International Online Journal of Educational Sciences, 2015, 7 (4), 11-21

iojes
www.iojes.net

International Online Journal of Educational Sciences

ISSN: 1309-2707

Longitudinal Analysis of T-STEM Academies: How Do Texas Inclusive STEM Academies (T-STEM) Perform in Mathematics, Science, and Reading?

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ARTICLE INFO

Article History:
Received 03.02.2015
Received in revised form 07.08.2015
Accepted 21.08.2015
Available online 12.09.2015

ABSTRACT

This study examines standalone inclusive STEM (Science, Technology, Engineering and Math) schools—T-STEM (Texas - STEM) in Texas—that operate as autonomous units. Researchers tracked two cohorts of ninth grade students of T-STEM and non-T-STEM schools between 2008 and 2011 to examine how schools' performances changed over times by school type in school level reading, mathematics, and science passing scores. To ensure that T-STEM schools and non-T-STEM schools have similar demographic compositions and achievement indicators, propensity score matching was used. After matching, the sample used for the analyses was nine T-STEM versus 27 non-T-STEM schools from 2008 and 18 T-STEM versus 52 non-T-STEM schools from 2009. Multivariate analysis of variance was performed to examine each cohort to determine how schools' performance changed over three years on mathematics, science, and reading TAKS (Texas Assessment of Knowledge and Skills) scores. Although each group had statistically significant growth for each of their three-year periods, there was no statistically significant difference between T-STEM schools and non-T-STEM schools.

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Keywords:
STEM, specialized stem schools, t-stem schools, mathematics, reading, and science

Introduction

The acronym STEM has been widely used to represent science, technology, engineering, and mathematics with its origins in 2001 by Judith A. Ramaley, an employee of the National Science Foundation (Breiner, Harkness, Johnson, & Koehler, 2012). Although STEM is commonly used in the educational arena, there is no common operational definition or conception of STEM (Breiner et al., 2012). Teachers of STEM fields and policy makers have various levels of understanding of STEM education (Brown, Brown, Reardon, & Merrill, 2011). Some conceptualize STEM as the purposeful integration of some or all of the four disciplines as they are used to solve real world problems, while others perceive STEM as a traditional disciplinary coursework lacking integration (Breiner et al., 2012). Despite the misconceptions of STEM, there is agreement that STEM has emerged as one of the top educational priorities (Schachter, 2011).

The educational priority of the STEM has emerged from the relationship between the economic growth of the countries and the skills needed for 21st century (Sahin, 2013; Sahin, Ayar, & Adiguzel, 2014; Sahin, Gulacar, & Stuessy, 2014; Sahin, 2015). According to the Organization for Economic Co-operation and Development (OECD) (2010), countries have to boost their innovation investment in order to succeed in their economy, and most of the innovations are originated from the STEM related fields (Breiner et al., 2012).

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DOI: http://dx.doi.org/10.15345/iojes.2015.04.002

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Therefore, today's nations should prioritize science, technology, math and engineering education to obtain sustainable economic growth (OECD, 2010).

The colloquy about STEM aroused from a concern that the United States was no longer competing nationally in STEM fields like they did in the past (Raju & Clayson, 2010). The conversation was also produced from the poor performance of students in the United States in science and mathematics (Johnson, 2012). Therefore, as a result of economics, politics, and international affairs, there was a petition for the need to train more students in STEM career fields (Thomas & Williams, 2010). STEM revolved from governmental policy and was specifically led by the National Science Foundation (Breiner et al., 2012). Policy makers and educators began to note that STEM is an important focus for education reform and global competitiveness; STEM skills are seen as the key to success for all students in the 21st century and rising jobs; and, there is a lack of STEM education in schools (Breiner et al., 2012; Brown et al., 2011; Bybee, 2010). Hence, the federal government set aside billions of dollars specifically for STEM education, including the *Race to the Top* competition (Breiner et al., 2012; Johnson, 2012).

