 may not always be the most appropriate predictor for HLM performance, it is plausible that the data collected through the pilot studies may contribute to the placement of all Hispanic EL students in HLM courses.

Future Directions

Unfortunately, a simple adjustment of prerequisites and utilization of an assessment at registration are not enough to ensure academic equity for Hispanic EL students. There must be a targeted approach to the construction, implementation, and evaluation of systems that best meets the academic needs of Hispanic EL students and encourages their success in mathematics both at the high school level and beyond. The construction and implementation of pilot studies are imperative to initiate the process of providing academic equity in mathematics for Hispanic EL students. In addition, the impact of culture and language, increased and expanded samples, and immigration-related trauma should be included in future research.

Proposed Pilot Studies

As evidenced by the framework of the current study, research on the topic, and lack of representation in math and science majors and careers, Hispanic EL students have historically been denied access to HLM courses. This renders direct data collection about their HLM capabilities a near impossible task. These pilot studies are designed to collect direct evidence as it relates to math performance of Hispanic EL students in order to develop a systemwide assessment tool. It is anticipated that the data collected would assist in the future development of evidence-based curricula and support programs that most appropriately support Hispanic EL students and their success in mathematics and science.

The three pilot studies presented below differ in their target cohort groups, the type of academic differentiation, and the level of inclusion of Hispanic EL students into no-EL math courses. However, all three require the identification of math skills at school registration through the use of a standardized, formative, grade-appropriate math assessment in the student's preferred language that incorporates state standards from the current curriculum maps. Since the intention of the three pilot studies is to measure a student's prior knowledge as it relates to the district's academic expectations, it is important to use the appropriate tool. The recommended tool for the initial assessment would be an eighth grade Pre-Algebra final exam created at the district level. This exam is standardized and approved for all eighth graders in the district. Therefore, it would provide an accurate picture of the mathematics abilities and aptitudes of the incoming Grade 9 Hispanic EL level 1 and 2 students, as they relate to the district's expectations.

Each of the proposed pilot studies is designed to be a standalone model, meaning that it may be implemented as an independent pilot study or in conjunction with the other proposed pilot studies. There is the possibility, based on resources and interest, that the pilot studies would be implemented in a school district simultaneously. However, this may not be feasible for a school district due to budgetary and staffing constraints. By presenting several options for pilot studies, school districts would have the autonomy to choose which pilot they believe best serves the needs of their students and is the most feasible to implement.

Pilot study 1. The first pilot study would require the use of differentiated instruction within the EL classroom to integrate a cohort of students with advanced math skills but limited language proficiency into non-EL classrooms during the second academic year. Often, discussion around differentiation in teaching revolves around making adjustments for students who need extra support because of a deficiency in skills. However, differentiation can also be done for students who have skills that are higher than the class average and require additional materials to encourage engagement and learning. In pilot study 1, the math skills of students would be identified at registration using an eighth grade Pre-Algebra final exam from the district. Teachers would receive this information, and instruction would be differentiated within the EL classroom for those who have been identified as having advanced skills in mathematics. It is anticipated that a group of students would emerge who would have demonstrated the skills to move into a non-EL math trajectory the following academic years.

With the recommendation of the teacher, a group of students would be encouraged to enroll in an EL Geometry course and a non-EL Algebra 2 course, concurrently, the following year. Enrolling in two math courses is an option available for no-EL students who are interested in pursuing HLM courses, like Advanced Placement Calculus, during their senior year. The students would continue to be monitored through the review of data gathered from teacher evaluations and performance on exams, progress reports, and report cards. The movement into HLM courses would be facilitated by additional supports, which may include an EL support specialist to assist with the mathematics language development or a second teacher in the math classroom to assist with language-based support when necessary. Successful completion of these math courses with a C- (1.7) or higher, regardless of a student's language proficiency, would be the sole prerequisite for movement into HLM courses, as it is with the no-EL students. The additional language assistance would be toward the goal of enhancing and demonstrating their math ability where the language might be a minor barrier, requiring a little additional support to make the needed difference in their math performance. From this, cohorts of Hispanic EL students who have enrolled and participated in both non-EL and HLM courses would emerge, and it would become possible to conduct further studies with the data collected. At the present time, there are no data available regarding the performance of Hispanic EL students in HLM courses because they have been denied access to those courses. This pilot study would provide the necessary data to complete a comprehensive assessment of HLM performance for Hispanic EL students. It would also provide an opportunity to further study the interactive influence of math and English language proficiency to understand how this issue actually affects the math performance outcome and to what degree. Until now, this has simply been assumed to cause an issue, but there is no evidence to support this claim.

