International Journal on New Trends in Education and Their Implications
January 2015 Volume: 6 Issue: 1 Article: 18 ISSN 1309-6249

STEM SCHOOLS VS. NON-STEM SCHOOLS: COMPARING STUDENTS' MATHEMATICS GROWTH RATE ON HIGH-STAKES TEST PERFORMANCE

Ali BICER
Texas A&M University
College Station, TX- USA

Bilgin NAVRUZ
Texas A&M University
College Station, TX- USA

Prof. Dr. Robert M. CAPRARO
Department of Teaching, Learning
and Culture, Texas A&M University
College Station, TX- USA

Assoc. Prof. Dr. Mary M. CAPRARO
Department of Teaching, Learning
and Culture
Texas A&M University
College Station, TX- USA

Tugba ONER
Texas A&M University
College Station, TX- USA

Peter BOEDEKER
Texas A&M University
College Station, TX- USA

ABSTRACT

The purpose of this study is to determine how students who attended T-STEM academies performed on the mathematics section of the Texas Assessment of Knowledge and Skills (TAKS) compared to their corresponding peers who attended traditional public schools in Texas. The present study included 18 T-STEM academies and 18 matched non-STEM schools. The sample consisted of three years of TAKS mathematics data for 3026 students, of which 1506 attended 18 T-STEM academies and 1520 attended 18 non-STEM schools in Texas. Hierarchical linear modeling (HLM) was used to construct a three-level model for analysis. Results revealed that at the end of grade 9, students who attended T-STEM academies performed higher in mathematics compared to their counterparts in comparison schools, but no difference was found in their mean mathematics score's growth rate from 2009 to 2011. In terms of gender, the present study found that female students who attended T-STEM academies performed higher on TAKS mathematics than male students in comparison schools.

Key Words: STEM, T-STEM academies, Inclusive STEM schools, TAKS, TEA.

INTRODUCTION

STEM education refers to teaching and learning in the disciplines of science, technology, engineering, and mathematics. Quality STEM education is critical for a country to be scientifically and technologically relevant. The two foremost reasons why STEM education in K-12 is critical are that today's world requires every individual to understand scientific and technological knowledge (National Research Council [NRC], 2011; Young, House, Wang, Singleton, SRI, International, & Klopfestein, 2011) and that the successes in STEM disciplines play a vital role for a country's future in the competitive global market (President's Council of Advisor on Science and Technology, 2010). Several reports, including those by the National Academy of Science, National Academy of Engineering, and Institute of Medicine (2011a), have already linked the importance of K-12 STEM education to the ability of the United States to maintain its current scientific leadership and economic power. Barack Obama, in response to this fact, has launch the *Educate and Innovate* program to cultivate STEM literacy in K-12 education and increase student interest in STEM related majors. The program focuses on K-12 education because those years are vitally important in developing students' interest in one of the STEM related subjects (Buxton, 2001). Increasing K-12 students' interest in STEM related disciplines is essential for encouraging more students to pursue STEM career pathways in postsecondary education settings. It is imperative that these formative years emphasize STEM success for the entire student population. To achieve this, the United States needs STEM schools that all students can attend regardless of their academic and social background (Bicer, Navruz, Capraro, & Capraro, 2014; Han, Capraro, & Capraro, 2014). This led to the development of specialized STEM school initiatives (Navruz, Erdogan, Bicer, Capraro, & Capraro, 2014; Thomos & Williams, 2009), which have already showed promising effects in increasing students' science and mathematics achievement (Capraro, Capraro, Morgan, Scheurich, Jones, Huggins, Corlu, & Younes, 2014; Young et al., 2011).

Concerns & Goals for STEM education

The National Assessment of Educational Progress (NAEP) showed that U.S. students were not proficient in mathematics and science (Schmidt, 2011). Additionally, international indicators (e.g., TIMMS and PISA) have showed that students from the United States did not perform well in mathematics and science compared to students in other developed countries (e.g., Singapore), thus putting their scientific leadership and economic power in danger. This result is one of the main reasons why the United States is concerned about STEM education in K-12 and why the first goal is to increase all students' success in STEM related disciplines.