Specialized STEM-Focused Schools

The National Science Foundation has managed federal funds by providing grant dollars to support STEM-based research conducted by educational institutions. As a result, educational institutions have committed to improving STEM education by creating statewide STEM education networks, specialized STEM schools, K-8 student programs, and STEM teacher professional development (Johnson, 2012). Creating Specialized STEM schools has been one of the growing areas for which educators have sought to improve STEM education in America. The President's Council of Advisors on Science and Technology has created a goal of establishing 1,000 STEM-focused schools over the next decade (Raju & Clayson, 2010).

Specialized STEM schools are designed to meet the needs for students who have an interest in science, technology, engineering, and mathematics and to prepare these students for the industry workforce by providing them with specific technical skills (Thomas & Williams, 2010). The literature documents Stuyvesant High School as the first STEM high school, which opened its doors in 1904 and was a manual training school for boys (Thomas & Williams, 2010). Other specialized STEM schools that opened in the early 20th century include Brooklyn Technical High School and the Bronx High School of Science (Thomas & Williams, 2010). Although the acronym STEM had not been developed and used during the early 20th century, these schools were designed with a science and mathematics focus. Most specialized STEM schools are supported by the state. There even exist state supported residential schools for gifted students in STEM (Cross & Frazier, 2010). Some research has also asserted that immersing students in STEM at an early age is one solution to increasing STEM interest and performance, resulting in the creation of STEM elementary schools (Raju & Clayson, 2010; Wai, Lubinski, Benbow, Steiger, 2010).

Specialized STEM secondary schools offer an advanced curriculum, mentorships, internships, and research apprenticeships in the field (Olszewski-Kubilius, 2010). STEM schools also typically have faculty or access to faculty with high levels of content expertise (Olszewski-Kubilius, 2010). STEM schools encourage scientific inquiry-based learning and give students the opportunity to learn more about STEM fields than they would at a traditional school (Raju & Clayson, 2010). Benefits of specialized STEM schools include: 1) an opportunity to enhance students' experiences with real world problems; 2) making connections to STEM fields and the workforce; 3) creating an interest and building motivation in STEM fields; and, 4) preparing students for college and university science and mathematics programs (Brown et al., 2011; Olszewski-Kubilius, 2010; Schmidt, Bohn, Rasmussen, & Sutherland, 2012). All of these advantages are free since specialized STEM schools are state supported, therefore providing an opportunity for even low socio-economic status students to have access to STEM education.

Texas STEM (T-STEM) schools. Texas began a T-STEM initiative, which is the largest investment in STEM schools in the United States with approximately $120 million in funding (Young, House, Wang, & Singleton, 2011). With this funding Texas opened a number of T-STEM academies and seven T-STEM technical assistance centers (Young et al., 2011). The T-STEM initiative was originally developed as a high school reform initiative under the Texas High School Project by the Texas Education Agency (TEA), Office of the Governor, Texas Legislature, Texas Higher Education Coordinating Board (THECB), Bill and Melinda Gates

Foundation, Michael and Susan Dell Foundation, Communities Foundation of Texas, National Instruments, Wallace Foundation, Greater Texas Foundation, and Meadows Foundation (Young et al., 2011).

The first T-STEM academies were opened in 2006 and they have to follow a detailed blueprint (Young et al., 2011). Texas STEM academies were developed as whole STEM schools or schools-within-schools. T-STEM academies are small schools that are not allowed to select students based on prior academic performance, and their populations must consist of at least 50% economically disadvantaged students or from ethnic minority groups (Young et al., 2011). These inclusive STEM schools do not require students to have a strong academic achievement background, but instead provide a support system to engage students in STEM and help them master content areas related to STEM (Young et al., 2011). Desired outcomes of the T-STEM academies include: college readiness, 21st century skills, and STEM career-related experiences (Young et al., 2011).

