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Enrollment in Science, Technology, Engineering, and Math Courses After Enactment of Texas' House Bill 5

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This is to certify that the doctoral dissertation by

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has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
the review committee have been made.

Walden University
2023

Abstract

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MEd, Texas Southern University, 2010

BS, Texas Southern University, 1999

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Psychology

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Abstract

Student participation and performance in science, technology, engineering, and math (STEM) have been an education concern in the United States for years. In 2013, Texas lawmakers passed House Bill 5 (HB5) to support increases in STEM awareness, particularly among ethnic minority and female students. To date, no studies have been conducted on the impact, if any, of HB5 on Texas high school students' course selections in STEM areas. Further, it is unknown whether the impact that does exist is equally distributed across socioeconomic status (SES), race/ethnicity, and gender groups. The purpose of this nonexperimental correlational quantitative study was to determine whether there was an increase post-HB5 in STEM course enrollments among African American, Latinx, and female high school students of various SES groups at a Texas regional service center. General systems and stereotype threat theories provided the theoretical framework for the study. Relative changes in enrollments in STEM classes for the 2016-2017 and 2020-2021 school years were computed from archival data from the Texas Education Agency Public Education Information Management System Standard Reports database. Multiple regression analyses were conducted to evaluate student race/ethnicity, gender, and SES as predictors of relative changes in enrollments in STEM courses. There were significant increases in enrollments among female students and decreases among male students across the two years and no differences between ethnicities or SES. Results may help educators and policy makers to understand the possible impact of HB5 on STEM enrollments and possibly develop further initiatives to attract more students to STEM areas leading to positive social change.

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Dedication

I dedicate this work to my family, especially my children, Christian, Joshua, and Caitlin; my beloved parents, John and Willie M. Allen; my brother and his wife, LeKeith and Letisha Allen; my nephew, LeKeith Jr.; and my New Zion Temple Church family and close friends. I am eternally grateful for your love, support, prayers, and sacrifice throughout this journey. This dream could not have been realized without your patience, continuous encouragement, and unshakable love. To Christian, Joshua, Caitlin and LeKeith Jr., never forget that you can do ALL THINGS THROUGH CHRIST, who strengthens you. Remember to follow your dreams and pursue your passion no matter how daunting that road ahead—it's worth it in the end. To my parents, this is your degree as much as it is mine. You have sacrificed so much to ensure that I can pursue my dreams, and I am forever grateful. I will make sure that your legacy lives on. Lastly, I dedicate this to my late grandmothers, Ida Mae Josey Jacobs and Katie Mae Allen Lewis, and my late great-aunts, Lois Josey Caldwell and Doris Blakes, who were a constant source of encouragement, always reminding me that greatness is within me and to keep pushing forward. Thank you for helping me realize that my life matters and that I am important. I am who I am because of each of you.

She believed she could ….so she did!

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Chapter 1: Introduction to the Study

House Bill 5 (HB5; see Appendix) is legislation passed by Texas lawmakers in May 2013 and adopted in January 2014 that represents a significant policy shift. It requires incoming high school students to endorse a "career pathway" among five categories: (a) science, technology, engineering, and mathematics (STEM); (b) business and industry; (c) public services; (d) arts and humanities; or (e) multidisciplinary (Texas Leg., 2013). According to the National Academy of Science (2011), STEM education promotes the study of the four disciplines as connected rather than taught in isolation.

The purpose of HB5 was to amend previous graduation requirements for high school students (Texas Leg., 2013). HB5 changed Texas high school curricula and graduation requirements to increase students' career and college readiness. Before the new mandate, there were three types of curriculum plans for high school graduation: (a) Minimum, (b) Recommended, and (c) Distinguished Advancement. Under the Minimum track, students only needed three years of mathematics, which included Algebra I and Geometry, and two science courses: Biology and Integrated Physics and Chemistry. They also needed 3 years of history or government courses to fulfill graduation requirements. However, for Recommended and Distinguished Advance Tracks, students needed to take two additional advanced mathematics and science courses to meet graduation requirements. In addition, students needed to pass 15 State of Texas Assessment of Academic Readiness (STAAR) end-of-course (EOC) exams in each content area, one per grade level. HB5 replaced the previous graduation plan with a new, one-track curricular structure with a single base called the Foundation Graduation Plan. Under this new plan, high school students must choose one of five “endorsement,” or content-specific, course sequences (Texas Leg., 2013). The Foundation Plan reduced the core requirements of the previous plan from a 4x4 structure (4 years each of English, math, science, and social studies) to 4 years of English and 3 of each of the other core subject areas, in addition to decreasing the number of EOC exams from 15 to five. The Texas Legislature also passed HB5 to increase students’ interest in and exposure to multiple career-related opportunities and postsecondary education entrance (Texas Leg., 2013). One rationale for the provisions in the bill was the need to increase minority participation in STEM (Estrada et al., 2016).

One of the mandates of HB5 is for entering high school students to select an endorsement area, also known as a “pathway,” which is an area of specialized interest, to increase their college or career readiness skills (Texas Leg., 2013). An *endorsement area* is defined as a sequence of prerequisites and subsequent advanced courses that meet the requirements of the State Board of Education for a given career pathway (Texas Education Agency [TEA], 2013). When students select an endorsement area, they are required to take a certain number of credits in coursework aligned with their chosen endorsement area (Texas Leg., 2013).

The purpose of this nonexperimental correlational quantitative study was to determine whether the school districts within a Texas regional service center region had been successful in increasing STEM course enrollment behaviors in advanced math and advanced science courses among African American, Latinx, female, and low-SES high school students since the passage of HB5 in 2013. The Texas regional service center that was examined in this study was one of 20 educational service centers in Texas. Center staff support local districts in attaining the missions, goals, and objectives set forth by the TEA. The mission of TEA is “to build the capacity of the Texas public education to provide to all students a quality education that enables them to achieve their potential and fully participate now and in the future in social, economic, and educational opportunities of our state and nation” (TEA, 2020).

In conducting this research, I sought to (a) determine whether there had been an increase in math and science STEM high school course enrollment behaviors among African American, Latinx, female, and low-SES high school students in a Texas regional service center region due to the passage of HB5 and (b) determine the impact, if any, of district-level demographics on math and science STEM course enrollment behaviors since the implementation of HB5 in the service center region. Such an evaluation was essential to determine if the bill had helped to increase enrollment behaviors in math and science STEM courses, which could overall increase interest in STEM careers among high school students (see Yoon & Strobel, 2017). In addition, addressing this research gap helps to explain how and how HB5 has influenced math and science STEM course enrollment behaviors among ethnic minority and female high school students and if the goal of increasing STEM course enrollment was being met for all demographics.

Chapter 1 begins with the background to this study. The statements of the research problem and purpose and the research questions (RQs) and hypotheses follow. In the chapter, I also introduce the nature of the research and define some of the significant terminology used throughout the study. In addition, I discuss the assumptions, scope and delimitations, and limitations of the research and its potential significance to the field of education.

Background

The U.S. and global economies have changed since the start of 2010's (National Science Foundation, 2021). Technology, especially digital technology, has become predominant. As a result, more emphasis is needed on increasing student interest in STEM-intensive careers so the United States can help meet the global demand for workers in these fields (Wang & Degol, 2017). Educational leaders have implemented vast initiatives on the national and state level to increase awareness of and interest in STEM among secondary education students (DeJarnette, 2012). Still, girls and racial and ethnic minorities are underrepresented in STEM careers.

STEM Enrollment Before Passage of House Bill 5

STEM course enrollment gaps existed before the implementation of HB5, research shows. For example, Yoon and Strobel (2017) explored six years of data (2008–2013) on high school student enrollment behaviors in math, science, and STEM courses before the major policy shift of HB5. They noted that student enrollment behaviors increased overall across years in prerequisite and advanced mathematics, advanced science, and STEM courses before the HB5 mandate went into effect. However, when the data were disaggregated by each course in mathematics and science, and/or by gender, disparities were noted. Racial/ethnic differences were constant across years in both advanced mathematics and advanced science courses. Gender disparity was greater in advanced science courses than advanced mathematics courses. I sought to extend the research of Yoon and Strobel by examining the impact, if any, of gender, race/ethnicity, and low SES on student enrollment behaviors after the implementation of HB5 in both advanced mathematics and advanced science courses.

STEM Enrollment After Passage of House Bill 5

Porterfield and Hendricks (2018) examined the effects of HB5 on college and career readiness course completion rates after the 83rd Texas legislative session. They suggested in their findings that property-poor districts saw an increase in the number of advanced course completions compared to property-wealthy districts. However, Porterfield and Hendricks also found no evidence of a significant change in course completion rates for STEM course sequences in the two school districts. Porterfield and Hendricks suggested that another study in Fall 2019 with data from the graduating class of 2018 might provide additional findings of interest to educators and legislators in student participation in STEM courses. This study extended the work performed by Porterfield and Hendricks (2018) by examining the potential impacts of low SES, race/ethnicity, and gender on STEM course enrollment behaviors for entering ninth graders of a Texas regional service center region between 2013 and 2019.

House Bill 5's Impact on Exam Testing

A significant achievement gap in Algebra I EOC exams was evident between African American and European American students with scores for African American students lower than before HB5. Stewart (2016) concluded that there was no reduction since the implementation of HB5 in this achievement gap. In addition, there was no change in achievement in math for economically disadvantaged students. Racial/ethnic differences were consistent across years in STEM courses before the policy shift. Stewart's research suggests that HB5 has not had the desired effect on exam testing since the implementation.

House Bill 5's Impact on College Readiness

Under HB5, high school students must pass designated coursework in their chosen endorsement area in addition to state-mandated exams, either the Texas Assessment of Knowledge and Skills (TAKS) or the STAAR EOC exam, to fulfill graduation requirements. TAKS was a summative assessment used before the implementation of HB5 to assess student attainment of reading, writing, math, science, and social studies skills required under Texas education standards. After the HB5 mandate, high school students transitioned from TAKS to the STAAR EOC to fulfill graduation requirements. They must also take the Scholastic Aptitude Test (SAT). The SAT is the most consistently taken college entrance exam; it is used globally to assess academic readiness for college entrance (Schur, 2015). Schur (2015) assessed the impact of HB5 on college readiness by using students' SAT composite scores and graduation rates among first-time test takers as indicators. "First-time test takers" refers to first-time takers of the SAT and the TAKS and/or STAAR. Schur found HB5 did not affect college readiness as measured by SAT scores. Schur investigated whether there was an effect on student performance on the test once Texas' high school graduation requirements changed from the TAKS to the EOC exam. Schur noted that the data revealed no indication that the transition from TAKS to HB5 EOC exams increased college readiness as measured by SAT scores. By studying the role, if any, of demographic factors in increasing STEM course enrollment behaviors, I sought to further scrutinize Schur's findings regarding the impact of HB5 on college readiness. By exploring whether demographic factors accounted for an increase in STEM course enrollment.

Recommendation to Increase STEM Participation

There is a need for evidence-based recommendations for policy and practice to improve STEM diversity and future research directions. Wang and Degol (2017) concluded that focusing on women's and girls' cognitive strength and stressing hard work and effort instead of talent can help increase female interest in science. Also, Wang and Degol suggested that organizational leaders should put research findings into action by creating micro- and macro-level programs that directly engage women and girls. This focus seems relevant given that gender differences were more significant in advanced science courses than in mathematics courses before the policy shift (Yoon & Strobel, 2017). Likewise, gender gaps in participation and achievement in STEM courses were more significant in advanced math and science courses before the policy shift (Yoon & Strobel, 2017).

Most of the literature regarding ethnic minorities in STEM has primarily focused on increasing interest in science. Estrada et al. (2016) provided recommendations for improving underrepresented minority persistence in STEM. Recommendations given include removing instruction barriers and providing an intervention that lifts students' interest, commitment, and ability to continue in STEM fields. Estrada et al. suggested that programs and schools must meet these five recommendations to improve participation in STEM: (a) documenting successes and failures, (b) creating partnerships with other successful programs to build relationships and increase self-efficacy, (c) giving students active learning experiences in curriculum-based instruction that can promote lifelong learning, (d) providing financial support from institutions to increase student persistence, and (e) activating students' creativity to inspire and innovate. Hence, Mau (2016) examined racial differences in entering, persisting in, and completing the STEM pipeline. Mau argued that math and science identity plays a role in students' future career choices and suggested that to increase female and minority student participation in STEM, early recruitment, interventions, and targeted support are needed.