Another concern is the size of the mathematics and science achievement gaps between students who come from a traditionally upper class background and those students who come from diverse ethnic and low socioeconomic status (SES) backgrounds. This achievement gap puts young people at a disadvantage when seeking employment because many of the high paying jobs require a high level of STEM related proficiency. Additionally, the domestic need for a workforce in STEM associated fields increased rapidly from 2008 to 2009, indicating that there are positions available for those who qualify. Thus, the second goal for K-12 STEM education is to "Expand the STEM-capable workforce and broaden the participation of women and minorities in that workforce" (NRC, 2011, p. 5). Achieving this goal would increase the available workforce for a rapidly expanding job market.

The National Science Foundation (2010) reported that while the unemployment rate from 2008 to 2009 increased 3.8%, the needs of the workforce in STEM associated jobs increased by 3.3%. In the next decade, it is projected that there will be 20 new occupations, of which 80% will be related to STEM fields. While 5% of these occupations will require an advanced STEM degree, 75% of them will require solely vocational certification or an undergraduate degree with a major in a STEM associated field (Lacey & Wright, 2009). In order to fill the rapidly increasing STEM workforce, more and more K-12 STEM students need to pursue STEM related majors in their post-secondary education and later follow STEM related career pathways.

The last concern is the 21st century's increasing scientific and technological demands that require every individual to know basic science and mathematics. In the past, science and mathematics were considered the disciplines for talented people (Stotts, 2011), but today's world requires each individual to know basic scientific, mathematical, and technological knowledge. Thus, the last and most important goal for STEM education, increasing STEM literacy for all students regardless of whether they pursue a STEM related career pathway, is vital (NRC, 2011). Achieving this goal is strategically important because current employers in various industries have complained of their employees' lack of mathematics, technology, and problem-solving skills. Increasing STEM literacy for all students, not just those who follow STEM related career pathways in their postsecondary education, will make future citizens capable of dealing with the complex problems of a scientifically and technologically driven 21st century society (NRC, 2011).

STEM Schools

STEM schools are designed to decrease the mathematics and science achievement gaps among various ethnic groups and to increase all K-12 students' mathematics and science scores on both national and international standardized tests (Bicer, Navruz, Capraro, & Capraro, 2014; Capraro, Capraro, & Lewis 2013; Capraro, Capraro, & Morgan, 2013). There are three types of STEM schools: selective STEM schools, inclusive (i.e., open-admission) STEM schools, and schools with STEM-focused career and technical education (CTE). Selective and inclusive STEM schools are the two most common STEM schools across the Unites States (NRC, 2011). The curriculum for selective and inclusive STEM schools was designed to improve students' science and mathematics learning by engaging students with hands-on tasks in a collaborative and competitive environment (Gonzalez & Kuenzi, 2012). There are some differences between these two types of STEM schools in terms of their organization. The clearest distinction between selective STEM schools and inclusive STEM schools is the admission criteria. Selective STEM schools admit only students who are talented in and motivated toward STEM related fields while inclusive STEM schools have no selective admission criteria. Because of the difference between admission criteria of the two STEM school types, inclusive STEM schools are considered to serve a broader population (NRC, 2011). Young, House, Wang, and Singleton (2011) noted that "Inclusive STEM schools are predicated on the dual promises that math and science competencies can be developed, and students from traditionally underrepresented populations need access to opportunity to develop these competencies to become full participants in areas of economic growth and prosperity" (p. 2). Therefore, inclusive STEM schools utilize a unique school structure to achieve the three goals stated by NRC (2011) for K-12 STEM education. In the present study, we only included inclusive STEM schools, which were compared with non-STEM schools.

In this study, STEM schools were selected from the state of Texas because it has one of the biggest inclusive STEM school initiatives in the United States. STEM schools in the state of Texas are known as Texas STEM (T-STEM) academies. T-STEM academies are defined by a unique "blueprint" that differentiates it from non-STEM schools. One important characteristic of the "blueprint" is the implementation of innovative instructional methods such as Project-Based Learning, Inquiry Based Learning, and Problem Based Learning. T-STEM academies are also well equipped with labs to facilitate the adoption and utilization of these innovative instructional methods. The blueprint requires that all T-STEM academies are inclusive and cannot be selective at the time of enrollment. In addition, the blueprint specifies that each T-STEM academy needs to comprise of at least 50% of students who are economically disadvantaged and at least 50% of students who come from traditionally underrepresented subpopulations (Young et al., 2011). Six T-STEM academies started serving students in 2006, and the number of T-STEM academies expanded from 2006 to 2014. Currently, there are 65 T-STEM academies (26 campuses for only high school students and 39 campuses for both middle and high school students) serving approximately 35,000 students in Texas. T-STEM academies were divided into groups based on their region, and each region is lead by a T-STEM center. T-STEM centers have the role of supporting T-STEM academies by creating innovative STEM instructional materials and providing effective professional development to teachers. There are seven T-STEM centers that support more than 2,800 STEM related teachers by empowering their teaching in STEM related subjects (Texas Education Agency, 2013). Besides creating innovative science and mathematics classrooms and delivering professional development to teachers, these educational centers were charged with a) researching innovative STEM curricula; and b) creating partnerships among businesses, universities, and school districts. T-STEM academies, along with professional development centers and networks, work collaboratively to increase the quality of instruction and students' academic performance in STEM-related subjects at secondary schools.