Students are attracted to T-STEM academies for various reasons such as access to college preparatory programs, access to new technology, and/or the opportunity to be in safe and orderly environments (Young et al., 2011). New specialized STEM schools are added to states and districts each year (Subotnik, Tai, Rickoff, & Almarode, 2010). In Texas, already existing schools have the opportunity to become T-STEM academies by completing an application process conducted by TEA. Selected schools have strict requirements and recommendations outlined by the detailed blueprint that they must follow in order to remain a TEA-designated T-STEM academy.

Outcomes for specialized STEM-focused schools. T-STEM academies were created on the premise that math and science competencies can be developed and underrepresented populations of students need opportunities to develop these competencies in order to become productive citizens in terms of economic growth and prosperity (Young et al., 2011). The integration of STEM is projected to better prepare students for the workforce that deals with business and industry by encouraging students to seek further training and careers in STEM fields (Williams, 2011). In addition, integrating STEM fields are projected to have a positive effect on student achievement (Becker & Park, 2011). Brown et al. (2011) stated that there is a belief that increasing math and science requirements in school, coupled with technology and engineering concepts, will help students to perform better and be more prepared for advanced education or jobs in STEM fields. Herschbach (2011) also made the claim that STEM initiatives will create instruction that is more relevant to the students' lives and in turn help improve student achievement specifically in mathematics and science (Herschbach, 2011). Hence, many researchers believe that STEM integration will result in better mathematics and science achieving students.

Prior research conducted on T-STEM academies has demonstrated that T-STEM academy students perform better in mathematics and science than non- T-STEM academy students from matched comparison schools (Young et al., 2011). In addition, ninth and tenth grade students from T-STEM academies had a higher likelihood of passing Reading TAKS than non-T-STEM academy students from matched comparison schools, but ninth graders from T-STEM academies performed similarly to students from non- T-STEM academies in Reading. There is very little research that documents the success or failures of students from specialized STEM schools, and best practices and outcomes from specialized STEM schools need to be recorded and made public (Subotnik et al., 2010).

This study specifically focused on standalone inclusive STEM schools—T-STEM in Texas—that operate as autonomous units. We tracked two cohorts of ninth grade students of T-STEM and non-T-STEM schools between 2008 and 2011 to examine how schools' performances changed over times by school type. The research questions were:

1. Did reading, science, and mathematics passing rates differ between T-STEM and non-T-STEM schools between 2008 and 2010?

2. Did reading, science, and mathematics passing rates differ between T-STEM and non-T-STEM schools between 2009 and 2011?

Methods

The focus of this study is to investigate the achievement of inclusive T-STEM academies compared to the matched traditional public schools.. T-STEM schools were founded with the promise of increasing

students' mathematics and science preparation. With that goal in mind, we aimed to compare the reading, math and science performances of students by using school level of data. Every student in public schools in Texas has been taking a TAKS test in given subjects. Based on the students' performances on the test, every school has a passing rate for each year. The researchers compared these passing rate scores between T-STEM and non-T-STEM schools to explain whether there is an effect of T-STEM programs on students' math, science, and reading scores.

Sample

The purpose of this study is to follow two cohorts of schools whose students were in ninth grade through eleventh grade in 2008 and 2009. Researchers compared school-level passing percentages of T-STEM academies with traditional public schools on science, mathematics, and reading between 2008 and 2011 for each cohort. The TAKS was designed in such a way that students were tested every year in mathematics and reading between third and eleventh grades but were tested on science at fifth, eighth, tenth, and eleventh grades only. The list of T-STEM academies were obtained from a report of Stanford Research Institute International (SRI International) (2010) that specifically studied T-STEM academies. All public high schools including T-STEM academies' 2008 to 2011 school level TAKS passing scores were obtained from the Texas Education Agency (TEA).