Furthermore, Salto et al. (2014) evaluated summer enrichment program efforts to increase minority students' interest in building self-efficacy by actively involving students in hands-on learning and providing mentors and activities geared towards STEM career development activities, including education on health disparities. Salto et al. noted that active learning experiences before college might increase science literacy among all students, arguing that preexposure would improve academic achievement in college-level coursework and increase the likelihood of students pursuing a STEM career. Such an evaluation is essential to determine whether HB5 had helped to increase enrollment behaviors in STEM courses, which could contribute to an increase in student interest in STEM careers (see Yoon & Strobel, 2017). In addressing this research gap, I sought to provide data to explain how HB5 has influenced interest in STEM among high school students and determine whether the goal of the increased pursuit of STEM was being met for all demographics.

Problem Statement

According to the National Science Foundation (2021) and National Center for Education Statistics (2012), only 5% of African Americans and 6% of Latinx individuals held professional jobs in STEM in the United States between 2010 and 2019. Similarly, women made up only 28% of the STEM workforce in the United States during this time period (National Science Foundation and National Center for Education Statistics, 2018). When Texas passed HB5 in 2013, students were then able to obtain a STEM endorsement (Texas Leg., 2013). STEM endorsements were among many mandated by HB5; however, no studies have been conducted to assess their impact on students' STEM course selections (Yoon & Strobel, 2017). Thus, the gap that was addressed in this research was that the impact of the implementation of HB5 on Texas high school students' course selection in STEM areas was unknown. Moreover, it was unknown whether the impact, if any, was equally distributed across socioeconomic status (SES), race/ethnicity, and gender.

Purpose of the Study

The purpose of this study was to determine if a Texas regional service center had been successful in increasing math and science STEM course enrollment behaviors among African American, Latinx, female, and lower SES high school students since the passage of HB5 in 2013. More specifically, I sought to (a) determine whether there had been an increase in African American, Latinx, female, and lower SES high school students' math and science enrollment behaviors in STEM courses in a Texas regional service center region due to the passage of HB5 and (b) determine the impact, if any, of district-level demographics on math and science STEM course enrollment behaviors since the implementation of HB5 in the service center region. Although national data have shown some gains in African American and Latinx student degree attainment in STEM, work is still needed to bring more diversity to the STEM workforce (Estrada et al., 2016). Efforts to encourage girls and racial/ethnic minority students to pursue STEM interests and careers might benefit from knowledge of the impact of HB5. In addition, since the implementation of HB5, no research has been conducted, according to my review of literature, to assess the impact on female and minority high school student math and science course enrollment behaviors in STEM and the distribution of this impact across demographics. To accomplish this purpose, I developed a series of RQs, based on the gap in the research, concerning the effect of SES, race/ethnicity, and gender (the independent variables) on STEM course enrollment behaviors (the dependent variable) since the implementation of HB5.

Research Questions and Hypotheses

I addressed the following RQs and their associated hypotheses:

RQ1: Does gender, race/ethnicity, and/or SES predict absolute differences in enrollment across STEM-related courses for 2014-2015 versus 2020-2021 among students enrolled in schools within a Texas regional service center region since the implementation of HB5?

$H_0 1$: Gender, race/ethnicity, and/or SES do not predict absolute differences in enrollment across STEM-related courses for 2014-2015 versus 2020-2021 among

students enrolled in schools within a Texas regional service center region since the implementation of HB5.

H_a1: Gender, race/ethnicity, and/or SES do predict absolute differences in enrollment across STEM-related courses for 2014-2015 versus 2020-2021 among students enrolled in schools within a Texas regional service center region since the implementation of HB5.

RQ2: Does gender, race/ethnicity, and/or SES predict relative differences in enrollment across 2014-2015 versus 2020-2021 among students enrolled in schools within a Texas regional service center region since the implementation of HB5?

H_02: Gender, race/ethnicity, and/or SES do not predict relative differences in enrollment across 2014-2015 versus 2020-2021 among students enrolled in schools within a Texas regional service center region since the implementation of HB5.

H_a2: Gender, race/ethnicity, and/or SES do predict relative differences in enrollment across 2014-2015 versus 2020-2021 among students enrolled in schools within a Texas regional service center region since the implementation of HB5.

Theoretical Framework

Two theories informed this study: Bertalanffy's (1950) general systems theory and Steele and Aronson's (1995) stereotype threat theory. General systems theory indicates that systems are made up of smaller parts that interact together to make up a whole (Bertalanffy, 1950). Accordingly, education reform would provide context for the entire system, and students, administrators, and teachers would make up smaller subunits working together to increase student participation in STEM. As applied to this study, this theory would conceptualize HB5 as an input into the educational system that interacts with the existing structures and affects STEM course enrollment behaviors as the outcome. As an input, the HB5 policy is predicted to interact with other subparts of education reform to increase student interest in STEM course selections, impacting student enrollment behaviors in STEM.

Steele and Aronson (1995) used stereotype threat theory to explore why underrepresented minorities and female adolescent students performed differently from their White male peers. The scholars found that the emphasis on stereotypes raised sociocultural barriers so that students lacked belief in their academic capabilities, hampering their success with STEM careers. Because of low performance in math and science, it is common for girls, women, and ethnic minorities to feel intimidated about enrolling in these courses, which further perpetuates the issue (Rozek et al., 2019). I applied stereotype threat theory to evaluate the influence of the HB5 policy on female and ethnic minority enrollment behaviors after its implementation; as assumption of H_a2 is that low SES, race/ethnicity, and/or gender predicts STEM course enrollment behavior. Ethnic minority students feel intimidated academically in math and science-related courses (Steele & Aronson, 1995). Because of negative stereotypes, ethnic minorities have been deterred by society and cultural beliefs about their capabilities to succeed in STEM careers (Steele & Aronson, 1995). In addition, STEM has been a male-dominated field of study (Baird, 2018). Therefore, girls and women interested in STEM may internalize a stereotyped belief that can negatively affect their academic performance in STEM courses (Baird, 2018). As a result, those girls and women do not “do” science and math, or if they struggle with math and science-intensive coursework, they believe it is because they are female, which may lead to disengagement and lack of interest (Baird, 2018).

Nature of the Study

The nature of this study was correlational quantitative. I selected this research method to evaluate whether there had been significant changes since the passage of HB5 in student enrollment in STEM-related courses among various groups of students. I evaluated a prediction model where the independent variables were students’ SES, race/ethnicity, and gender and the dependent variables were relative difference and absolute difference in enrollment between the school year 2014-2015 (the initiation of HB5) and 2019-2020, as reported by the TEA Public Education Information Management System (PEIMS), specifically the Standard Reports: Teacher FTE Counts and Student Course Enrollment Reports and Student Program and Special Populations Report. By using archival secondary data from the PEIMS, specifically the Standard Reports: Foundation High School Student Enrollment Reports, I was able to evaluate the overall number of students enrolling in all STEM-related academic courses in a Texas regional service center region.

Definitions

Endorsement: A sequence of courses in a particular area that provides the prerequisites and subsequent advanced high school courses that meet the requirements of the State Board of Education for a selected career pathway (TEA, 2013).

Science, technology, engineering, and math (STEM): A "method of hands-on teaching and learning where students learn to apply academic content by creatively solving real-world problems with innovative design-based thinking to prepare students for future career opportunities" (TEA, 2020, Texas STEM Education Definition section).

Assumptions

In conducting this study, I assumed that the secondary data that I retrieved from the TEA were an accurate representation of district STEM course enrollment. I also assumed that each school district recorded its enrollment data and reported these data to TEA without error. I also has assumptions about my data, which I tested prior to the analysis. These included assumptions of normality, homoscedasticity, and absence of multicollinearity. The assumption of normality was that the regression residuals would be normally distributed (Fields, 2014; Pallant, 2016). I tested this assumption through an examination of a normal probability plot. Skewness and kurtosis values indicated that none of the variables were outside the ±2 range, which is considered the standard for normality (Fields, 2014; Pallant, 2016). The assumption of homoscedasticity means that the variance around the regression line is the same across all values of the independent (predictor) variables, it is tested by examining a scatterplot of residuals versus the predicted values (Hair et al., 2014). Finally, the absence of multicollinearity means that the independent variables are not too highly correlated with each other (Hair et al., 2014). I tested this assumption using Variance Inflation Factors (VIF). VIF measures how much the variance of the predictor variable is influenced by the other predictor variables and values over 10 suggest the presence of multicollinearity (Hair et al., 2014). Therefore, the VIF values higher than 10 indicates correlation between the independent variables such as ethnicity/race, gender, and SES.

Scope and Delimitations

Delimitations are factors that a researcher deliberately imposes on the study to narrow the scope and create the research boundaries. This study had certain boundaries. One of those boundaries was the purpose of this correlational quantitative study: to determine whether a Texas regional service center region had successfully increased STEM course enrollment behaviors among African American, Latinx, female, and low-SES students since the passage of HB5 in 2013. More specifically, I evaluated a prediction model where the independent variables were students’ SES, race/ethnicity, and gender and the dependent variables were absolute difference and relative difference in enrollment between the school year 2014-2015 versus 2019-2020.

According to Simon and Goes (2011), delimitations result from specific decisions made by the researcher. For example, the delimitations of the study included selecting only the STEM-related course enrollment data from a Texas regional service center region. Another delimitation is that the study only focused on specific race/ethnicity, gender, and SES demographic enrollment behaviors from African American, Latinx, female, and low-SES high school students attending high schools in a Texas regional service center region. Last, there are several endorsement tracks provided by HB5, such as (a) STEM, (b) Business and Industry, (c) Public Service, (d) Arts and Humanities, and (e) Multidisciplinary Studies. STEM is one such endorsement where students can take a combination of no more than two of the categories listed: (a) STEM, (b) career and technical education courses related to STEM, (c) computer science, (d) mathematics, and (e) science (Texas Leg., 2013). In this study, I explored only enrollment behaviors in math and science stem-related courses.

Limitations

Limitations are restrictions that are outside of the researcher's control. I know of six limitations of this study. First, I used aggregated data across districts; therefore, I could not determine enrollment behaviors relative to school size and overall school performance to increase student enrollment at the district level. Second, using aggregated data meant that student performance was not considered because the focus of this study was on examining enrollment behaviors since the implementation of HB5. Third, I used aggregated data, isolating enrollment behaviors by the effects of school districts and school sizes; I could not control overall school performance. Fourth, I used only student enrollment behaviors to capture high school students' interest in STEM courses and course-taking patterns after the passage of HB5. Thus, students' performance data were not considered for this study. Last, the student demographics (i.e., gender, race/ethnicity, SES) included in this study provided a limited picture of students' interest in STEM disciplines at the high school level.

Significance

This research provides insights on how HB5 has affected high school students' course selection in STEM areas and whether these selections differ across demographics. The results of this study may help educators and policy makers understand the effects of HB5 on students' course choices and interest in STEM. The results of this study can inform district leaders about other initiatives that would potentially attract more students to pursue an interest in STEM areas. This study could identify the effect of HB5 on STEM course enrollment behaviors for female, SES, and underrepresented minority students and highlight the role district demographics play in establishing this effect.

Summary

In this chapter, I described my nonexperimental correlational quantitative research study. In the Background section, I provided an overview of the research that supported this study. The problem and purpose statements helped to clarify the study's focus on the impact, if any, of the implementation of HB5 on Texas high school students' course selection in STEM areas and whether this impact is equally distributed across SES, race/ethnicity, and gender. Next, I presented the RQs and hypotheses for the quantitative study. In the Theoretical Framework section, I outlined the general system (Bertalanffy, 1950) and stereotype threat (Steele & Aronson, 1995) theories that undergirded this study. Next, I highlighted the rationale for the quantitative design of this research study. In the Definitions section, I clarified key terminology for this study. I set the boundaries for this study in the Assumptions, Scope and Delimitations, and Limitations sections. Near the end of Chapter 1, I explained the significance of this study, including its potential impact on professional practice within the educational discipline. In Chapter 2, I will describe my literature search strategy, provide a more in-depth overview of my theoretical framework, and provide a thorough review of current literature about the topic areas of this study.

Chapter 2: Literature Review

Introduction

The purpose of this nonexperimental correlational quantitative study was to determine if there had been an increase in STEM-related course enrollments among African American, Latinx, female, and various SES groups of high school students at a Texas regional service center since the implementation of HB5. Female and ethnic minority students do not enroll in STEM courses nearly as often as White male students (Allen-Ramdial & Campbell, 2014; Museus et al., 2011). The reasons behind such low enrollment behaviors in STEM learning represent a topic for research. Unfortunately, there is a lack of empirical data on enrollment behaviors before and after the implementation of HB5. Specifically, this study focused on enrollment behaviors since the implementation of HB5 among African American, Latinx, high school female, and low-SES students who live within a Texas regional service center region.

Additionally, I used a prediction model where the independent variables were students' SES, race/ethnicity, and gender, and the dependent variables were relative difference and absolute difference in enrollment between the 2014-2015 (initiation of HB5) and 2019-2020 school years, as reported by TEA's PEIMS. No studies have been conducted to assess the impact of HB5 on students' STEM course enrollment behavior frequency (Yoon & Strobel, 2017).