T-STEM Academies' Promising Effects

Researchers conducted both qualitative and quantitative studies to explore the effects of attending T-STEM academies on students' science, reading, social science, and mathematics achievement (Capraro et al. 2013; Gourgey et al., 2009; Stotts, 2011; Young et al., 2011). The qualitative (Gourgey et al., 2009) and quantitative studies (Capraro et al. 2013; Stotts, 2011; Young et al., 2011) regarding T-STEM academies indicated promising effects of T-STEM academies on students' academic achievement.

To determine if the positive effects of attending T-STEM academies on students' academic achievement continues, a longitudinal method was used (Capraro et al. 2013; Young et al., 2011). Applying a longitudinal method enables researchers to characterize patterns of change in students' scores over time, which includes both the average trajectory and the variability of each student's trajectories. To compare students' academic achievement in terms of their school types (T-STEM academies and non-STEM schools [traditional public schools]), researchers applied various comparison techniques, such as exact matching or propensity score matching. Results from these studies indicated that students who were in grade 9 in T-STEM academies achieved slightly higher mathematics scores than their peers in the comparison schools. Similarly, results showed that students who were in grade 10 in T-STEM academies received higher mathematics and science scores than their peers in the comparison schools. These findings showed a difference favoring T-STEM academies, but the Cohen's *d* effect size reported ranged from 0.35 to 2.03. Results also noted that students who were in grade 9 and attended T-STEM academies were 1.8 times more likely to meet the benchmarks of TAKS reading and mathematics than their counterparts in comparison schools. Likewise, students who were in grade 10 and attended T-STEM academies were 1.5 times more likely to meet the benchmarks of TAKS reading, mathematics, social science, and science than their counterparts in comparison schools (Young et al., 2011).

In another attempt to characterize students' academic patterns of change over time in T-STEM academies (Gourney et al., 2009), students who were in grade 10 and participated in T-STEM academies increased their mathematics and reading high-stakes test results compared to their corresponding scores in grade 9. Students who were in grade 10 and came from low-SES backgrounds increased their mathematics scores compared to their mathematics scores in grade 9. In terms of ethnic background, Hispanic students who were in grade 10 showed the largest increase within any of the ethnic groups in their mathematics scores compared to their mathematics scores at grade 9. Likewise, Bicer (2014) found that attending T-STEM academies statistically significantly increased Hispanic students' mathematics mean score relative to White students' mathematics scores in non-STEM schools. Navruz, Erdogan, Bicer, Capraro, and Capraro (2014) conducted a study to understand how students' TAKS mathematics scores changed after their school converted to inclusive STEM high schools. Results from this study revealed that students had a statistically significant increase on their mathematics scores after their school adopted and implemented STEM curriculum and instruction. This study also examined the effects of adopting STEM curriculum on females and males. Evidence from this study showed that "both genders experienced practically important changes" (p. 67).

Researchers mostly focused on students' test scores to compare the success of T-STEM academies compared to matched schools; however, NRC (2011) noted that students' test scores do not tell the whole story of success. In response, researchers also examined the relationship between school types (T-STEM and non-STEM) and dropout rate as a measure of success. Results revealed that students who attended T-STEM academies are 0.8 times less likely to be absent from school than their peers in comparison schools (Young et al., 2011; cf. Capraro et al. 2014). Students who attended T-STEM academies were more comfortable with STEM related disciplines and more likely to pursue a college degree, and more female students took advanced placement (AP) courses (Stotts, 2011). Another important finding revealed that one of the high schools changed its rating from Academically Unacceptable to Academically Acceptable as a result of students' academic achievement scores on high-stakes tests and demographic groups. After schools became T-STEM academies, more students enrolled in college level courses than when their schools were non-STEM schools (Stotts, 2011). The STEM academies were more successful across a wide range of variables including test scores, attitude, truancy, and college matriculation.