Table 1. School level cohorts by grade and year Instrument

2008	2009	2010	2011	Cohorts
9th Grade	10th Grade	11th Grade		Cohort 1
	9th Grade	10th Grade	11th Grade	Cohort 2

The Texas Assessment of Knowledge and Skills (TAKS) is a large scale standardized test that has been used to assess students' achievements on reading, math, science, and writing. This test has been administrated by the state of Texas on public and private schools on students in grades three through eleven. In Texas, student performance is monitored by the annual TAKS proficiency standards, which emphasized the most measureable outcome during this time period (Young et al., 2011). Texas has recently developed a new state assessment, the State of Texas Assessments of Academic Readiness (STAAR), which currently serves as the new measureable outcome. The test comprises selective response type questions. Only the writing test does not include selective response type questions. The questions are scored by computer and converted into a scale to show students' status on test scores. The test data of each school and school district is available at the website of Texas Education Agency (TEA) for interested parties.

Variables

Independent variables. The primary independent variable was T-STEM academy status, which was coded to compare to all available public high schools with selected T-STEM schools. According to the SRI study, there were a total of 33 schools designated as T-STEM academies by year 2009. Six of these academies were a school-within-a-school, and thus data were not observed for those six schools due to the fact that every student at the school did not participate in the specialized STEM academy. Hence, the remaining 27 T-STEM academies were evaluated. TAKS data provided by TEA was filtered to remove the non-T-STEM academies, leaving nine T-STEM academies from 2008 and 18 T-STEM academies from 2009 for which data were available for analysis

Propensity score matching (Guo & Fraser, 2010) was used to create a pool of non-T-STEM schools for comparison purposes in determining the effect of T-STEM schools on schools' mathematics, science, and reading passing percentages. To ensure that T-STEM schools and non-T-STEM schools have similar demographic compositions and achievement indicators, we calculated a propensity score (logit) of participating in the T-STEM initiatives for each school based on a set of school characteristics. We next selected a nearest neighbor comparison group. The matching variables we used were school level enrollment size, campus accountability rating, TAKS mathematics and reading passing rates for the previous year, community type, percentage of economically disadvantaged student, and percentage of African-American and Hispanic students. We matched each T-STEM school with two or more comparison schools that had the

closest propensity scores (one-to-k nearest neighbor matching). It was not possible to match each T-STEM school with an equal number of public schools due to the distribution of the propensity score.

Final numbers we used for the analyses were nine T-STEM versus 27 non-T-STEM schools from 2008 and 18 T-STEM versus 52 non-T-STEM schools from 2009. A number of T-STEM academies did not have continuous data for the three years of the study because (1) some T-STEM school districts re-structured their schools into new grade configurations that no longer fit our requirements, and (2) some T-STEM schools were closed.

Dependent variables. The TAKS assessment program was the basis for selecting dependent variables. For the analyses here, overall school percent passing rate for grades nine through eleven, as well as mathematics (grades nine through eleven), science (grades ten and eleven), and reading (grades nine through eleven) school percent passing were the primary dependent variables examined. Reading was assessed at grade nine while it is represented as English Language Arts at grades ten and eleven. High school mathematics testing focused on Algebra I, Geometry, and Algebra II, which were assessed in grades nine to eleven respectively. Science assessment focused on Biology, Chemistry and Physics topics in grades ten and eleven. TAKS was replaced for the 2012 assessments with the State of Texas Assessments of Academic Readiness (STAAR).

Analyses

A repeated measure of Multivariate Analysis of variance method was performed to analyze each cohort to determine how schools' performance changed over three years on mathematics, science, and reading TAKS scores. The analysis was conducted in within and between levels. In within level, the improvements of each school were compared. In between level, the difference between T-STEM and other schools were also compared. SPSS software package was employed to perform the analyses. Schools were followed over a three-year period, from 2008 to 2010 and 2009 to 2011 for each cohort. Science scores were available for grades ten and eleven due to the testing structure. A multivariate approach was chosen, because multivariate analysis is not affected by the sphericity assumption (Nimon & Williams, 2009). Also, Maxwell and Delaney suggested that when we have a large sample size, it is better to choose the multivariate method over the univariate method (2004). It was assumed by the authors that the focus of interest would be on each content area rather than for a multivariate perspective for this study. The overall passing rate, which is the proportion of students passing all tests administered for that grade, represents a multivariate picture of the schools' performance across subject matter areas.