Such an evaluation was essential to determine if the bill had helped to increase enrollments behaviors in STEM courses (see Yoon & Strobel, 2017). Moreover, it was unknown whether this impact was equally distributed across SES, race/ethnicity, and gender. By addressing this research gap, I sought to provide data to explain how HB5 has influenced college readiness in STEM course enrollment behaviors among high school students and if this goal is being met for all demographics.

Thus, it was essential to determine if district leaders had successfully increased STEM course enrollment behaviors of African Americans, Latinx, female, and low-SES high school students since the passage of HB5 in 2013, potentially increasing the flow within the "STEM pipeline." The STEM pipeline is a metaphor used to describe how students matriculate through their schooling, eventually graduating high school with or without a future interest in a STEM career (Allen-Ramdial & Campbell, 2014; Alpher, 1993; Ball et al., 2017; Berryman, 1983). Students enter the STEM pipeline early in their education journey while passing through various STEM exposure stages and experiences. However, many students are not interested in STEM learning or "leak" out of the STEM pipeline for multiple reasons. Therefore, the aim of this study was to determine if a Texas regional service center region had been successful in increasing STEM course enrollment behaviors among low SES, African American, Latinx, and female adolescent students since the passage of HB5 in 2013. More specifically, I sought to (a) determine if there had been an increase in course enrollment behaviors in African American, Latinx, female, and low-SES high school students in STEM high school courses in a Texas regional service center region since the implementation of HB5 and (b) predict the impact, if any, of district-level SES demographics on STEM endorsement enrollment behaviors after implementing HB5 in the service center region. I also examined whether there had been a subsequent increase in the flow of young students through the STEM pipeline.

I begin Chapter 2 by discussing the literature search strategies that I applied to complete this literature review. Then, I discuss the two theories that constituted the study's theoretical framework: Bertalanffy's (1950) general systems theory and Steele and Aronson's (1995) stereotype threat theory. I provide the rationale for the selection of both theories. The literature review that follows includes discussion of STEM education and the need for local, state, and national awareness. I discuss ethnic minorities and why this group of individuals is underrepresented in the STEM pipeline. The literature review also includes discussion of high school girls and women and their lack of interest in the STEM pipeline. I also discuss HB5 legislation and how HB5 allows high school students the freedom of choice to select an endorsement area of specialized interest in either STEM or other endorsement areas for future college readiness after high school. Another literature review topic is how various types of peer pressure may influence a student's choice in STEM. Last, I focus on the barriers that may prevent an individual from choosing a STEM career path. The literature review clarifies the effect that HB5 policy has had on district enrollment behaviors of African American, Latinx, female, and low-SES high school students in STEM courses in a Texas regional service center region since the implementation of HB5 and how HB5 has affected district-level demographic variables such as SES in STEM course enrollment behaviors.

Literature Search Strategy

I used a variety of scholarly sources to find current literature for the review. These sources included empirical research articles from peer-reviewed journals, books, stakeholder policy statements, and published reports. Databases and search engines accessed included IEEE Xplore Digital Library, PsycARTICLES, Google Scholar, SAGE Journals, ScienceDirect, ERIC, Directory of Open Access Journals, Taylor and Francis Online, and Education Source. Most sources utilized in this review were published in 2014 or afterward. I entered the following search terms and phrases into the databases: *STEM education*, *underrepresented minorities* and *STEM*, *African American* and *STEM*, *Latinx* and *STEM*, *female* and *STEM*, *women* and *STEM*, *gender*, *ethnicity* or *race*, *socioeconomic status in STEM*, *STEM policy*, *House Bill 5* (HB5), *science self-efficacy*, *self-efficacy*, *college and career technical education* and *STEM*, *educational and career pathways STEM*, *general systems theory*, *stereotype threat theory*, *parents' influence* and *STEM*, *peer influence* and *STEM*, *teacher influence* and *STEM*, and *science aspiration in high school*.

Theoretical Foundation

Two theories informed this study: Bertalanffy's (1950) general systems theory and Steele and Aronson's (1995) stereotype threat theory. Bertalanffy's general systems theory explains how systems are composed of vital parts that allow them to function as a unit. I used stereotype threat theory to describe the phenomenon of minority and female student enrollment behaviors in STEM courses. When students receive negative feedback from parents, teachers, and/or peers, they may decide not to enroll in STEM courses. In addition, situational, emotional, and/or societal experiences that ethnic/minority students may experience can also affect STEM course enrollment behaviors.

General Systems Theory

General systems theory indicates that systems are made up of smaller parts that interact together to make up a whole (Bertalanffy, 1950). In this context, education reform would provide context for the entire system, and student interest in STEM courses, administrators, and teachers would make up smaller subunits working together to increase participation in STEM. As applied to this study, this theory would conceptualize HB5 as an input into the educational system that interacts with the existing structures and affects STEM course enrollment behaviors as the outcome. As an input, the HB5 policy is predicted to interact with other education reform subparts to increase student interest in STEM course selections, impacting student enrollment behaviors in STEM.

Stereotype Threat Theory

Stereotype threat can occur when underrepresented minorities and female adolescent students believe their capabilities academically to succeed in STEM careers are threatened by sociocultural barriers (Steele & Aronson, 1995). Because of low performance in math and science, it is not uncommon for girls and ethnic minorities to feel intimidated about enrolling in these courses, which further perpetuates the issue (Rozek et al., 2019). I applied stereotype threat theory to evaluate the influence of the HB5 policy on female and ethnic minority enrollment behaviors after its implementation. Ethnic minority students feel intimidated academically in math and science-related courses (Steele & Aronson, 1995). Ethnic minorities have been hampered by stereotypes perpetuated through society and cultural beliefs (Steele & Aronson, 1995). STEM has been a male-dominated field of study; therefore, girls and women possessing an interest in STEM may feel threatened because of the belief they struggle with math and science-intensive coursework, which may lead to disengagement and lack of interest (Baird, 2018). If stereotype threat is present, it is hypothesized that STEM course enrollment behaviors are lower among girls/women and members of ethnic minority groups than their counterparts, particularly among girls/women who are either African American or Latinx in STEM courses after the HB5 legislation.

Rationale for Theory Use

The general systems and stereotype threat theories were appropriate choices as the theoretical framework for my study. First, general systems theory and stereotype threat are justified because they align with the purpose of the study. The purpose of this study was to explore if a regional service center in Texas had been successful in increasing STEM course enrollment behaviors among African Americans, Latinx, female, and low-SES high school students since the passage of HB5. I investigated if there had been an increase among African American, Latinx, female, and low-SES high school students in STEM high school course enrollment behaviors in a Texas regional service center region since the implementation of HB5. In addition, I predicted the impact, if any, of district-level demographics on STEM course enrollment behaviors after the implementation of HB5 in the service center region. The author of general systems theory indicated that systems are made up of smaller parts that interact together to make up a whole

(Bertalanffy, 1950). In this context, education reform would provide context for the entire system. Students interested in STEM courses, administrators, and teachers would make up smaller subunits working together to increase participation in STEM. As applied to this study, this theory would conceptualize HB5 as an input into the educational system that interacts with the existing structures affecting STEM course enrollment behaviors as the outcome. As an input, HB5 is predicted to interact with other subparts of education reform to increase student interest in STEM course selections, impacting student enrollment behaviors in STEM. Stereotype threat theory predicts underrepresented minorities and female adolescent students feel threatened by sociocultural barriers to believing in their capabilities academically to succeed in STEM careers (Steele & Aronson, 1995). I applied stereotype threat to evaluate the influence of HB5 on female and ethnic minority enrollment behaviors after its implementation.

Literature Review Related to Key Variables and/or Concepts

STEM Education and Awareness

The United States has been at the forefront of advancements in technological innovations. For example, sending the first man to the moon placed the United States at an advantage over other countries (Xie & Killewald, 2012). However, there have been challenges in implementing STEM education in the United States for several decades, threatening its global competitiveness in today’s economy (National Center for Science and Engineering Statistics, 2017; National Science Board, 2018). Given the wealth of the United States economy, students are failing to meet educational demands in advanced math and science courses compared with countries such as Taiwan, Finland, and Hungary

(Killewald & Xie, 2013; Xie et al., 2015). To prepare students for 21st- century job opportunities, a more concentrated effort is needed to increase U.S. students' interest in pursuing STEM-related professions (Yoon & Strobel, 2017).

Many students are ill-prepared for STEM-based curricula's rigor, challenge, and expectations (Brophy et al., 2008). New career opportunities in STEM have become available (Milfort, 2012), but the current workforce does not meet the demand. For example, the number of STEM job opportunities is expected to increase between 2018 and 2028 (Fayer et al., 2017). At the same time, it is projected that there will be a shortage of qualified, skilled workers to fill the demand for STEM jobs (National Math and Science Initiative, 2020). According to the President's Council of Advisors on Science and Technology (2012), to meet the growing demand for filling future STEM employment opportunities, the United States needs to increase undergraduate STEM degree attainment by 34%. Due to the need to address this increasing demand for qualified candidates and ensure the United States remains competitive in STEM innovation, STEM education has become a significant concern on the national, regional, state, and local community levels (Roche, 2019; Wackler & Kontos, 2018). Therefore, the United States needs to raise awareness of STEM opportunities and exposure to STEM courses to increase qualified, skilled laborers to meet the growing demand.

Participation of Ethnic Minority Group Members in STEM

Due to disparities in educational attainment (Mau, 2016; Xie et al., 2015), minority STEM under-participation has remained a national concern. The achievement gap in science that exists between ethnic minority and female students and their counterparts has been researched for years. This gap is attributed to poor educational skills in both math and science courses. Additionally, a lack of parental understanding of what is needed to prepare a student for a STEM career is another cause for concern. Plus, ethnic minority students may not be able to apply STEM concepts in their everyday life to see the benefits of pursuing a career in STEM. During the first 2 years of primary schooling, significant achievement gaps between minority and White students in science manifest themselves. For example, Curran and Kellogg (2016) noted considerable science achievement gaps exist between Hispanic and White students. However, by the end of the 1st year, this achievement gap shifts towards Black students (Curran & Kellogg, 2016). In addition, several researchers have used data from the Early Childhood Longitudinal Study (ECLS-K) and concluded that by the end of third grade, Black students perform more poorly than their White counterparts in school. This deficit continues to increase as the student progresses through secondary education (Kohlhas et al., 2010; Morgan et al., 2016; Quinn & Cooc, 2015). Large-scale assessments such as the National Assessment of Educational Progress and Trends on International Mathematics and Science Study have also documented racial and gender achievement gaps as early as fourth grade (National Center for Education Statistics, 2012; U.S. Department of Education, 2012). Underrepresented minorities take fewer advanced science courses than their nonminority counterparts in high school (Kelly, 2009; National Science Board, 2014; Nord et al., 2011; Riegle-Crumb & King, 2010; Xie et al., 2015). Underrepresented minorities are also more likely to receive intervention and take fewer advanced science courses (Kao & Thompson, 2003; Oakes, 1990). To conclude, disparities in educational attainment among minority students will continue to exist due to the lack of early intervention, educational resources, and support in STEM education.

Participation of Latinx Individuals in STEM

The Latinx community is the most prominent and fastest-growing ethnic minority group in the United States (Colby & Ortman, 2015), but they remain underrepresented in STEM (National Science Foundation, 2016). Latinx students in the United States encounter various stereotypes about their academic achievement (Gonzalez et al., 2002), their aptitude (Gandara & Contreras, 2009), and their ability to thrive in a STEM career (Gandara & Contreras, 2009). However, through positive self-affirmations and the declaration of solid core values, Latinx students have been able to counteract identity threats (Cohen et al., 2006; Cohen, Garcia, Purdie-Vaughns et al., 2009; Cook et al., 2012; Hernandez et al., 2017; Sherman et al., 2013; Yeager & Walton, 2011). For example, Hernandez et al. (2017) conducted a study to dismantle Latinx individuals' negative perceptions of their academic ability, intelligence, and capacity to succeed in STEM careers. Hernandez et al. (2017) noted that self-affirmation and having positive role models are effective measures to increase Latinx science identity. Through self-affirmation, Latinx students can reduce negative self-perceptions of their capacity for success by declaring core values about themselves and strengthening their self-concept, which allows them to better deal with negative stereotypes in their environment.

Participation of African Americans in STEM

African Americans remain underrepresented in STEM, with only 9% filling U.S. STEM occupations (National Research Council, 2011). According to Archer et al., (2012), to increase STEM involvement, students and families need to understand the personal relevance of STEM and how it can transfer into future career aspirations. Archer et al. (2012) suggested promoting the message that science “opens doors” to a wide range of career opportunities, both in and beyond science, to help encourage African Americans to attain a science career.