The present study applied a longitudinal method to track students' mathematics success between the years of 2009 and 2011. Researchers have already applied a longitudinal method to characterize students' success between the years of 2007 and 2009 (Young et al., 2011). However, these studies were conducted in the earlier stage of newly established T-STEM academies. Therefore, the present study involved only schools that turned into T-STEM academies before the 2008-2009 school years. This constraint ensures that the schools have had adequate time to implement STEM-specific curriculum and teaching to show promising effects on students' mathematics achievement.

Research Questions

1) How does initial student mathematics performance differ by school type?
2) What are the mathematical benefits for students who attend T-STEM academies for three years as compared to their non-STEM counterparts?

METHOD

In this quantitative research project, student and school-level data about students who attended inclusive stand-alone T-STEM academies, as well as matched students who attended non-STEM high schools, were obtained from the Texas Education Agency (TEA) website. This statewide analysis was based upon 36 schools, of which 18 were T-STEM academies and 18 were matched non- STEM (traditional public) schools. In this study, only 18 of the 65 T-STEM academies were selected because of the selection criteria of becoming an inclusive T-STEM school on or before the 2008-2009 school year and because of the designation of the academy whether stand-alone or school-within-school. In stand-alone academies, the entire school is a STEM school, meaning that 100% of the students attending the school are members of the STEM program. A school-within-school is a different dynamic in which STEM is a program available within a traditional school setting, meaning that not all students that attend the school are necessarily engaged in the STEM program. Thus, the present study included students who attended stand-alone T-STEM academies for at least three years. The sample consisted of three years of Texas Assessment of Knowledge and Skills (TAKS) mathematics data for 3026 students, of whom 1506 attended 18 T-STEM academies and 1520 attended 18 non-STEM schools in Texas. The first measurement for the sample was taken when students were at the end of 9th grade in 2009, and the last measurement for the same students was taken when they were at the end of 11th grade in 2011.

In order to match students who attended 18 T-STEM academies with their corresponding peers who attended 18 non-STEM schools, school-level data was first matched by following the TEA campus comparison method. This comparison is based upon the following school-level variables: 1) ethnicity (% of Hispanic, % of African American, and % of White students), 2) economic disadvantaged status (free lunch, reduced price lunch, other public assistance, and none), 3) English language proficiency (ELP) (met the English language proficiency state standard and did not meet the English Language proficiency standard), and 4) school mobility rate (expressed as a ratio of the whole school population to students moving into and out of the school in one year). T-STEM academies and non-T-STEM schools were matched with a 1:1 exact matching strategy using the following: ethnicity, SES, ELP, and school mobility rate.

Students were excluded from the study if they did not have any mathematics TAKS scores in any of the measurement years 2009, 2010, or 2011. Students were also excluded if they: (1) left a T-STEM school and transferred into a non-STEM school, or (2) transferred into a T-STEM school from a non-STEM school. These exclusions ensured that the students who attended STEM academies received at least three years of STEM education during their high school years.

In this study, students' mathematics TAKS scale scores were used as an outcome estimate of students' mathematics achievement. A student's mathematics TAKS score at the end of 9th grade was modeled as the estimated initial mathematics achievement plus the change over time, that is, the rate of change, (π_{1jk}), plus error. Additionally, students' gender, ethnicity, and SES background were further added to the model in order to estimate each group's (gender, ethnicity, and SES) initial status and growth rate in mathematics. Further, students' school type was added as the last predictor to the model in order to estimate students' initial status and growth rate in terms of their school types (i.e., STEM or non-STEM).