Results

Mixed between-within subjects analysis of variance were conducted to analyze the differences of two types of schools (non-T-STEM and T-STEM schools) on students' scores in reading math and science, across two cohorts (see Table 1). For all six analyses, the critical value was selected as .05 to test the null hypotheses. The results of null hypotheses testing showed that T-STEM and non-T-STEM schools did not statistically differ from each other in reading, math, and science scores (see Table 2).

Table 2. Summary table of analyses

	Cohort - 1		Cohort – 2	
Tests	P	η_p^2	p	η_p^2
Reading	.931	.000	.522	.006
Math	.164	.056	.197	.024
Science	.262	.037	.171	.027

Analysis 1: Cohort 1 (2008 - 2010)

Comparison of reading scores. There was no statistically significant interaction between years and groups, Wilks' Lambda = .95, F (2,33) = .861, p = .432, partial eta squared = .05. There was a statistically significant main effect for years, Wilks' Lambda = .71, F (2, 33) = 6.717, p < .004, partial eta squared = .289, with both T-STEM and non-T-STEM groups showing an increase in reading scores within the three years

(see Table 3). The main effect comparing the types of schools was not statistically significant, F (1, 34) = .008, p = .931, partial eta squared = .000, implying no difference in the reading scores of both schools.

Table 3. Mean passing percentages for TAKS reading by T-STEM and non-T-S-TEM schools

	T-STEM Schools				Non-T-STEM Schools			
Years	n	M	SD	$d_{08\text{-}10}$	n	M	SD	$d_{08\text{-}10}$
2008	9	.92	.10	-	27	.90	.08	-
2009	9	.91	.08	-	27	.92	.06	-
2010	9	.95	.06	0.36	27	.96	.04	0.95
$d_{TS10\text{-}NTS10}$	-	-	-	-0.20	-	-	-	-

Analysis 2: Cohort 1 (2008 - 2010)

Comparison of math scores. There was no statistically significant interaction between years and groups, Wilks' Lambda = .87, F (2,33) = 2.251, p = .096, partial eta squared = .133. There was a statistically significant main effect for years, Wilks' Lambda = .35, F (2, 33) = 30.531, p < .05, partial eta squared = .649, with both T-STEM and non-T-STEM groups showing an increase in math scores within the three years (see Table 4). The main effect comparing the types of schools was not statistically significant, F (1, 34) = 2.020, p = .164, partial eta squared = .056, implying no difference in the math scores of both schools.

Analysis 3: Cohort 1 (2008 - 2010)

Comparison of science scores. There was no statistically significant interaction between years and groups, Wilks' Lambda = .94, F (2,33) = 1.124, p = .337, partial eta squared = .06. There was a statistically significant main effect for years, Wilks' Lambda = .307, F (2, 33) = 37.273, p < .000, partial eta squared = .307, with both T-STEM and non-T-STEM groups showing an increase in science scores within the three years (see Table 5). The main effect comparing the types of schools was not statistically significant, F (1, 34) = 1.301, p = .262, partial eta squared = .037, implying no difference in the science scores of both schools.