Participation of Girls and Women in STEM

Although women make up 47% of today’s workforce, they only account for 25% of the college-educated STEM workers, with 28% having a career in STEM (U.S. Department of Commerce, 2017). Therefore, it is critical to identify the origin and current causes to understand the gender gaps in STEM. According to Curran and Kellogg (2016), gender gaps in science achievement begin to appear as early as first grade. As girls start to progress through formal schooling, their interest in science learning wanes.

Female participation, or lack thereof, in STEM has gained national, state, and local government attention (National Academy of Science, 2011). Many high-profile companies have sponsored grant programs and educational initiatives to increase female interest in STEM as early as elementary school (Museus et al., 2011). It is believed that females' lack of interest is due to the stereotype that STEM is a male profession (Cadaret et al., 2017; Wang & Degol, 2013). When it comes to cognitive abilities, Wang and Degol (2017) noted that females score lower in abstract thinking than males. However, Wang and Degol noted cognitive ability was not the primary cause of the decline of female interest in STEM. It has also been suggested that some girls and women rank high in different areas of cognitive abilities, and therefore they focus on other career paths that are not science or math-based (Halpern et al., 2007; Wang & Degol, 2017). Familial and peer pressure have been noted to suppress female enrollment in STEM courses (Wang & Degol, 2013). Increasing the self-efficacy of girls and women related to science can increase their interest and subsequent persistence in STEM (Wang & Degol, 2017).

STEM Legislation in Texas

In 2013, Texas entered a new system of graduation requirements into legislation called HB5. The primary goal of HB5 is to reduce the number of core courses in math, science, reading, and history that are required for high school students to graduate. In addition to reducing the number of courses per year to satisfy graduation requirements, HB5 also included guidelines for districts to increase career and college readiness for students preparing for college or preparing to enter the workforce directly after high school (Texas Leg., 2013). The goal of HB5 was to promote college and career readiness among incoming high school students (Texas Leg., 2013) to prepare and equip students for the future. In addition, HB5 was designated to increase exposure to multiple career-related opportunities to keep incoming high school students advancing and interested in STEM careers (Mellor et al., 2015). To prepare students for career or college entry, as of Fall 2014, students entering ninth grade in Texas must choose one of five areas of endorsement (business/industry, STEM, multidisciplinary studies, public service, or arts/humanities) for centralized instruction for career and college readiness as a graduation requirement (Texas Leg., 2013). In Texas, each local school district determines a coherent sequence of courses and identifies courses within that sequence as advanced classes to satisfy an endorsement requirement (Texas Leg., 2013).

High school students need to be exposed to advanced math and science coursework to increase student interest and motivation in STEM careers (Wang, 2013). In addition, the goal of HB5 is to promote college and career readiness among all students. The President's Council of Advisors on Science and Technology (2010) indicates that minority and female students need more support in career readiness than their non-minority male peers to close the opportunity gap. As such, it is vital to understand the impact of HB5 on this population.

Since the implementation of HB5 in Texas, all students have to select an area of interest endorsement to fulfill their graduation requirements. There are five areas in which a student can obtain an endorsement: (a) STEM, (b) business and industry, (c) public services, (d) arts and humanities, and (e) multidisciplinary career and technical education. This study only focused on the STEM area of endorsement. In addition, this study seeks to understand if, in meeting the requirements for HB5, there has been a significant change in enrollment behaviors (Texas Leg., 2013).

Peer Pressure as a Factor in STEM Participation

Peer pressure occurs when individuals are influenced by their cohort to participate or not participate in a specific activity, even if they do not want to do so. According to Foltz et al. (2015), social pressure from peers can play a role in whether an individual will continue to pursue a STEM degree. It is not uncommon for students to solicit advice from their peers and value their peers' advice more than that of any other significant person in their lives. What others think can have a profound impact on how someone perceives themselves.

Ethnic minority students who display a lack of science aspiration may do so because they face negative peer pressure at some point in their educational journey (Mau & Li, 2018). Peer pressure can either influence an individual positively or negatively. It is not uncommon for ethnic/racial minority students to face opposition to having an interest in STEM from family members, peers, teachers, and society (Steele, 1997). The "face" of what a scientist should look like has been stereotyped for many years. Stereotypical beliefs that students of certain ethnic/racial groups may face from their peers may include not understanding the vast job opportunities one can potentially seek in the STEM industry. Another drawback of peer influence could be missing out on the positive effects STEM exposure can have on SES. Such peer pressure can lead an individual to change their career aspiration from STEM to another field of study.

Teachers' and Parents' Influence on STEM Participation

Popa and Ciascal (2017) found that teachers are an essential factor in attracting young people into STEM fields. Teachers can have either a "fixed" or a "growth" mindset that can shape a student's perception either positively or negatively regarding their academic abilities (Canning et al., 2019). Ethnic/racial minority students can encounter situational cues in their STEM classwork that cause them to feel judged based upon their lack of academic abilities (e.g., assessment testing, problem-solving ability). Fixed mindset teachers believe students are incapable of learning and will not take the opportunity to develop and increase student learning. Teachers with a "growth" mindset belief toward their students will take the necessary steps to increase student motivation and build self-efficacy toward the desired learning outcome (Canning et al., 2019).

Building self-efficacy and science identity in math and science students can increase their science aspiration toward future STEM learning. In addition, teachers' interactions can influence a student's level of science aspiration.

A parent can influence a student's perception of their math and science ability by communicating their own experiences and beliefs about math. Research shows male students tend to have more family support than female students when demonstrating their math and science abilities (Jacobs & Eccles, 1992; Tiedemann, 2000a, 2000b). These beliefs, in turn, help shape children's beliefs in their math ability. Parental support was more common in math for boys than for girls (Rice et al., 2013), but there was a more significant difference in family support in science for female students (Rice et al., 2013). This difference in support for female children suggests that science careers are geared toward men because they are deemed more masculine (Rice et al., 2013). Mau and Li (2018) reported students with high SES and parental involvement aspired to STEM careers compared to students who aspired to non-STEM careers. For example, of the 21,144 ninth-grade students in their study, Mau and Li (2018) found only 2,416 had STEM career aspirations. In addition, STEM students had higher math/science self-efficacy, science identity, and science utility than their non-STEM counterparts. Still, non-STEM students with low SES and no significant differences in parental involvement had a higher interest in math and science than did STEM students.

Barriers to STEM Participation

In STEM, students can face many barriers that can influence their pursuit of and interest in STEM education, including but not limited to financial barriers, self-efficacy, gender, ethnicity, and lack of preparation. Barriers can be situational, emotional, and/or societal experiences that a student may encounter that can hinder them from pursuing a goal. Stereotype behavior is another barrier that influences ethnic minority students, teachers, peers, and other stakeholders regarding STEM (Kelly, 2016). For example, girls may feel less interested in STEM because of the lack of female role models, so they have a decreased sense of belonging in this field of study (Blickenstaff, 2005). This same lack of belonging can also negatively influence ethnic minority student participation in STEM courses and careers.

Socioeconomic Status

Research shows that students with higher SES parents are more likely to choose higher-level math and science coursework in high school and pursue an interest in STEM than students with parents from lower economic backgrounds (Eddy & Brownell, 2016; Wang & Degol, 2013). Several studies have documented intervention strategies to increase participation and interest and support STEM coursework for low-SES students. Rozek et al. (2019) noted that low-income students could benefit from intervention strategies to reduce stress and test anxiety in math and science courses to increase participation in additional STEM coursework while in high school. When students can control their anxiety about math and science, they can positively affect future science and math exposure. Rozek et al. (2019) suggested the implementation of expressive writing techniques for ethnic minority students can help them channel and thereby defuse their anxiety by removing stereotypical beliefs about ethnic minorities' participation in STEM. Kao and Thompson (2003) suggested that underrepresented minority students who are members of poor, less educated families are overly represented among the underemployed compared to their counterparts in future educational attainment.

Self-Efficacy and Imposter Syndrome

Self-efficacy is defined as an individual's belief in their ability to organize and execute actions required to manage prospective situations (Bandura, 1977, 1994). On the other hand, "imposter syndrome" is a term coined by Clance and Imes (1978) that explains how an individual's internal feelings can lead them to believe that they are inadequate despite their ability and successes. Roche and Manzi (2019) found that increased levels of self-efficacy increase persistence in the face of challenges and obstacles. Self-efficacy plays a significant role in how students perceive their math and science ability and whether they continue to pursue an interest in STEM (Bean et al., 2016). As girls progress through adolescence, their self-efficacy level is predicted to remain the same or decrease compared to that of their male counterparts (Bean et al., 2016).

Student Gender

Gender expectations from family and society can deter female students from pursuing STEM careers. Brown and Leaper (2010) conducted a study where boys and girls rated their experience of academic sexism. Brown and Leaper (2010) noted that girls were more commonly told they were not as good at math, science, and computers than boys, which harmed their math and science competence perceptions. Research suggests that girls experience lower self-efficacy or perceptions about their ability to accomplish academic tasks (Bandura, 1986, 1994) in most math and science subjects (Louis &

Mistle, 2012). Due to the lack of family, teacher, and peer support, girls' interest in STEM-related disciplines declines by the time they reach middle school (Aschbacher et al., 2010; Farmer, 2008; Heddy & Sinatra, 2017; Ogle et al., 2017; Stakes & Nickens, 2005). Research Tai et al. (2006) supports the notion that early intervention is needed to increase strong science identity among female students. Female self-efficacy will have to improve to increase female interest in STEM education.

Race/Ethnicity

Race/ethnicity was a significant influence on persistence in the STEM pipeline after high school (Salto et al., 2014). Disparities in educational attainment in math and science courses begin to emerge as early as kindergarten for ethnic minority students. Differences continue as students enter the educational system (Fryer & Levitt, 2004; Jencks & Phillips, 1998; Reardon, 2008), resulting in disproportionate enrollment in low-level math and science courses (Kao & Thompson, 2003; Oakes, 1990). According to previous studies, race/ethnicity, ACT scores, and high school grade point average significantly predicted STEM completion rates in college. The ACT is a standardized test used for college admission in the United States (College Board, n.d.). Grade point average is a measure of how well a student has scored in various academic courses on average throughout a semester or school year (GPA - Definition, Meaning & Synonyms, n.d.). Flores (2011) identified school curriculum, structural and cultural factors, and subtle discrimination as contributing factors that could impede student interest in STEM fields of study.

Lack of Preparation: Early Intervention and Lack of Career Development

The most critical impact on STEM entrance is the intent to major in STEM, which is directly affected by high school student experience and success in mathematics and science courses (Wang, 2013). Structured career planning can support science aspirations to increase student STEM engagement. Belser et al. (2017) suggested that students were more likely to continue a STEM pathway when they participated in STEM-focused career planning opportunities. It has been recorded by Curran and Kellogg (2016) that achievement gaps for African Americans and Latinx begin to manifest themselves during the first 2 years of formal schooling and continue to increase as they progress through school. Curran and Kellogg suggested when students can control their anxiety about math and science, they can positively affect future science and math exposure. Inadequate high school preparation was identified as the most significant barrier for ethnic minority students to begin to set future STEM educational goals and career aspirations (Henley & Roberts, 2016). Career development initiatives can increase minority and female student retention rates in STEM. Early exposure to computing interventions is well suited to improve STEM attitudes at an early age. By instilling intrinsic and utility values early on during a student's education, the flow of minority students in STEM may increase.

Secondary Data Set

I analyzed secondary data from TEA's PEIMS Standard Reports: Teacher FTE Counts and Student Course Enrollment, Student Program and Special Populations Report for all districts and high schools in a Texas regional service center region from 2014 to 2019 academic school years. This data set has provided socioeconomic data and enrollment behaviors of students who have selected a STEM endorsement. In addition, this data set has provided STEM course enrollment behaviors for African American and Latinx students from 2014 to the 2019 academic year. In addition, this data set will offer enrollment behaviors for STEM endorsement based on gender. Lastly, this data set has also provided high school district-level enrollment behaviors based upon specific demographics (SES, race/ethnicity, and gender) to predict the success of HB5 in increasing high school STEM endorsement enrollment behaviors in the Texas regional service center region.

Implications for Positive Social Change

The results of this study may help educators and policy makers understand whether students' gender, race/ethnicity, and/or SES are associated with relative changes in enrollment in STEM courses since passage of HB5. The results of this study may inform district leaders about other initiatives that would potentially attract more students to pursue an interest in STEM areas. This study could identify the effects of HB5 on STEM course enrollment behaviors for adolescent girls and members of minority groups underrepresented in STEM and the role district demographics have on this effect.