HLM Analytic Procedures

Hierarchical linear modeling (HLM) was used to construct a three-level model for analysis. Level-1 was the repeated measures, which were nested within students. Level-2 was the students who were further nested within school types. Level-3 was the school types (STEM and non-STEM). This three-level model was used in the present study to characterize patterns of change in students' measures over time, which included both the average trajectory and the variability of students' trajectories. This technique also allowed the simultaneous estimation of between-schools variables (STEM schools and non-STEM schools), within-school level variables (ethnicity, gender, and SES), and the variances of students' repeated measures. A series of model fit indices were estimated by using HLM software, and this procedure resulted in the best model (see Table 1) with specific student and school-level variables. First, students' 9th grade mathematics TAKS scale scores were added as an outcome. Second, based on a theoretical and empirical consideration reported by NRC (2011), each student-level variable (ethnicity, gender, and SES) was added one at a time to the model and evaluated for statistical significance. The same procedure was followed for the school-level predictor, and its effects were also evaluated for statistical significance. The slopes of student-and school-level variables were "fixed" and not allowed to randomly vary if random effects of these variables were not statistically significant in improving the model fitness. The indices of model fitness were based on a Chi-square test, in which deviations' scores and degrees of freedom (*df*) provided by HLM software were subtracted from each other to determine whether the slope of the variables had random or fixed effects.

RESULTS

To examine the differences in mathematics achievement at the end of grade 9, and the growth rate of mathematics achievement from grade 9 to grade 11, a three-level growth model in HLM software was conducted. To address the two research questions, the results section addresses aspects of the questions across two sections: 1) differences in mathematics achievement at the end of grade 9, and 2) differences in growth rate of mathematics achievement from grade 9 to grade 11.

Differences in Mathematics Scores at the end of Grade 9

The results indicated statistically significant differences in students' mathematics achievement at grade 9 for all independent Level-2 variables. In addition, the interaction effects between 'STEM9' and 'Gender' were found statistically significant at $p < 0.05$. Table 1 illustrates 9th graders' mathematics achievement relative to the mathematics achievement of our reference group (WHITE, male, high-SES students in non-STEM schools).

The predicted mean math achievement of our reference baseline group at the end of 9th grade (γ_{000} = 2265.551923) was statistically significant at $p < 0.01$. The difference between T-STEM academies and non-STEM schools ($\boldsymbol{\gamma_{001}}$ = 102.139905) was statistically significant at $p < .01$, which indicates that students in T-STEM academies have higher mathematics scores than students in non-STEM schools at the end of 9th grade controlling for ethnicity, gender, and SES.

We were also concerned about the impact of school types on students' mathematics achievement by students' ethnic background. Results showed that the effect of being Hispanic on students' predicted mean mathematics score relative to White students' predicted mean mathematics score ($\boldsymbol{\gamma_{010}}$ = -96.532630) was statistically significant, $p < .001$. It showed there was a statistically significant difference between Hispanic and White students in terms of their predicted mean mathematics score at the end of grade 9 controlling for SES, gender, and school type. In other words, at the end of grade 9, White students' predicted mean mathematics TAKS score was higher than Hispanic students' predicted mean mathematics TAKS score. Similarly, African American students' predicted mean mathematics score relative to the White students' predicated mean score ($\boldsymbol{\gamma_{020}}$ = -173.758141) was also statistically significantly different ($p < 0.01$). In other words, there is a difference between African American students' mathematics achievement and White students' mathematics achievement at the end of grade 9 controlling for gender, SES, and school type. At the end of grade 9, White students achieved higher mathematics scores than African American students' mathematics score.

Table 1: Final Estimation of Fixed Effects

Fixed Effect	Coefficient	Standard error	*t*-ratio	Approx. *d.f.*	*p*-value
For INTRCPT1, π_0					
For INTRCPT2, β_{00}					
INTRCPT3, γ_{000}	2265.551923	16.564143	136.774	34	<0.001
STEM9, γ_{001}	102.139905	22.540964	4.531	34	<0.001
For H, β_{01}					
INTRCPT3, γ_{010}	-96.532630	14.333986	-6.735	3025	<0.001
For B, β_{02}					
INTRCPT3, γ_{020}	-173.758141	16.156283	-10.755	3025	<0.001
For FEMALE, β_{03}					
INTRCPT3, γ_{030}	22.848168	8.735190	2.616	3025	0.009
STEM9, γ_{031}	-48.234222	16.621230	-2.902	3025	0.004
For SES, β_{04}					
INTRCPT3, γ_{040}	-49.574607	13.986314	-3.545	3025	<0.001
STEM9, γ_{041}	31.177788	15.587501	2.000	3025	0.046