Pilot study 2. A second approach to examining math performance for EL students would be to develop a pilot study that creates a cohort of Hispanic EL students at the time of registration. While Hispanic EL students in pilot study 1 were receiving additional advanced-math opportunities within the EL math course, in pilot study 2 the registration-identified strong EL math students would be dispersed into non-EL math courses. Although this approach is a standalone model, meaning that the district has the ability to utilize this pilot independently from the other two discussed in this section, it is possible for a school district to choose to run both pilot study 1 and 2 concurrently with different sets of students, leading to comparison of the two systems. This would provide a wider and more comprehensive set of data that could be utilized to further study math performance among Hispanic EL students and directly compare the benefits and difficulties of each model.

The study would begin with the identification of students who at the time of school registration demonstrate a higher-level of mathematics abilities across a range of concepts and therefore have the potential to succeed in HLM courses. The identification would be done using an eighth grade Pre-Algebra final exam created at the school district level. This cohort of HLM students would be constructed of Hispanic EL students who registered within the first 3 weeks of the start of school. Although students who enter school after the first 3 weeks would not be included in the study group, the assessment would still be given at registration so teachers may have a reference as to student abilities. This group of students may be included in pilot study 1. It is estimated that there would be 20 students that compose the cohort, and these students would be dispersed into two different non-EL Algebra courses. Despite their language proficiency, the identified students would immediately be assigned to one of two non-EL Algebra 1 courses, where they would be immersed in a regular course with English-speaking peers. By placing 10 students each in two classes of 30 students, the students would have a peer group, and the supports would be able to be focused on specific classes rather than trying to disperse them disproportionately into different course sections. Acknowledging that the transition may be difficult because of factors associated with both language proficiency and the acculturation process, extra supports would be in place for this group of students. Members of the cohort would have access to an EL teacher during the class period whose responsibility would be to ensure the students are understanding the linguistic concepts associated with mathematics. The additional language assistance would be toward the goal of enhancing and demonstrating their math ability where the language might be a minor barrier with little additional support, which could make a difference in their math performance. Using technology, it may be possible to pre-teach concepts to students in their native language prior to their introduction. Assessments would be utilized to gather additional data regarding the placement and progress of students in the cohort as they move through each academic year. Similar to Pilot Study 1, this pilot study would provide the necessary data to complete a comprehensive assessment of HLM performance for Hispanic EL students. It would also provide an opportunity to further study the interactive influence of math and English language proficiency to understand how this issue actually affects the math performance outcome and to what degree.

Pilot study 3. There is the possibility of using a third approach to examining math performance for Hispanic EL students, which would be to utilize the district's eighth grade Pre-Algebra final exam as placement examination at registration to place the highest performing Hispanic EL students into mathematics courses based on their abilities. Performance on this placement examination would allow for the separation of the highest performing Hispanic EL students due to their mathematical capabilities and demonstration of foundational knowledge, as opposed to linguistic capabilities. The course would be designated as an Honors EL Algebra 1 course and would follow the same curriculum and content as a no-EL Honors Algebra 1 course but with additional linguistic support. This would provide an opportunity for EL students to perform the complex coursework that prepares them for HLM courses while developing the necessary linguistic skills in a supportive environment. It would also force a shift in the long-standing, yet unsupported, assumption that Hispanic EL students do not begin high school in the United States at the same academic level as their non-EL peers. Similar to the other pilot studies, assessments would be utilized to gather additional data regarding the progress of students in the cohort as they move through each academic year. This pilot study would provide the necessary data to complete a comprehensive assessment of HLM performance for Hispanic EL students. It would also provide an opportunity to further study the interactive influence of math and English language proficiency to understand how this issue actually affects the math performance outcome and to what degree.