Summary and Conclusions

Female and ethnic/minority students are not in STEM as often as White male students. The reasons behind such low enrollment behaviors in participation in STEM courses represent a topic for research. At the same time, scholars have conducted varied investigations to explore why females and minorities are underrepresented in STEM careers. Regarding the findings of this chapter, several key points can be derived. The first key point focused on the literature search strategies applied for this literature review. The second strand was dedicated to the two theoretical frameworks: Bertalanffy’s (1950) general systems theory and Steele and Aronson's (1995) stereotype threat theory. The third key point is centered on the RQs this study has examined. The fourth key point focused on the rationale for the researcher's theories in this study. The fifth key point concentrated on STEM education and the need for local, state, and national awareness. The sixth key point focused on ethnic minorities and why this group of individuals is underrepresented in the STEM pipeline. The seventh key point concentrated on high school girls and women and their lack of interest in fueling the STEM pipeline. The eighth key point focused on HB5 legislation and how HB5 allows high school students the freedom of choice to select an endorsement area of specialized interest in either STEM or other endorsement areas for future career and college readiness after high school. The ninth key point centered on various types of peer pressure that may influence a student's choice in STEM. The final key point focused on the barriers that may prevent an individual from choosing a STEM career pathway. This summary concludes Chapter 2. Chapter 3 details the research design and rationale of the study, essential information concerning the population and sample, and data analysis information needed to understand the correlation between each variable.

Chapter 3: Research Method

The purpose of this nonexperimental correlational quantitative study was to determine if race/ethnicity (African American, Latinx), gender (female, male), and/or SES (lower, higher) have helped to predict relative changes in STEM course enrollments since the implementation of HB5. I used TEA archival data to accomplish this purpose. In the following sections, I first review the purpose of this study and the RQs before providing an overview of the research method and design. Next, I describe the methodology, including the population and sampling procedures and the materials and instruments I used to conduct this study. Operational definitions of the study variables and information on the data collection and analysis processes are also provided. Chapter 3 will conclude with a description of the ethical procedures for the study and a summary of the chapter.

Research Design and Rationale

The nature of this study was quantitative. I selected this method to provide evidence to determine whether there had been significant changes since the passage of HB5 in student enrollment in Advanced Placement (AP) STEM courses among various groups of students. I investigated a prediction model where the independent variables were students' SES), race/ethnicity, and gender, and the dependent variables were the relative difference and absolute difference in AP STEM course enrollment between the 2016–2017 and 2020–2021 school years, as reported by the TEA PEIMS, specifically the Standard Reports: Teacher FTE Counts and Student Course Enrollment Reports and Student Program and Special Populations Report. STEM course enrollment data for the district were paired with district demographic data from the TEA PEIMS Standard Reports Region Teacher FTE and Student Course Enrollment Reports for the 2016 and 2020 academic school years. I used multiple linear regression data analysis. I used AP STEM student course enrollment data for 2016–2017 as a baseline to compare with data from the 2020–2021 school year, which occurred after the enforcement of the HB5 policy. According to Pallant (2005), a multiple linear regression analysis can show how well a set of variables can predict a particular outcome, which variable is the best predictor, and whether a specific predictor variable can predict an outcome when the effects of another variable are controlled for (p. 140).

I sought to answer two RQs for this study. My aim was to determine whether a Texas regional service center had successfully increased STEM course enrollment behaviors among African American, Latinx, female, and low-SES high school students in STEM course enrollment since the passage of HB5 in 2013. The questions were:

RQ1: Does gender, race/ethnicity, and/or SES predict absolute differences in enrollment across STEM-related courses for 2014-2015 versus 2019-2020 among students enrolled in schools within a Texas regional service center since the implementation of HB5?

RQ2: Does gender, race/ethnicity, and/or SES predict relative differences in enrollment across STEM-related courses for 2014-2015 versus 2019-2020 among students enrolled in schools within a Texas regional service center since the implementation of HB5?

Methodology

The source of information for this study was archival data from the TEA PEIMS, specifically the Standard Reports: Teacher FTE and Student Course Enrollment Reports and Student Program and Special Populations Report. The archival data are available by request. The methodology for this study was quantitative and featured multiple linear regression. I analyzed annual numerical data to understand what happened between 2016 and 2020 regarding AP STEM course enrollment behaviors in a Texas regional service center region. The objective was to analyze student course enrollment behaviors, gender, ethnicity, and SES to determine whether HB5 predicted changes in student choice among these demographic groups for enrolling in STEM courses.

Population

This study took place in the Southeast region of Texas. This regional service center's enrollment was 1,248,425 at the time of data collection, including 228,979 African American students, 646,031 Latinx students, 608,588 female students, and 235,173 students from other ethnic demographics. In addition, there were 770,858 students coded as economically disadvantaged in this educational service region.

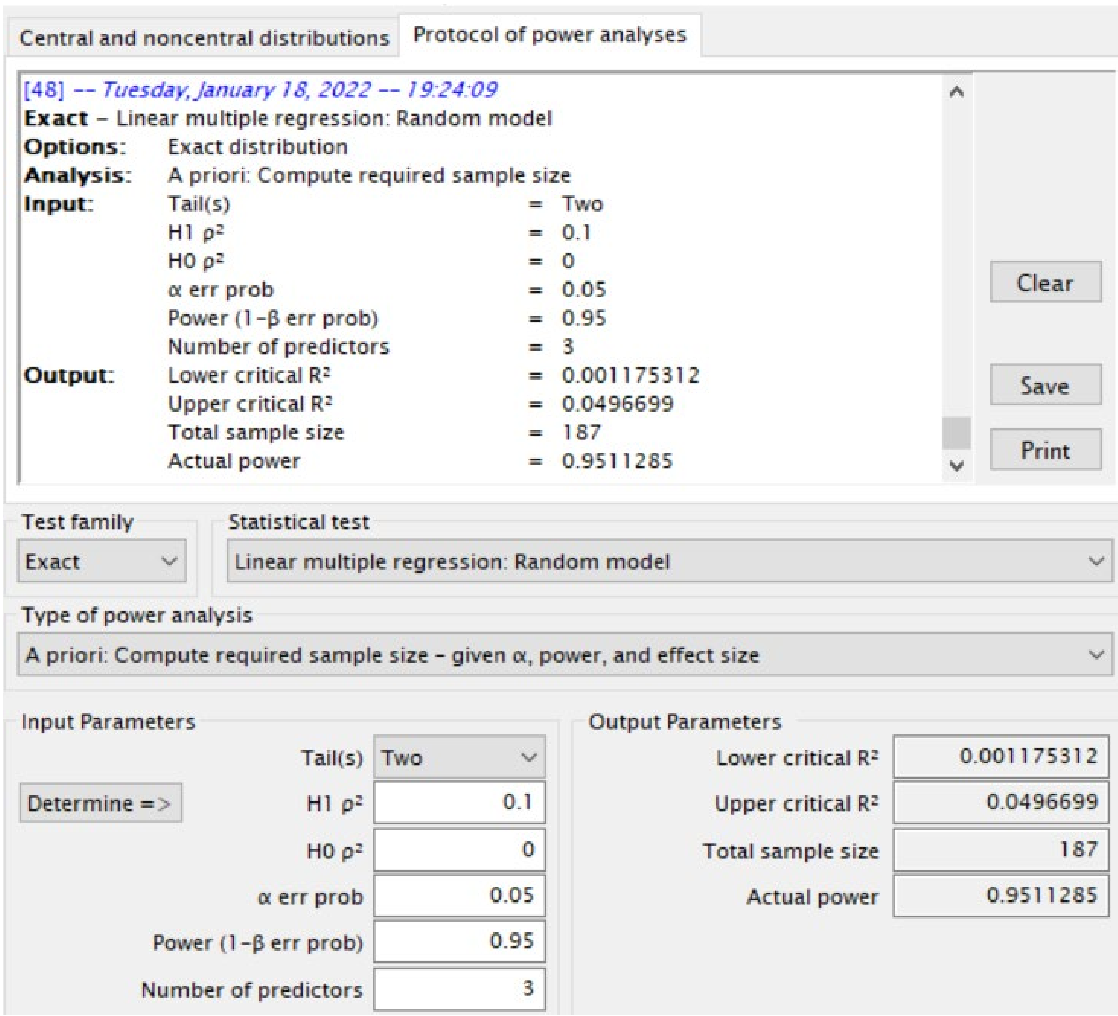
Sampling and Sampling Procedures

The regional service center consisted of 48 independent school districts with 143 high schools. It is located in the Southeast region of Texas. This regional service center is one of 20 regional education service centers founded by the Texas Legislature in 1967 to assist and support school districts and charter schools with improving student and teacher performance outcomes (Region Education Center, n.d.). I obtained data for students of various racial/ethnic, gender, and SES groups enrolled in STEM-related courses in the 2016 and 2020 school years.

The sample sizes were sufficient for statistical analyses using multiple linear and multiple logistic regression. The general guideline for multiple linear regression is a minimum sample size of 10 to 20 cases per predictor variable (Hair et al., 2014). I used G*Power to estimate the minimum sample size with three independent variables (gender, ethnicity, and SES) for multiple linear regression with a power of .80 and statistical significance of .05. The result indicated a minimum sample size of 187 (see Figure 1).

Figure 1

G Power 3 Minimum Sample Size for Multiple Linear Regression*



A logistic regression was needed to compare the two years of interest. Again, I used G*Power to estimate the minimum sample. As seen in Figure 2, the minimum sample size for the required power was 568.

Figure 2

*G*Power 3 Minimum Sample Size for Multiple Logistic Regression*

z tests – Logistic regression

Options:	Large sample z–Test, Demidenko (2007) with var corr		
Analysis:	A priori: Compute required sample size		
Input:	Tail(s)	=	One
	Odds ratio	=	1.3
	Pr(Y=1|X=1) H0	=	0.2
	α err prob	=	0.05
	Power (1–β err prob)	=	0.80
	R^2 other X	=	0
	X distribution	=	Normal
	X parm μ	=	0
	X parm σ	=	1
Output:	Critical z	=	1.6448536
	Total sample size	=	568
	Actual power	=	0.8005867

Archival Data

I analyzed secondary data from TEA PEIMS Standard Reports: Teacher FTE and Student Course Enrollment Reports for all districts and high schools in a Texas regional service center from the 2016-2017 and 2020-2021 academic school years. This report provides the number of high school students enrolled each year in each STEM-related course. In addition, this report also provides demographic enrollment data (SES, race/ethnicity, and gender) for school districts that reside in a Texas regional service center for each school year. The nature of the research design was a quantitative nonexperimental design. No other studies have been conducted to determine the possible changes in STEM enrollment behaviors since HB5 for African American, Latinx, female, and low-SES high school students for AP STEM courses.

Instrumentation and Operationalization of Constructs

The operationalization of the dependent and independent variables is as follows:

Dependent Variable

There were two dependent variables: the absolute difference in STEM course enrollment behaviors and the relative difference in STEM course enrollment behaviors. I retrieved STEM course enrollment data from TEA's PEIMS. Specifically, I analyzed Standard Reports: Foundation High School Enrollment Reports for all districts and high schools in a Texas regional service center from the 2016 and 2020 academic school years. I analyzed SES as a categorical variable in SPSS because each student was categorized as either economically disadvantaged or not; theoretically, students must meet specific criteria to be labeled economically disadvantaged. I considered the variable race/ethnicity nominal because I had categorized the data with no rank order. I considered the variable as gender categorical but was entered into SPSS as nominal with categorical codes with two naturally occurring categories of male or female based on the data set.

Absolute Difference in STEM Course Enrollment. This analysis considered the difference between the 2016-2017 student enrollment and the 2020-2021 student enrollment in AP STEM-related courses separately for each demographic variable (gender, race/ethnicity, and SES).

Relative Difference of STEM Course Enrollment. This analysis considered gender, race/ethnicity, and SES as joint predictors for differences between 2016–2017 student enrollment total (Year 1) and the 2020–2021 student enrollment (Year 2) in targeted AP STEM-related courses.

Predictor Variables

Three independent predictor variables are: SES, race/ethnicity, and gender.

Race/Ethnicity. As the most frequent ethnic/racial group was Hispanic, and relative numbers of White and Other ethnicity groups were low, students were coded as either Hispanic/Latinx or Other (Babbin, 2017). Race/ethnicity was entered in SPSS as nominal because I categorized it with no specific rank order.

Gender. Gender was also a categorical variable coded into two naturally occurring categories of female (coded as 0) or male (coded as 1; Babbin, 2017).