Table 4. Mean passing percentages for TAKS math scores by T-STEM and non-T-S-TEM schools

	T-STEM Schools				Non-T-STEM Schools			
Years	n	M	SD	$d_{08\text{-}10}$	n	M	SD	$d_{08\text{-}10}$
2008	9	.92	.10	-	27	.90	.08	-
2009	9	.91	.08	-	27	.92	.06	-
2010	9	.95	.06	0.36	27	.96	.04	0.95
$d_{TS10\text{-}NTS10}$	-	-	-	-0.20	-	-	-	-

Table 5. Mean passing percentages for TAKS science scores by T-STEM and non-T-S-TEM schools

	T-STEM Schools				Non-T-STEM Schools			
Years	n	M	SD	$d_{08\text{-}10}$	n	M	SD	$d_{08\text{-}10}$
2008	9	.79	.22	-	27	.70	.18	-
2009	9	.78	.18	-	27	.71	.16	-
2010	9	.94	.08	0.90	27	.93	.06	1.71
$d_{TS10\text{-}NTS10}$	-	-	-	0.14	-	-	-	-

Analysis 4: Cohort 2 (2009 - 2011)

Comparison of reading scores. There was no statistically significant interaction between years and groups, Wilks' Lambda = .93, F (2,67) = 2.349, p = .103, partial eta squared = .07. There was a statistically

significant main effect for years, Wilks' Lambda = .825, F (2, 67) = 7.125, p < .002, partial eta squared = .175, with both T-STEM and non-T-STEM groups showing an increase in reading scores within the three years (see Table 6). The main effect comparing the types of schools was not statistically significant, F (1, 68) = .414, p = .522, partial eta squared = .006, implying no difference in the reading scores of both schools.

Table 6. Mean passing percentages for TAKS reading scores by T-STEM and non-T-S-TEM schools

	T-STEM Schools				Non-T-STEM Schools			
Years	n	M	SD	$d_{08\text{-}10}$	n	M	SD	$d_{08\text{-}10}$
2008	18	.94	.06	-	52	.91	.08	-
2009	18	.94	.05	-	52	.94	.06	-
2010	18	.96	.05	0.36	52	.96	.05	0.75
$d_{TS10\text{-}NTS10}$	-	-	-	0	-	-	-	-

Analysis 5: Cohort 2 (2009 - 2011)

Comparison of math scores. There was no statistically significant interaction between years and groups, Wilks' Lambda = .985, F (2,67) = .514, p = .60, partial eta squared = .015. There was a statistically significant main effect for years, Wilks' Lambda = .342, F (2, 67) = 64.534, p < .05, partial eta squared = .658, with both T-STEM and non-T-STEM groups showing an increase in math scores within the three years (see Table 7). The main effect comparing the types of schools was not statistically significant, F (1, 68) = 1.699, p = .197, partial eta squared = .024, implying no difference in the math scores of both schools.

Table 7. Mean passing percentages for TAKS math scores by T-STEM and non-T-S-TEM schools

	T-STEM Schools				Non-T-STEM Schools			
Years	n	M	SD	$d_{08\text{-}10}$	n	M	SD	$d_{08\text{-}10}$
2008	18	.78	.13	-	52	.72	.19	-
2009	18	.82	.12	-	52	.77	.16	-
2010	18	.94	.06	1.58	52	.91	.11	1.22
$d_{TS10\text{-}NTS10}$	-	-	-	0.34	-	-	-	-

Analysis 6: Cohort 2 (2009 - 2011)

Comparison of science scores. There was no statistically significant interaction between years and groups, Wilks' Lambda = .96, F (2,67) = 1.553, p = .219, partial eta squared = .044. There was a statistically significant main effect for years, Wilks' Lambda = .338, F (2, 67) = 65.478, p < .05, partial eta squared = .662, with both T-STEM and non-T-STEM groups showing an increase in science scores within the three years (see Table 8). The main effect comparing the types of schools was not statistically significant, F (1, 68) = 1.917, p = .171, partial eta squared = .027, implying no difference in the science scores of both schools.