Because females continue to be underrepresented in STEM fields, we were also interested in how the students in T-STEM academies and non-STEM schools compared by gender. The effect for gender on students' predicted mean mathematics score (γ_{030} = 22.85) was statistically significant at $p < 0.01$, which indicated that there was a difference between female and male students at grade 9 controlling for ethnicity, SES, and school type. At the end of grade 9, female students achieved higher mathematics scores than did male students. Additionally, the interaction effect of 'FEMALE' and 'STEM9' as FEMALE*STEM9 (γ_{031} =-48.23) was statistically significant, $p < 0.01$, which showed that there was a statistically significant difference between female students in T-STEM academies and male students in non-STEM schools in terms of their mathematics scores at grade 9 controlling for ethnicity and SES. Male students in non-STEM schools achieved higher mathematics scores than female students in T-STEM academies, controlling for ethnicity and SES.

When it came to SES, the effect of SES on students' mathematics achievement (γ_{040} = -49.574607) was statistically significant, $p < 0.01$, which illustrated that there was a difference between low-and high-SES students on math achievement at grade 9 controlling for gender, ethnicity, and school type. At the end of grade 9, high-SES students achieved higher mathematics scores than low-SES students controlling for gender, ethnicity, and school type. However, the interaction effect as 'SES*STEM9' (γ_{041} = 31.18) was also statistically significant, $p < 0.05$. It showed that there was a statistically significant difference between low-SES students in T-STEM academies and high-SES students in non-STEM schools in terms of their mathematics scores at grade 9 controlling for gender and ethnicity. At grade 9, low-SES students in T-STEM academies achieved higher mathematics scores than high-SES students in non-STEM schools controlling for gender and ethnicity.

Differences in the Growth Rate of Mathematics Achievement

Results indicated statistically significant differences in the growth rate of math achievement for all independent Level-2 variables. In addition, the interaction effect of 'STEM9' and 'FEMALE, was found to be statistically significant at $p < .01$. The findings related to the differences in the mathematics scores' growth represented in Table 2.

The average annual growth rate of mathematics achievement for our reference group (WHITE, male, high-SES students in non-STEM schools) (γ_{100} = 25.97, $p < 0.01$) showed an increase of 25.97 points per year. The change per year was statistically significantly different from 0. In addition, the effect of time*STEM9 (γ_{101} =-23.30) was statistically significant at $p < 0.01$, which showed there was a statistically significant difference between students in T-STEM academies and non-STEM schools in terms of their growth in mathematics scores controlling for gender, ethnicity, and SES. Results showed that the growth rate of students' mathematics scores in non-STEM schools was higher than that of students in T-STEM academies controlling for gender, ethnicity, and SES.

Table 2: Final Estimation of Fixed Effects

Fixed Effect	Coefficient	Standard error	*t*-ratio	Approx. *d.f.*	*p*-value
For TIME slope, π_1					
For INTRCPT2, β_{10}					
INTRCPT3, γ_{100}	25.968299	5.048436	5.144	34	<0.001
STEM9, γ_{101}	-12.082513	11.739254	-1.029	34	0.311
For H, β_{11}					
INTRCPT3, γ_{110}	10.106036	3.467278	2.915	3025	0.004
For B, β_{12}					
INTRCPT3, γ_{120}	20.520762	3.194384	6.424	3025	<0.001
For FEMALE, β_{13}					
INTRCPT3, γ_{130}	-9.035162	2.190104	-4.125	3025	<0.001
STEM9, γ_{131}	14.840486	5.454409	2.721	3025	0.007
For SES, β_{14}					
INTRCPT3, γ_{140}	6.574822	2.571577	2.557	3025	0.011

From Table 2, the average annual growth rate of math achievement for Hispanic students ($\boldsymbol{\gamma_{120}}$ =10.11) showed that it increased 10.11 points per year, $p < 0.01$. The change per year was statistically significantly different from 0. The average annual growth rate of mathematics achievement for African American students ($\boldsymbol{\gamma_{120}}$ =20.52) increased 20.52 points per year, $p < 0.01$. The change per year was statistically significantly different from 0.