Socioeconomic Status. The SES data reported the number of students per district and region within the defined economically disadvantaged criteria ranges. Economically disadvantaged were identified with one or more of the following categories: (a) eligible for free meals under the National School Lunch And Child Nutrition Program; (b) eligible for Reduced-price Meals under the National School Lunch And Child Nutrition Program; (c) from a family with an annual income at or below the official federal poverty line; (d) eligible for Temporary Assistance to Needy Families or other public assistance; (e) received a Pell Grant or comparable state program of need-based financial assistance; (f) eligible for programs assisted under Title II of the Job Training Partnership Act; or (g) eligible for benefits under the Food Stamp Act of 1977 (TEA, 2021). I entered this variable into SPSS as categorical. This variable was coded 0 for economically disadvantaged and 1 for not economically disadvantaged. I used SPSS statistics software (Version 28) for statistical analyses. Although checking for missing values is often the initial step in data cleaning, archived data sets retrieved from TEA for public view are complete without missing data.

Data Analysis Plan

Research Questions and Hypotheses

I developed two RQs and sets of corresponding hypotheses for this study. I wanted to determine whether a Texas regional service center had successfully increased STEM course enrollment behaviors among ethnic (Hispanic, Other), gender (female, male), and SES (high, low) high schools since the passage of HB5 in 2013. The RQs and hypotheses were as follows:

RQ1: Does gender, race/ethnicity, and/or SES predict absolute differences in enrollment across STEM-related courses for 2014-2015 versus 2019-2020 among students enrolled in schools within a Texas regional service center since the implementation of HB5?

$H_0$1: Gender, race/ethnicity, and/or SES do not predict absolute differences in enrollment across STEM-related courses for 2014-2015 versus 2019-2020 among students enrolled in schools within a Texas regional service center region since the implementation of HB5.

H_a1: Gender, race/ethnicity, and/or SES do predict absolute differences in enrollment across STEM-related courses for 2014-2015 versus 2019-2020 among

students enrolled in schools within a Texas regional service center region since the implementation of HB5.

RQ2: Does gender, race/ethnicity, and/or SES predict relative differences in enrollment across STEM-related courses for 2014-2015 versus 2019-2020 among students enrolled in schools within a Texas regional service center since the implementation of HB5?

$H_0$2: Gender, race/ethnicity, and/or SES do not predict relative differences in enrollment across 2014-2015 versus 2019-2020 among students enrolled in schools within a Texas regional service center region since the implementation of HB5.

H_a2: Gender, race/ethnicity, and/or SES do predict relative differences in enrollment across 2014-2015 versus 2019-2020 among students enrolled in schools within a Texas regional service center region since the implementation of HB5.

Evaluation of Data in Relation to Assumptions for Analyses

Multivariate data analysis was used to answer RQ1 and RQ2. This study examined the relationship between the independent variables race/ethnicity, gender, and SES and the dependent variable STEM course enrollment behaviors. Multivariate data analysis is analyzing multiple variables in a single or set of relationships (Hair et al., 2010). Multivariate data analysis enabled me to determine if there was a relationship between SES, race/ethnicity, and/or gender with the dependent variable of STEM course enrollment. Multiple linear regression and logistic regression were used to examine if the independent variables predicted the outcome variable of enrollment behaviors in STEM courses per year and between years.

Before running the multiple linear regression analysis, I tested whether the data met the multiple linear regression assumptions. According to Laerd Statistics (2018), there are eight assumptions. The first assumption was that the dependent variable was continuous. For this study, the dependent variable was STEM course enrollment behaviors since the implementation of HB5. The continuous data contained the differences between enrollment numbers for the two years considered. The second assumption was that there were two or more independent variables. This study has three independent variables: SES, race/ethnicity, and gender. The third assumption was that observations are independent, meaning students from one sample did not influence students in another. For this study, each independent variable was truly independent. For example, gender does not limit/control the same student's race/ethnicity and/or SES classification. The fourth assumption was the need for a linear relationship between each independent and dependent variable. As there only are two categories for each predictor, it would not be possible to observe a curvilinear relationship.

The fifth and sixth assumptions were that the data should be homoscedastic and not show multicollinearity. In this study, Levene's test of equality of error variance test for homogeneity was used to test for homoscedasticity. To evaluate multicollinearity, I employed the variance inflation factor analysis, which measures the correlation and strength of correlation between the predictor variables in a regression model (Hair et al., 2014). The seventh assumption was that there should not be outliers. In this study, there should not be outliers; box plots were used to confirm. The final assumption was that there would be a normal distribution. After correcting for outliers, I found mean and standard deviation in descriptive statistics and was used for each variable to check for the normal distribution of the dependent variable scores.

Similarly, I examined the data to evaluate assumptions for logistic regression analysis. In accordance with assumptions (Laerd Statistics, 2018), the outcome variable for my analyses was enrollment data for two years, and the categories were mutually exclusive. All predictors were categorical and independent.

Threats to Validity

Threats to validity refer to anything that might prevent researchers from making reliable inferences about their study from the collected data (Babbin, 2017). Threats are essential to discuss in quantitative research because experimental and correlational designs must meet rigorous standards for external and face validity to be recognized by the academic community as having a high level of trustworthiness (Campbell & Stanley, 1963). Evans (2013) noted that validity represents what is real. External validity is the "basis for generalizability to other populations, settings, and times" (Ferguson, 2004, p. 16). This study was limited to information related only to AP STEM class enrollments in Texas for specific periods. Whether these results would generalize to other districts and/or school systems is unknown.

Hair et al. (2014) declared that "face validity is the most important validity test." They explained that "face validity" must be established before any theoretical testing when using confirmatory factor analysis" (p. 778). Although the TEA data set would appear to have face validity, there may have been errors in data entries or definitions of groups, etc., that may limit the exact correctness of the information. It is a judgment call at face value to decide if the data set was measuring what it is supposed to measure.

Ethical Procedures

I followed Walden University Institutional Review Board procedures in conducting this study. I used archival data that already masks the identities of individual students. I did not contact students or other personnel about the courses of interest. I only needed to obtain permission and access to TEA archival data files. I implemented the following precautionary measures to protect the identity of each school district and high school located within its boundaries: Any identifying information, such as the name of each school district, was removed and replaced with a numerical code to ensure confidentiality. I removed each high school's name in each district and replaced it with a capital letter code.

Summary

I used SPSS to analyze the archival data retrieved from TEA PEIMS Standard Reports: Teacher FTE and Student Course Enrollments and the Student Program and Special Population Reports for all districts and high schools in a Regional Service Center. This non-experimental correlational quantitative study used multivariate data analysis, which included correlation and multiple linear regression, as well as logistic regression analyses, to test to answer the RQs. In Chapter 4, I will present the data analysis findings and discuss the practice, research, and theoretical implications.

Chapter 4: Results

Introduction

The purpose of this nonexperimental correlational quantitative study was to determine if the school districts within a Texas regional service center region had been successful in increasing STEM course enrollment behaviors in advanced math and advanced science courses among African American, Latinx, female, and low-SES high school students since the passage of HB5 in 2013. To accomplish this purpose, I conducted multiple linear regression and multiple logistic regression analyses to determine if changes in enrollment in advanced high school AP STEM courses for two school years, 2016–2017 and 2020–2021, could be predicted by the race/ethnicity, gender, and/or SES of the students. The RQs and hypotheses for this study were as follows:

RQ1: Does gender, race/ethnicity, and/or SES predict absolute differences in enrollment across STEM-related courses for 2016-2017 versus 2020-2021 among students enrolled in schools within a Texas regional service center since the implementation of HB5?

$H_0 1$: Gender, race/ethnicity, and/or SES do not predict absolute differences in enrollment across STEM-related courses for 2016-2017 versus 2020-2021 among students enrolled in schools within a Texas regional service center region since the implementation of HB5.

$H_a 1$: Gender, race/ethnicity, and/or SES do predict absolute differences in enrollment in STEM-related courses from 2016-2017 versus 2020-2021 among

students enrolled in schools within a Texas regional service center region since the implementation of HB5.

RQ2: Does gender, race/ethnicity, and/or SES predict relative differences in enrollment across STEM-related courses for 2016-2017 versus 2020-2021 among students enrolled in schools within a Texas regional service center since the implementation of HB5?

$H_0$2: Gender, race/ethnicity, and/or SES do not predict relative differences in enrollment across STEM-related courses for 2016-2017 versus 2020-2021 among students enrolled in schools within a Texas regional service center region since the implementation of HB5.

H_a2: Gender, race/ethnicity, and/or SES do predict relative differences in enrollment across STEM-related courses for 2016-2017 versus 2020-2021 among students enrolled in schools within a Texas regional service center region since the implementation of HB5.

This chapter begins with a summary of the collected enrollment figures for various demographic groups. The sample consisted of 4,043 students in AP Biology and AP Statistics for 2016-2017 and 2020-2021. I present the results of chi-square analyses to evaluate RQ1. The logistic regression results are then presented to answer RQ2. A summary concludes this chapter.

Data Collection

I obtained deidentified, secondary student data from the TEA PEIMS, specifically the Standard Reports: Teacher FTE and Student Course Enrollment Reports and Student

Program and Special Population Report. I obtained these data reports after receiving Institutional Review Board approval from Walden University (no. 10-25-22-0279333). The target population for this study consisted of 12,800 high school students enrolled during the 2016 and 2020 school years in a regional service center in southeastern Texas. At the time of the study, the regional service center of interest consisted of 48 independent school districts with 143 high schools. In total, there were 12,800 students enrolled over the 2 years in all courses. Due to the initial size of the data set and consistent with the approved Institutional Review Board request, I modified the population to a smaller sample size that was more feasible to analyze. To narrow down the initial data set, I elected to use only data related to students in one science elective, AP Biology, and one math elective, AP Statistics, for the twp school years of interest. For this study, the minimum number of cases was 20 per predictor variable for multiple linear regression analyses and at least 1,188 cases to run a binary logistic regression, which was not an issue due to the data set size.

Results

Research Question 1

RQ1: Does gender, race/ethnicity, and/or low SES predict absolute differences in enrollment across STEM-related courses for 2016-2017 versus 2020-2021among students enrolled in schools within a Texas regional service center since the implementation of HB5? To answer this question, I considered the absolute numbers of enrollment behaviors for each year. SPSS Version 28 was employed for all data analyses. To evaluate demographic changes in enrollment behaviors, I applied chi-square analyses to evaluate differences across the twp years for each demographic variable. A binary logistic regression was used to simultaneously evaluate the three demographic variables as predictors of changes in enrollment behaviors between the two years.

In this section, I compare enrollment behaviors for each of the years in question, 2016-2017 and 2020-2021, for AP Statistics and AP Biology within each demographic variable. Chi-square analyses and results follow. The chi-square test of independence is appropriate when the goal of the RQ is to determine whether values on a categorical variable (here, school year) are independent (McHugh, 2013). The chi-square test of independence requires the expected frequencies to be sufficiently large. At least 80% of expected frequencies should be greater than or equal to five, with none less than one (McHugh, 2013). Statistical significance is evaluated by calculating a chi-square statistic (χ^2) and obtaining a *p*-value from χ^2 distribution with $(r – 1) \times (c-1)$ degrees of freedom, where r and c are the numbers of rows and columns in the contingency table. An alpha of 0.05 was used when accessing statistical significance. My data met the primary assumptions of the chi-square test outlined by McHugh (2013):

- The level of measurement of all the variables is nominal or ordinal.
- The sample sizes of the study groups may be unequal.
- The categories for comparison are mutually exclusive.
- The expected values of the cells are five or more in at least 80% of the cells, and no cells have expected values of less than five.

Total Enrollment in Courses Across the Years

In general, enrollment behaviors for the two courses of interest increased across the two years (see Table 1). However, the changes in enrollment behaviors were not statistically significant when considering only differences in the relative enrollment behaviors across the 2 years: χ^2 (df = 1, N = 4,043) = .97, p < *n.s.*

Table 1

Absolute Differences in Enrollments: AP Statistics and AP Biology Courses

Variable	2016-2017	2020-2021	Difference
AP Statistics	820	1,080	260
AP Biology	892	1,251	359
Total	1,712	2,331	99

Note. AP = Advanced Placement.

Gender

Table 2 reflects the total population by gender of students enrolled in AP Statistics and AP Biology for 2016-2017 and 2020-2021. There was a change in the relative proportion of males to females across the two selected school years. In 2016-2017, there were more males (955; 56%) than females (757; 44%) enrolled in AP Statistics and AP Biology courses. However, in 2020-2021, the reverse was true: female participation (1,241; 53%) increased, and male participation (1,090; 47%) declined across these two courses. The change in enrollment behaviors for the gender groups across the two years was statistically significant: χ^2(df = 1, N = 4,043) = 32.14, p < .001.

Table 2

Gender Frequencies for 2016-2017 and 2020-2021 in AP Statistics and AP Biology

Gender	2016-2017		2020-2021	
	N	%	*N*	%
Female	757	44.2	1,241	53.2
Male	955	55.8	1,090	46.8
Total	1,712	100	2,331	100

Note. AP = Advanced Placement.