Overview and Conclusions of Pilot Studies

There are advantages and disadvantages to the three proposed pilot studies presented above. Pilot study 1 would keep all Hispanic EL students in the same EL mathematics cohort and allow the teacher to differentiate learning for students with advanced skills by increasing the rigor and level of instruction for them. The advantages to this approach are that all Hispanic EL students would have the opportunity to remain within a familiar classroom and not be forced to immediately assimilate to a new experience, which may negatively impact their learning. This type of pilot study may be viewed as a challenge, as a significant amount of trust is delegated to the teacher to make the necessary instructional adjustments. Teachers who are not appropriately trained to effectively differentiate instruction for all EL students may negatively impact student outcomes. Pilot study 2, which identifies and places Hispanic EL students into appropriate non-EL math courses based on their abilities as opposed to linguistic level, alleviates the dependency on a teacher to differentiate instruction within the classroom. However, its success relies on the use of an EL specialist in the classroom who can assist in not only academic learning but also assimilation, as this group would be immediately integrated with English-speaking peers. Over time, this may become economically unviable for school districts experiencing financial difficulties. Pilot study 3, which consists of utilizing a test at registration to place Hispanic EL students who demonstrate a higher level of mathematical abilities into an advanced course, would provide a space for Hispanic EL students to simultaneously develop the requisite skills for HLM courses and assimilate linguistically and socially with other EL students.

Registration assessment. Regardless of which of the above models the school system would use, the construction and implementation of pathways for Hispanic EL students to access HLM courses would not only provide opportunities that have historically been denied for this group but also generate data specific to their math performance. The eighth grade Pre-Algebra final exam, which has been standardized and approved for all eighth graders in the district, would be the starting point in the construction of pilot studies. This would generate data that could be utilized to build a formal assessment used at the initial registration. This math aptitude selection tool would be composed of items created by a formal criterion key item analysis. This item analysis would consist of studying pre-registration results of the math assessment in conjunction with the performance of ELs in HLM courses. The use of an item analysis on specific math and non-math questions would allow for the development of a valid and predictive assessment instrument that can then be used at registration or at the end of the first year that more appropriately identifies student abilities and places them accordingly. Allowing students to participate in HLM and giving them a large pool of math questions at the start of the year would create an opportunity to develop a psychometrically and educationally valid assessment tool that effectively predicts HLM performance based on early high school math items that are statistically found to differentiate HLM and non-HLM high performers.

Additional Considerations

To thoroughly explore mathematical placement of Hispanic EL students, it is imperative that the potential influence of culture and language on performance for this group of students be included, as historically it has been assumed that factors related to culture and language make inclusion in HLM courses impossible. A more open-minded, fair, and science-driven approach would be to test out the influence of these factors in the context of varying math performance and aptitude and consider interventions and supports for any issue that does emerge as a real factor with scientific evidence to support the claim. For many students, the process of acculturation is closely connected to their academic experiences, as the school is where many will learn the social and cultural norms associated with living in the United States. There are issues related to racism, acculturation, and connectedness that may also arise, as they are critical to immigrants, especially ones who have just arrived in this country. Once Hispanic EL students are permitted access to HLM, it will be possible to collect data on their performance in HLM and subsequently the cultural and linguistic influence, if any, on mathematical performance. Due to the heterogeneity of Hispanic EL students, it is likely that subgroups of students will emerge at varying levels of performance and also degrees of need. It is plausible that there will be a group of Hispanic EL students whose mathematical foundation established in their native language will be strong enough to overcome any linguistic challenges they may encounter and they will perform well independently in HLM. It is equally plausible that there will be a second group of Hispanic EL students who have the mathematical ability to participate in HLM but require additional support to improve their potential to achieve success in HLM and a third group for whom modest intervention will not be enough. These supports may be related to but not limited to academic, linguistic, and/or socioemotional challenges and will be determined by analyses of data. Future research would need to help identify each of these three broad-based groups.