The average annual growth rate for mathematics achievement for female students controlling for SES, ethnicity, and school type ($\boldsymbol{\gamma_{130}}$ =-9.03) showed that the growth rate of mathematics achievement decreased 9.03 per year, $p < 0.01$. The change per year was statistically significantly different from 0. We also have the interaction effect of female*STEM9 ($\boldsymbol{\gamma_{131}}$ =14.84) that was statistically significant, $p < 0.01$, which indicated that there was a statistically significant difference between female students in T-STEM academies and male students in non-STEM schools in terms of the rate of change in math achievement controlling for ethnicity and SES. Female students in T-STEM academies had a higher mathematics growth rate than did male students in non-STEM schools. Lastly, the average annual growth rate of mathematics achievement for low-SES students controlling for gender, ethnicity, and school type ($\boldsymbol{\gamma_{130}}$ = 6.57) was statistically significant, $p < 0.01$, showing that the growth rate of mathematics achievement decreased 6.57 per year, $p < 0.05$.

DISCUSSION

The objective of the present study is to examine how students who attended T-STEM academies performed on TAKS mathematics in 2009 and how their TAKS mathematics performance changed from 2009 to 2011 compared to their counterparts in comparison schools. To the best of our knowledge, this study is unique in terms of T-STEM school selection. The present study only included schools that had transitioned to T-STEM academies prior to the 2008-2009 school year. This ensured that students who attended these schools received at least three years of a STEM emphasized education. This criterion also makes sure that schools that turned into T-STEM academies have had sufficient time to fully implement STEM teaching and learning practices to show their effects on students' mathematics achievement. Three years is considered sufficient time because NRC (2011) reported that T-STEM academies showed their effects on students' academic achievement in three years.

Looking at the results, findings indicated that our reference group's (White, male, high-SES in non-STEM schools) predicted mean TAKS mathematics score was significantly lower than students' predicted mean TAKS mathematics score in T-STEM academies at the end of grade 9. This finding is consistent with prior work by Young et al. (2011), which found that students who attended T-STEM academies performed higher on TAKS mathematics than their counterparts in comparison schools at grade 9. This might be explained by the fact that mathematics classrooms in most public-traditional schools focused on either teaching the theoretical background of mathematics or teaching procedural mathematics (Stotts, 2011). Thus, students' mathematics learning in non-STEM schools may become more rote memorization than meaningful learning, and students may have difficulty applying previously learned mathematical facts to new mathematical topics. In order for students to learn mathematics more meaningfully, they need to develop both conceptual and procedural understanding of mathematical facts (Ashlock, 2005), but for some students this cannot be achieved without scaffolding. In terms of school types, students' mathematics scores are statistically significantly different in favor of T-STEM academies. T-STEM academies' mathematics instruction might be one potential cause of this achievement difference. From this result, it is possible to deduce that T-STEM academies fulfill their duty, which is to improve students' mathematics and science scores, in terms of mathematics. It might be better for non-STEM schools to adopt STEM learning and teaching practices in mathematics classrooms to increase their students' mathematics learning. STEM practices (i.e., Project Based Learning [PBL], and Problem Based Learning) in T-STEM academies' mathematics classrooms give students ownership of their education and provide opportunities to work collaboratively on applicable, hands on activities that are more meaningful than traditional, rote memorization assignments. These instructional methods might be appealing because they simultaneously develop students' conceptual and procedural mathematical understanding.

Another finding revealed that at the end of grade 9, low-SES students in T-STEM academies achieved higher mathematics scores than students in our reference group. This result might be explained by the possibility that low-SES students who attended T-STEM academies were already interested in STEM related disciplines, which resulted in their decision to attend T-STEM academies. This result may also be explained due to T-STEM academies' obligation about serving underrepresented subpopulations (ethnic minority, female, and low-SES). This obligation provides opportunities to low-SES students, who are interested in STEM related disciplines, to show their potential through enrollment in T-STEM academies. This is important because previous studies reported that the existing mathematics achievement gap between low and high-SES students favored high-SES groups (Bicer, Capraro, & Capraro, 2013), and another report (NRC, 2011) emphasized that decreasing the mathematics achievement gap between low-and high-SES students is an essential goal for STEM education. By taking into account the fact that low-SES students may enroll in T-STEM academies due to a preexisting interest in STEM disciplines, we can conclude that T-STEM academies' curriculum and teaching features, such as hands-on activities, scaffolding, group work, and real life applications (Avery, Chambliss, Pruiett, & Stotts, 2010; Young et al., 2011) may help low-SES students achieve their potential in mathematics.