Ethnicity

Table 3 shows the distribution of enrollees by ethnic group for grades 9 to 12 in the 2016 and 2020 school years. The student population was quite diverse for both years. Most students (52%) are identified as Other, which the TEA identified as Asian, American Indian/Alaska Native, Multiracial, and Hawaiian/other Pacific. The following most populous groups were White (22%) and Hispanic/Latinx (22%), with African American students (4%) a noted minority (RQ1).

Table 3

Race/Ethnicity of Students Enrolled in 2016-2017 and 2020-2021 in AP Statistics and AP Biology (All Ethnic Classification)

Race/ethnicity	2016-2017		2020-2021	
	N	%	*N*	%
African American	64	3.7	81	3.5
Hispanic/Latinx	381	22.3	500	21.5
White	374	21.8	546	23.4
Other	893	52.2	1,204	51.7
Total	1,712	100	2,331	100

Note. AP = Advanced Placement.

However, because enrollment behavior among African American students was low, they were combined with the Hispanic/Latinx group (see Table 4) as these two groups are the focus of this study; White ethnicity was added to the Mixed group (see Table 4). The distribution of ethnic composition of the target courses did not differ significantly across the 2 years: χ^2 (df = 1, N = 4043) = .375, p < *n.s*.

Table 4

Race/Ethnicity of Students Enrolled in 2016 and 2020 in AP Statistics and AP Biology (Restricted to Two Groups)

Ethnicity	2016-2017	2020-2021

	N	%	*N*	%
Hispanic/African American	445	43.4	581	56.6
Mixed	1,267	42.0	1,750	58.0
Total	1,712	100	2,331	100

Note. AP = Advanced Placement.

SES

Table 5 presents the results for the SES of high school students enrolled in the AP Statistics and AP Biology classes in 2016 and 2020. Students labeled “yes” met specific criteria for being economically disadvantaged. Economically disadvantaged are identified with one or more of the following categories: (a) eligible for free meals under the National School Lunch And Child Nutrition Program; (b) eligible for reduced-price meals under the National School Lunch and Child Nutrition Program; (c) from a family with an annual income at or below the official federal poverty line; (d) eligible for Temporary Assistance to Needy Families or other public assistance; (e) received a Pell Grant or comparable state program of need-based financial assistance; (f) eligible for programs assisted under Title II of the Job Training Partnership Act; or (g) eligible for benefits under the Food Stamp Act of 1977 (TEA, 2021). Students labeled “no” did not meet the previous criteria for being economically disadvantaged. For both years, 23% of students enrolled in both AP Biology and AP Statistics courses were identified as economically disadvantaged. Thus, there was no difference related to SES for enrollment behaviors across the 2 years: χ^2 (*df* = 1, N = 4043) = .142, *p* < *n.s*.

Table 5

Socioeconomic Status of Students Enrolled in AP Statistics and AP Biology Courses

SES	2016-2017		2020-2021	
	N	%	*N*	%
Yes	389	22.7	518	22.2
No	1,323	77.3	1,813	77.8
Total	1,712	100	2,331	100

Note. SES = socioeconomic status; AP = Advanced Placement.

Research Question 2

RQ2 was, Does gender, race/ethnicity, and/or low SES predict relative differences in enrollment across STEM-related courses for 2016-2017 versus 2020-2021 among students enrolled in schools within a Texas regional service center since the implementation of HB5? I performed a binary logistic regression to evaluate predictors of possible enrollment differences between the two school years (2016 and 2020). Binary logistic regressions are appropriate when the dependent variable is categorical rather than continuous (Statistics Solutions, n.d.). As before, the predictors---gender, ethnicity, and SES---also were categorical variables.

The binary logistic regression analysis determined whether gender, race/ethnicity and/or lower SES predicted STEM course enrollment behaviors. I used a significance level of .05 in the binary logistic regression analysis. The results of the binary logistic regression are shown in Tables 6 and 7.

The omnibus test of model coefficients is called "goodness of fit." It implies if the level of significance is less than .05, there is some relevance between the dependent and independent variables. A test of the entire model was statistically significant, χ^2 (df = 3, N = 4043) = 33.182, $p < .001$. However, results of other evaluations of fit suggest that the results may not be practically significant. The Hosmer and Lemeshow Test is the most frequently used "fit" test in SPSS. The Hosmer and Lemeshow test results need to be greater than $p = .05$; if less than $p = .05$, it is a poor fit (Hosmer et al., 2013). The Hosmer and Lemeshow value for this analysis has a probability of < .001, which means the outcome was a poor fit and will not support the model.

The model summary explains the amount of variation in the dependent variable. Table 6 contains results from the Cox and Snell R^2, and Nagelkerke R^2, which explain variation in the dependent variable (STEM course enrollment behaviors) attributable to the predictor variables (gender, race/ethnicity, and/or lower SES). The Nagelkerke R^2 value of .011 indicated that the predictor variables in the model could explain only 1.1% probability of STEM course enrollment. In fact, the model correctly classified only 57.7% of the cases.

Table 6

Binary Logistics Regression Model Summary

Step	-2 log likelihood	Cox and Snell R^2	Nagelkerke R^2
1	5476.461 [a]	.008	.011

[a] Estimation terminated at iteration number 3 because parameter estimates change by less than .001.

The binary logistic regression is summarized in Table 7. There was a statistically significant reversal in the gender enrollment patterns across the 2 years: the proportion of females increased, while the proportion of males decreased from 2016 to 2020. Of the predictor variables, only gender (β = .693, p = <.001) was a statistically significant predictor of enrollment behaviors across the 2 years.

Table 7

Binary Logistics Regression Analysis Summary for Differences in Enrollments for AP Statistics and AP Biology Courses in 2016-2017 and 2020-2021

Variable	B	*SE*	β	*p*
Constant	.521	.093	1.7	<.001
Ethnicity	-.081	.088	.922	.360
Gender	-.367	.064	.693	< .001
SES	-.009	.087	.991	.922

Note. AP = Advanced Placement; SES = socioeconomic status.

Summary

This non-experimental quantitative research study aimed to explore if enrollment behaviors for AP Statistics and AP Biology changed significantly after the implementation of HB5. The increase in total enrollment figures for these courses for 2016 and 2020 was not statistically significant. However, when I compared the demographic characteristics of the students enrolled in these courses in the 2016-2017 and 2020-2021 school years, the only statistically significant demographic change was related to gender. There was a statistically significant increase in enrollment among female students and a statistically significant decrease in enrollment among males. By comparison, race/ethnicity and lower SES did not differ significantly among enrollees across the two years.

Chapter 4 presented a summary of the methods and results of statistical analyses of archival data to evaluate RQ1 and RQ2: were changes in enrollment behaviors for AP Statistics and AP Biology courses related to changes in the demographics of the enrolled students? The demographics of interest were gender, SES, and race/ethnicity. The school years for comparison were 2016-2017 and 2020-2021. This question is relevant because one goal of Texas' HB5 was to increase enrollment behaviors in STEM courses, especially among underrepresented demographic groups. Chapter 5 will discuss and evaluate the study and its findings concerning these educational goals supported by HB5. In addition, I will discuss the limitations of this research and recommendations for future research will be addressed.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The purpose of this nonexperimental correlational quantitative study was to determine if the school districts within a Texas regional service center region had been successful in increasing STEM course enrollment behaviors in advanced math and advanced science courses among African American, Latinx, female, and low-SES high school students since the passage of HB5 in 2013. To accomplish this purpose, I sought to answer two RQs to determine if there were absolute and relative changes in enrollment behaviors among advanced high school AP STEM courses for 2016–2017 versus 2020–2021 school years among students in various demographic groups. To analyze the data, I used multiple linear regression analysis and multiple logistic regression analysis. Based on the findings, I identified some notable characteristics in the trends in enrollment behaviors of students in one advanced mathematics and one advanced science course. I will address each characteristic one by one within this discussion.

Interpretation of the Findings

I viewed the results through the theoretical lens of stereotype threat theory (Steele & Aronson, 1995) and general systems theory (Bertalanffy, 1950). The stereotype threat theory explained course enrollment behaviors among underrepresented minority students and female participation in STEM course-taking. Stereotype threat can occur when underrepresented ethnic minorities and female adolescent students believe their ability to succeed in STEM careers is threatened by sociocultural barriers (Steele & Aronson, 1995). The general systems theory framework modeled how the HB5 policy worked within the educational system to support increasing STEM enrollment among underrepresented minorities and female students. In this context, education reform would provide context for the entire system, and student interest in STEM courses, administrators, and teachers would make up smaller subunits working together to increase participation in STEM. Applying general systems theory, HB5 would be an input into the educational system that interacts with the existing structures and affects STEM course enrollment behaviors as the outcome. As an input, the HB5 policy is predicted to interact with other education reform subparts to increase student interest in STEM course selections, impacting student enrollment behaviors in STEM. As shown in Table 1, general enrollments, not considering demographics, for the AP Statistics and AP Biology courses increased across the 2 years. However, the change in overall enrollment behaviors for these two years was not statistically significant.

Gender

There was a statistically significant increase in enrollment among female students but a decline among male students. The findings of this study differ from those of other current literature that female student populations express a significantly lower interest in taking advanced math and advanced science courses due to their competence perceptions (Brown & Leaper, 2010). My findings support other literature showing that increasing science-related self-efficacy among girls and women can increase their interest and persistence in STEM (Wang & Degol, 2017). My study’s findings also support Villa's (2021) study in which there was an increase in advanced course selections among female students. These findings for one region in Texas are a positive indicator of the potential to reduce gender disparity in postsecondary STEM majors. My results extend the research conducted by Card and Payne (2020) on course selection gender gaps. Card and Payne noted that the gap between male and female students with STEM course prerequisites was small. This study confirms Sadker and Sadker's (2012) findings that female students perceive their school environment to be an influence on their enrollment in advanced math and science courses. However, work is still necessary to increase interest and types of support for female students to cultivate and sustain interests in STEM learning.

Race/Ethnicity

The key findings related to the race/ethnicity predictor variable indicated that the distribution of ethnic composition of the target courses did not differ significantly across the two years. The overall enrollment of race/ethnicity seemed to increase by a tiny margin among African American and Latinx students in AP Statistics and AP Biology courses. However, the racial/ethnic gap among African Americans' enrollment behaviors in the advanced mathematics and science courses was still low after four years (refer to Table 3). The findings of this study are consistent with other current literature that has noted that disparities exist among African Americans and Latinx in educational attainment (Mau, 2016; Xie et al., 2015). Research shows that math and science identities are linked to success in how students perceive their advanced math and science course abilities (Gonzalez et al., 2020). A student may find it challenging to establish an academic identity that supports academic success if they do not believe they are capable of mathematics or if a student believes they are not math or science people (Gonzalez et al., 2020). Similar to previous reports (Fryer & Levitt, 2004; Jencks & Phillips, 1998;

Reardon, 2008), differences related to ethnicity continue as students enter the educational system, beginning with disparities in enrollment in low-level math and science courses (Kao & Thompson, 2003; Oakes, 1990). As Flores (2011) suggested, school curriculum, structural and cultural factors, and subtle discrimination are contributing factors that could impede student interest in STEM fields of study. As the percentage of different racial/ethnic groups across STEM occupations has not increased since the early 2000s, except for Asians, this suggests that more research is needed to determine what other factors are associated with an increased likelihood of minority students choosing a STEM major and pursuing a STEM field (National Science Foundation, 2018). Therefore, further investigation is necessary to understand other factors that may influence underrepresented populations' career choices and persistence in STEM, beginning with educational practices in grammar and middle school and including later stages of the educational journey. Further, these efforts should be focused on within academic communities and other external systems. These efforts should be based on appropriate educational theory and evidence-based research.

Socioeconomic Status

For both years, I identified 23% of students enrolled in AP Statistics and AP Biology as economically disadvantaged (see Table 5). The data relating to this demographic predictor variable indicated no difference across the two years. The results of this study support other reports (such as Chen, 2009) that family SES does not directly influence, and in some cases even works against, a person's desire to pursue a career in

STEM. Perhaps underprivileged adolescents see STEM education as a way to advance their social mobility (Ireland et al., 2018; Lee & Zhou, 2015; Xie & Goyette, 2003).