In addition, it would be beneficial to continue to collect and analyze data related to mathematics and Hispanic EL students using a wider range of participants. The current project was conducted at one high school with level 1 and 2 Hispanic EL students; however, follow-up studies should be expanded to include all Hispanic EL students from all of the high schools in the district. This would include Hispanic EL students with English proficiency levels 1–5. It may be possible at a later time to construct an additional study that includes all level 1 and 2 EL students, regardless of race and ethnicity. However, for the purpose of this follow-up study, identifying as Hispanic will remain an inclusion criterion. Foreign-born Hispanic students have high school dropout rates (National Center for Education Statistics, 2016), low rates of post-secondary attendance, retention, and graduation (Callahan, 2005; College Board, 2018), and disproportionately low visibility in STEM-related programs and careers (College Board, 2018), which, according to the U.S. Bureau of Labor Statistics (2021), are the fields experiencing the greatest job growth. These factors, and others, place Hispanic EL students at increased risk for continued social, political, and economic marginalization. The purpose of conducting a follow-up study that expands the sample to include all Hispanic EL students in the school district is three-fold. First, a larger sample size would increase the statistical power of the study, allowing for multiple analyses and FWER and false discovery rate corrective measures. Second, it would allow for the district to measure if the academic limitations placed on Hispanic EL students are a school- or district-based issue. Lastly, it would explore if there are differences in HLM performance among Hispanic EL students based on their English proficiency level (1–5) as assessed by ACCESS and if there is an interaction between performance in mathematics and the level of English proficiency.

It would be incomplete if a discussion regarding student placement ignored the potential impact of trauma on immigrant students. It is recommended, in conjunction with academic placement, that districts develop and implement a social-emotional learning screener for EL students that is given at the time of registration. The current registration process lacks an assessment of the social-emotional functioning of entering EL students and disregards the emotional challenges these students may have faced in the process of immigration. The lack of a social-emotional learner screener limits and delays access to behavioral health, potentially creating a wait of months or even years to provide necessary services. For some, their journey is impressive, leaving their families behind and spending months traveling with strangers through Guatemala and Mexico where they encounter horrific perils, including, rape, physical and emotional abuse, and being witness to the deaths of their traveling companions (Infante, Idrovo, Sánchez-Domínguez, Vinhas, & González-Vázquez, 2012; Perreira & Ornelas, 2013). Eventually, they cross the border into the United States, where they are apprehended and placed in detention centers waiting for weeks to months to be placed with a sponsor (Amuedo-Dorantes & Puttitanun, 2016), who may not even be related to them. The trauma is exacerbated when they are placed in a new environment and expected to successfully acculturate to a new country and school (Perreira & Ornelas, 2013), lacking the ability to communicate and without the necessary support in place. This is impossible to achieve, even for the most resilient individual, without appropriate counseling services and a mechanism to make them feel welcome and supported. By taking a reactive, instead of proactive, approach, the opportunity to provide immediate and necessary services in their native language is lost. Instead, by allowing them the necessary support, this would lead to managing not only many of their past experiences but also their present and future ones. Implementing a combination of academic assessments and social-emotional screening at registration would assist in the mitigation of nonacademic barriers to academic success and allow students to reach the academic potential they may have but are unable to attain due to unmet social and emotional needs (Amuedo-Dorantes & Puttitanun, 2016; Aviles de Bradley, 2011; Cardoso, 2018; Perreira & Ornelas, 2013; Rubens et al., 2013).

It is anticipated that the construction and implementation of these pilot studies, in addition to the inclusion of a social-emotional learning screener at registration, would provide greater opportunities for the advancement of all Hispanic EL students as well as the provision of extra services to assist with nonacademic barriers to academic success. Accounting for, acknowledging, and adjusting curricula and coursework based on the differences among Hispanic EL students rather than their shared linguistic capabilities would improve both access and equity for this group of students.

Conclusion

Perhaps the greatest challenge in creating transformative change for Hispanic EL students is in altering the opinions that native-born American educators have not only towards Hispanic EL students but towards documented and undocumented immigrants. While the current system encourages social segregation between EL and native English-speaking students (Levinson et al., 2007), it is anticipated that the inclusion of EL students would create a stronger sense of integrated and coordinated school community that is beneficial for everyone. The process of inclusion begins at placement and with the acknowledgement that where a student has come from is equally important as to where they are now. By expanding what is known to include English proficiency, content knowledge, and factors related to their social-emotional state and constructing an evaluation tool that more effectively measures these, it is more likely that the student will begin their U.S. educational experience at a more individualized and appropriate Zone of Proximal Development (Vygotsky, 1978). To change the mindset at both the school and district level, there will have to be a shift away from labeling EL students as “those kids who don’t speak English.” This shift will only be successful when EL students are fully integrated into the school community and they have the opportunity to engage in a meaningful educational experience that incorporates both their past and their present in order to assist them in securing their best future.