Our findings also indicated differentiation in gender. Our reference group showed greater mathematics achievement than females in T-STEM academies at the end of grade 9 controlling for ethnicity and SES. However, female students' mathematics growth rate was statistically significantly higher than our reference groups' mathematics growth rate. This might be explained by the fact that female students who attended T-STEM academies may have more positive attitudes towards STEM related disciplines when presented with opportunities for science and mathematics learning. The curriculum and instruction strategies (group work, active engagement, hands-on activities, real life applications, cooperative and collaborative learning, etc.) in T-STEM academies could have provided a framework for greater engagement (Myers & Fouts, 1992; Oakes, 1990). This result also could lead us to the conclusion that with proper strategies female students' achievement and interest in STEM disciplines could be increased. Increasing female students' achievement and interest in STEM disciplines would lead them to pursue STEM careers, which will close the gap for females in the STEM pipeline (Blickenstaff, 2005) and aid to increase the number of people who are in the STEM workforce. Female students experienced enhanced mathematics performance as indicated by their TAKS mathematics test scores. In terms of ethnicity, it was found that the reference group that included White students had statistically significantly higher mean mathematics scores than Hispanic and African American students at the end of 9th grade. This shows parallel results with our previous findings (Oner et al., 2014), which showed that African

American students' mean mathematics scores were statistically significantly lower than White students among group of students in T-STEM academies.

BIODATA AND CONTACT ADDRESSES OF AUTHORS

Ali BICER is a Ph.D student in Mathematics Education, in the Department of Teaching, Learning and Culture at Texas A&M University. His research interests include STEM education and literacy studies in mathematics. Physical Address: 428 Harrington Tower, College Station, TX 77843-4232.

Ali BICER
Texas A&M University
College Station, TX- USA
E. Mail: alibicer@tamu.edu

Bilgin NAVRUZ is a Ph.D student in Educational Psychology at Texas A&M University. His research interests include quantitative methods as they apply in mathematics education. Physical Address: 428 Harrington Tower, College Station, TX 77843-4232.

Bilgin NAVRUZ
Texas A&M University
College Station, TX- USA
E. Mail: bilgin@tamu.edu

Robert M. CAPRARO, is a Professor of Mathematics Education in the Department of Teaching, Learning and Culture at Texas A&M University. His research interests include representational models and learning transfer, curriculum design and evaluation in mathematics and science, Project-Based Learning (PBL); and school change. He has 22 peer-reviewed articles and over 1.3 million in external funding. Dr. Capraro travels extensively, working with schools and school districts to plan for develop, and execute mathematics curriculum innovations including project-based learning, creative mathematics assessment, and designing and mathematics learning for transfer. Physical Address: 428 Harrington Tower, College Station, TX

Prof. Dr. Robert M. CAPRARO
Department of Teaching, Learning
and Culture, Texas A&M University
College Station, TX- USA
E. Mail: rcapraro@tamu.edu

International Journal on New Trends in Education and Their Implications
January 2015 Volume: 6 Issue: 1 Article: 18 ISSN 1309-6249

Dr. Mary Margaret CAPRARO is an Associate Professor of Mathematics Education in the Department of Teaching, Learning and Culture at Texas A&M University. Her research interests include quantitative methods as they apply in mathematics education, the mathematics teacher preparation, and assessment of mathematics teaching and learning. Physical Address: 428 Harrington Tower, College Station, TX 77843-4232.

Assoc. Prof. Dr. Mary M. CAPRARO
Department of Teaching, Learning, and Culture, Texas A&M University
College Station, TX- USA
E. Mail: mmcapraro@tamu.edu

Ayse Tugba ONER is a Ph.D. student in the Department of Teaching, Learning and Culture, specialized in Mathematics Education at Texas A&M University. Her research interests are STEM education and teacher education. Physical address: 409 Harrington Tower, College Station, TX, 77843.

Tugba ONER
Texas A&M University
College Station, TX- USA
E. Mail: tugbaone@tamu.edu

Peter BOEDEKER is a Ph.D. student in the Department of Teaching, Learning and Culture, specializing in Mathematics Education at Texas A&M University. His research interests are STEM education and pre-service teacher education. Physical address: 428 Harrington Tower, College Station, TX, 77843.

Peter BOEDEKER
Texas A&M University
College Station, TX – United States
E. Mail: peteboe06@tamu.edu

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