Further, the findings of this study disconfirm other research literature that has reported that students with higher SES parents are more likely to choose higher-level math and science coursework in high school and pursue an interest in STEM than students with parents from lower economic backgrounds (Eddy & Brownell, 2016; Villa, 2021; Wang & Degol, 2017). According to Ballard's (2018) research, there is a connection between the proportion of economically disadvantaged students enrolled in advanced math and science classes at a Virginia public high school and their enrollment in those courses. Another investigation revealed a relationship between moderate achievement gaps in science, parental education, and family income (Ballard, 2018). SES did not predict STEM result expectations positively (Turner et al., 2019). The main ways parental education and household income affected scientific achievement were through math and reading ability (Betancur et al., 2018). Additionally, they advocate for increased educational outreach to communities and students from economically disadvantaged groups emphasizing the benefits of STEM education and careers.

Overall Predictor Model

The standardized beta weight for the constant (year) was statistically significant (see Table 7). However, gender was the only statistically significant predictor across the two years. In sum, the overall results for predicting advanced math and advanced science course enrollment behaviors among females were the only significant predictor variable of changes across years.

Limitations of the Study

Data analyses included several restrictions. First, there is a possibility that information about the students who enrolled in STEM courses online or at a nearby community/university during their high school years to earn advanced high school course credits was left out of the study's data, which were based on student enrollment records for all the on-campus courses offered in Texas high schools. More research is required to examine middle school students' trends in course-taking or early high school course credit achievement to understand further the effects of middle school and early high school coursework on future performance in high school and college preparation.

Second, I did not assess enrollment changes in light of potential variations in school districts, class sizes, and academic performance. High school's effects on students' college readiness are not particularly significant (Schur, 2015). Still, more research is needed to compare potential differences in high enrollment patterns in STEM-related courses to understand the school dynamics that may affect students' choices.

Thirdly, I did not check student performance data; instead, I looked at course enrollment data because I was interested in high school students' interest in STEM-related courses and course-taking trends. The impact of STEM-related courses on students' college STEM enrollment can be investigated using a longitudinal project that gathers data on each student's performance in the courses and postsecondary status. Future studies could look into the direct effects of enrolling in STEM-related courses on students' performance in the future and their connection to the postsecondary STEM pipeline.

Fourth, although there are many STEM-related courses, this research mainly concentrated on advanced math (AP Statistics) and advanced science (AP Biology). Hence, more investigation is required into student enrollment patterns in other STEM-related courses and how those courses affect students' postsecondary endorsement and STEM performance.

Finally, the demographics of this study's participants---namely gender, race/ethnicity, and SES---provided a limited picture of students' interest in STEM fields at the high school level. SES did not predict STEM effectiveness but positively predicted STEM results in expectations (Turner et al., 2019). Future research should consider the significance of other variables, such as the influence of first-generation status and the parent's educational level. Additionally, they advocate for increased educational outreach to communities and students from economically disadvantaged groups emphasizing the benefits of STEM education and careers. According to a 2018 study, there is a negative association between the proportion of economically disadvantaged students enrolling in advanced math and science classes at a Virginia public high school and their SES revealed a relationship between moderate achievement gaps in science and parental education and family income (Ballard, 2018). The main ways parental education and household income affected scientific achievement were through math and reading ability (Betancur et al., 2018).

Recommendations

The results of this study could contribute to expanding state-level understanding of students' preference for STEM courses as we have been working for decades to increase routes for diverse students seeking STEM degrees (Long et al., 2012). Secondly, the data on student enrollment patterns in STEM courses, broken down by gender, race, ethnicity, and SES, can offer crucial information about what institutional K-12 adjustments would most influence the pipeline. As a result, this study can be used as a starting point for future research into the factors influencing students in the Texas regional service center areas' decision to enroll in STEM-related courses across racial, ethnic, gender, and socioeconomic lines.

Thirdly, according to the 2021 U.S. Census (United States Census Bureau, 2021), racial and ethnic diversity has increased with the proportion of minorities over White. Thus, there is a potential relevance to extend the consideration of these findings concerning other culturally diverse school districts, not only in Texas but across the country. As Texas is one of the largest states with a diverse demographic profile, the current status and issues of Texas education could be relevant to the student population in the nation's future.

Fourth, the results of this study will educate high school students, parents, teachers, counselors, policy makers, and administrators, as well as state policy makers, about the importance and need for adequate course preparation in high school, which will encourage and support students to succeed in STEM fields postsecondary. The findings of this study partially support Schur’s (2015) findings that HB5 has no impact on college readiness among high school students because there is no indication or impact that HB5 has increased STEM course enrollment behaviors by demographics: only enrollment increases among females in the selected STEM courses were observed.

This study's findings can support ways to address demographic disparities in STEM. Parents are cited as a source of strength and support in developmental and motivational theories for students' STEM motivating views (Starr et al., 2022). Parents can access information and services from school counselors about STEM courses, activities, and employment options. In recent research, parents said that more culturally sensitive communication from school counselors would be beneficial. They also said that counselors need to be aware of the systemic barriers that ethnic minority kids may encounter when pursuing STEM education (Oh et al., 2020).

In addition, it would be advisable to create a unique preparatory program for students to increase STEM diversity. Teachers can raise math and science proficiency among students through front-loading STEM enrichment options via early intervention, after-school STEM programming and coursework throughout elementary and middle school, tutoring possibilities, and family support. Students may also have the chance to share their personal experiences through career counseling.

The creation of STEM education initiatives that cater to the requirements of the African American and Latinx youth population may be influenced by identifying the difficulties and possibilities that these students face in their math and science education (Park-Taylor et al., 2022). Olszewski-Kubilius's study from 2022 demonstrated the value of these helpful possibilities, such as those created by partnerships between universities and school districts. There was an increase in the percentage of students entering high school enrolled in AP courses. The findings of another study by LaForce et al. (2019) set the stage for further research to examine inclusive STEM high school strategies that have reduced race/ethnicity and gender gaps in STEM courses. The positive implementation of specific strategies that inclusive STEM high schools implement can contribute to STEM outcomes across diverse populations, which can help reduce the disparities among African American and Latinx and female students. Districts and government officials can invest in programs that encourage a “STEM for all” approach and provide financial resources to minority students can help meet the needs to diversify STEM course enrollment behaviors in high school.

Promoting integrated STEM and science education throughout k–12 schools frequently increase involvement and equity (Peters-Burton & Knight, 2022). Teacher preparation initiatives and support in integrating STEM coursework may help increase STEM course enrollment among underrepresented minority students. More research is required since there is a shortage of literature on STEM teacher training and professional development specifically designed to influence teachers' consideration of equity or diversity in the classroom. These integration elements may provide an equitable classroom using cognitive apprenticeships, authentic contexts, real-world problem-solving, and modeling practices. Therefore, the results of this study have a broader impact and can inform career counselors and university recruitment efforts to tailor their messaging to students' behavior regarding course selections.

Implications

The conclusions drawn from the study potentially have significant implications for positive social change in education. The results of this study may help educators and policy makers understand the effects of HB5 on students' course choices and interest in

STEM. The results of this study can also inform district leaders about other initiatives that would potentially attract more African American, Latinx, and female students to pursue an interest in STEM areas. The study's results demonstrated that work is still needed to increase underrepresented minorities and female participation in STEM. This study also advances the knowledge in STEM education because it can inform policy makers, teachers, and administrators to implement active learning experiences before high school to increase science literacy among underrepresented minority students, arguing that pre-exposure would increase the likelihood of students pursuing an interest in STEM.

Conclusion

The key findings for this non-experimental quantitative comparative design study revealed that following the passage of HB5 in 2013, new initiatives have resulted in a significant increase in female enrollment in advanced science and math courses, relative to a decrease in male enrollment. However, there were no significant differences in enrollments among SES or ethnicity groups.

America's and the world's economies now look very different (National Science Foundation, 2021). As a result, greater focus must be placed on fostering students' interest in STEM and math-intensive occupations for the United States to contribute to meeting the worldwide demand for professionals in these disciplines (Wang & Degol, 2017). For secondary students to become more aware of and remain interested in STEM, significant national and state-level measures are still required (Dejarnette, 2012). Yet, more should be done to address this issue earlier in students' educational attainment because girls and minorities are underrepresented in STEM fields.

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Appendix: House Bill 5

The following is an excerpt of the Texas House and Senate versions of House Bill 5 (Texas Leg., 2013):

House Bill 5
Senate Amendments
Section-by-Section Analysis

HOUSE VERSION

SECTION 15. (a) Section 28.025, Education Code, is amended by amending Subsections (a), (b), (b-1), (b-2), (b-3), (b-4), (b-5), (b-7), (b-9), (b-10), (b-11), and (e) and adding Subsections (b-12), (b-13), (b-14), (b-15), (b-16), (b-17), (b-18), (c-1), (c-2), (c-3), (e-1), (e-2), (e-3), (h), and (h-1) to read as follows:

(a) The State Board of Education by rule shall determine curriculum requirements for the foundation [~~minimum, recommended, and advanced~~] high school program [~~programs~~] that are consistent with the required curriculum under Section 28.002. The [~~Subject to Subsection (b-1), the~~] State Board of Education shall designate the specific courses in the foundation curriculum under Section 28.002(a)(1) required under [~~for a student participating in~~] the foundation [~~minimum, recommended, or advanced~~] high school program. Except as provided by this section [~~Subsection (b-1)~~], the State Board of Education may not designate a specific course or a specific number of credits in the enrichment curriculum as requirements for the [~~recommended~~] program.

(b) A school district shall ensure that each student enrolls in the courses necessary to complete the curriculum requirements identified by the State Board of Education under Subsection (a) for the foundation [~~recommended or advanced~~] high school program and the courses necessary to complete the curriculum requirements established under Subsection (b-14) for the distinguished level of achievement under the foundation high school program, unless the student and the student's parent or legal guardian:

(1) are provided with the information required to be provided under Section 33.007(b) in a language in which the parent or legal guardian is proficient, or the information is conveyed to

SENATE VERSION (IE)

SECTION 12. (a) Section 28.025, Education Code, is amended by amending Subsections (a), (b), (b-1), (b-2), (b-4), (b-5), (b-7), (b-9), (b-10), (b-11), and (e) and adding Subsections (b-12), (b-13), (c-1), (c-2), (c-3), (c-4), (h), and (h-1) to read as follows: [FA4(1)]

(a) The State Board of Education by rule shall determine curriculum requirements for the foundation [~~minimum, recommended, and advanced~~] high school program [~~programs~~] that are consistent with the required curriculum under Section 28.002. The [~~Subject to Subsection (b-1), the~~] State Board of Education shall designate the specific courses in the foundation curriculum under Section 28.002(a)(1) required under [~~for a student participating in~~] the foundation [~~minimum, recommended, or advanced~~] high school program. Except as otherwise provided by this section [~~Subsection (b-1)~~], the State Board of Education may not designate a specific course or a specific number of credits in the enrichment curriculum as requirements for the foundation high school [~~recommended~~] program.

(b) A school district shall ensure that each student, on entering ninth grade, indicates in writing an endorsement under Subsection (c-1) that the student intends to earn. A district shall permit a student to choose, at any time, to earn an endorsement other than the endorsement the student previously indicated. A student may graduate under the foundation high school program without earning an endorsement if, after the student's sophomore year: [FA17]

(1) the student and the student's parent or person standing in parental relation to the student are advised by a school counselor of the specific benefits of graduating from high

HOUSE VERSION	SENATE VERSION (IE)
(4) arts and humanities, which includes courses directly related to political science, world languages, cultural studies, English literature, history, and fine arts; and	(2) an academic achievement in arts and humanities endorsement by earning: (A) one additional credit in mathematics, which must be an Algebra II credit if an Algebra II credit is not used to satisfy the curriculum requirements for the foundation high school program; (B) one additional credit in social studies; and (C) one additional credit in fine arts or one credit in career and technology education or technology applications; [FA14(6)]
(5) multidisciplinary studies, which allows a student to select courses from the curriculum of each endorsement area described by Subdivisions (1) through (4).	(4) a distinguished achievement endorsement by: (A) successfully completing English III and Algebra II courses and achieving a scale score on an advanced placement test, an international baccalaureate examination, the SAT, an SAT Subject Test, the ACT, or another nationally recognized assessment instrument, not including an end-of-course assessment instrument under Section 39.023(c), that indicates readiness to enroll in an institution of higher education, as determined by the commissioner; and (B) earning: (i) one additional credit in mathematics, including Algebra II; (ii) one additional credit in science; (iii) one additional credit in social studies; and (iv) one additional credit in the same language in a language other than English in which the student earned two credits for purposes of Subsection (b-1)(5). [FA27(2)]
(c-2) In adopting rules under Subsection (c-1), the State Board of Education shall: (1) require a student in order to earn any endorsement to successfully complete four credits in mathematics, which must include: (A) the courses described by Subsection (b-1)(2); and (B) an additional advanced mathematics course authorized	(c-2) The State Board of Education shall designate the specific courses required for an endorsement under Subsection (c-1) for courses included in the foundation curriculum under Section 28.002(a)(1).