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Appendix A

Summary of All A Priori Sample Size Calculations Across Various Alpha Levels

A Priori Sample Size Calculations for Correlations and t-tests with Medium Effect Sizes

Alpha	Power	Correlation Sample Size (ES=.3)	*t*-test Sample Size (ES=.5)
.05	.8	84	64 x 2 = 128
.01	.8	122	96 x 2 = 192
.007	.8	134	102 x 2 = 204
.0028	.9	156	120 x 2 = 240
no-EL- no-HLM =663		no-EL- HLM=536	

A Priori Sample Size Calculations for Multiple Regression with 7 IVs and Medium ES (.15)

Alpha	Power	Effect Size RE: R^2 (F2)	Minimum Sample Size
.05	.8	.15	103
.0125	.8	.15	137
.01	.8	.15	142
.007	.8	.15	150
.005	.8	.15	157
.0028	.8	.15	170

Appendix B

FWER Comparison of Alpha Threshold Per Study and Across All Studies

Study	RQ	Inference (I) or Descriptive (D)	Statistics/Analysis	Cumulative FWER per study	Cumulative FWER across all study
1	1-1A and B	I	2 correlations	2	2
1	1-2	I	1 *t*-test HLM vs no-EL no-HLM	3	3
1	1-3 Additional cutoffs	D	Cutoff process of 1-3	X	X
			Alpha per study-add 1 for PHs	.05/4	
2	2-1	I	Multiple regression model *R*2	1	4
2	2-2	Instruction only	Algorithm - instructional and not used because R^2 and original *r* of linking variable both modest so no need.	X	X
2	2-3 PH	Exploratory I	PH Betas -explore per Rubin*	X	X
			Alpha per study-add 1 for PHs	.05/2	
3	3-1	D	Frequency distribution analyses	X	X
3	3-2	I	3 new *t*-tests (3 total): 1. EL–no-EL HLM 2. EL-no EL No HLM 3. EL all to General all ** Best same level 4. ***Already have from Study 1:*** HLM vs No EL No HLM	3 (extra)**	7
Total					.05/7=.00714

*RQ-2-3 was designed as an exploratory post hoc question and was treated as exploratory using a modest alpha of .1 as a pattern of interest requiring more stringent alpha controlled replication.
**3 additional a priori tests were included for FWER related follow up analyses. These were then used to create Study 3 Post Hoc to further investigate how Algebra performance compared across each sample group.

Appendix C

FWER Considerations for Alpha Threshold with Resulting *p* Values

Study	RQ	Inference (I) or Descriptive (D)	Statistics/Analysis	Culminative FWER per study	Culminative FWER across all study	Obtained *p* value
1	1-1A & B	I	2 correlations	2	2	1. .000322 * 2. <$1.47\text{x}10^{-15}$*
1	1-2	I	1 *t*-test HLM vs no-EL no-HLM	3	3	3. $1.0\text{x}10^{-81}$
1	1-3	D	Cutoff process of 1-3	X	X	
			Alpha per study-add 1 for PHs	.05/4		
2	2-1	I	Multiple regression model R^2	1	4	4. .006 *
2	2-2	Instruction only	Algorithm -instructional only not used because R^2 and original *r* of linking variable both modest	X	X	
2	2-3 PH	Exploratory I	PH Betas -explore Rubin	X	X	n/a
			Alpha per study-add 1 for PHs	.05/2		
Study 3: Post Hoc Additional Follow-up Study Using the 3 *a priori* test slots factored into FWER considerations:						
3	3-1	D	Frequency distribution analyses	X	X	
3	3-2	I	3 new *t*-tests (4 total): 5. EL- no-EL HLM 6. EL-no-EL no HLM 7. EL All to Mainstream All ** Best same level 8. ***Already have from Study 1:*** HLM vs no-EL no-HLM	3	7	9. (1)<$1.0\text{x}10^{-8}$ 10.(2)<$1.0\text{x}10^{-13}$ 11.(3).088** (4) #3 above already completed: <$1.0\text{x}10^{-81}$

* met FWER significance < .007
** *t*-test was rerun using a more appropriate equivalence test per Lakens et al. (2018)

Appendix D

Sample Selection of Hispanic EL 1+2 Compared to no-EL HLM and no-EL no-HLM