Table 8. Mean passing percentages for TAKS science scores by T-STEM and non-T-S-TEM schools

	T-STEM Schools				Non-T-STEM Schools			
Years	n	M	SD	$d_{08\text{-}10}$	n	M	SD	$d_{08\text{-}10}$
2008	18	.78	.13	-	52	.72	.19	-
2009	18	.83	.13	-	52	.77	.16	-
2010	18	.94	.07	1.53	52	.92	.10	1.32
$d_{TS10\text{-}NTS10}$	-	-	-	0.23	-	-	-	-

Discussion

Researchers compared school-level passing percentages of T-STEM academies with traditional public schools on science, mathematics, and reading between 2008 and 2011 for two ninth cohorts. We found that there was no statistical significant difference between school types in mathematics, readings, and science although there were significant increases within subjects in both cohorts. The purpose of the study was to examine the value added component to determine if the of costs associated with the development of STEM schools was providing an important impact on K-12 education in Texas. Texas was one choice among nine other states where there was a relatively large number of STEM designated high schools that have been in existence for at least three years. Texas, however, provides a more open educational evaluation process than most other states. It allows researchers to request and purchase high stakes data without student identifiers and releases test items. These important factors made Texas an excellent choice because of the transparency. Finally, the most important reason for using Texas was that STEM and non-STEM schools alike are all required to take the state accountability exam. The results are clear. There is little difference between matched schools on science, mathematics or reading. The eta squared effects for the multivariate longitudinal model all ranged from .000 to .056. None noteworthy and none of the *p*-values meeting our *a priori* <.05 alpha level. One would conclude that there is no difference when comparing similar schools' (STEM and non-STEM) impact on student learning for three years. Propensity score matching ensured that the salient background variables were the same at inception for the comparison schools.

On the other hand, this is not a case of close enough comparisons or schools from a nearby district where the researchers had access. The schools were selected from across the state using the state database with data purchased from the Texas Education Agency; these comparison schools were exemplary matches. So the important question is why do STEM schools not show greater student gains especially in mathematics and science? STEM schools have greater assistance and follow a strict model that prescribes many characteristics for the STEM school, paired with a great deal of external oversight. Perhaps the model a STEM school is expected to follow is flawed or the curriculum used for STEM teaching and learning is state-of-the-art for the 20 Century and not the 21st. The teaching methods at many schools have still not changed. This phenomenon is not new or unfamiliar to any teacher educator or anyone else who spends time in K-12 classrooms. The accountability instrument drives instruction. Teachers have limited time for inquiry or for developing student mastery. One anecdote comes from a before-school-starts planning meeting with district curriculum specialists working on the forthcoming year's scope and sequence. "This year for math we have 2.1 (days) per objective. I suggest we consider adding up all those .1's and then allocate them to the objectives where a school is not doing well on the (state accountability instrument)." Math curriculum today is being taught parceled out as if every mathematics concept or idea is equally difficult or simple to teach. So teachers do what they can to make things work, which is not teaching differently, but teaching quickly. Even with teaching quickly, which we believe happens across the two groups and in fact across the entire U.S., there is bright spot.

If one considers each group, STEM and non-STEM, and one considers each group's longitudinal growth, a very important result emerges. Non-STEM schools do a much better job of bringing more students along. Even though schools are the same at inception, in nearly every case the standard deviation decreases from inception to a point lower than that of the comparison STEM schools. The standard deviation is a measure of the "spread-outness" of the data. Therefore, a smaller standard deviation the more closely students are clustered around the mean. Another perspective is examination of the standardized effect sizes. In each case, the non-STEM schools had a larger effect from 2008 to 2010. This is in part confounded, meaning that in 2008 ninth graders contributed to that score but so did tenth and eleventh graders. One might consider this an important issue, but all of the schools had been in existence long enough that all the eleventh graders had also been part of the STEM movement at the school. So if a parent were trying to decide whether or not to put their child in STEM school or a non-STEM school with all other factors being equal, the non-STEM school would be a better choice. This being said, however, STEM schools provide other opportunities that are not measured by students being able to answer math, science, and reading questions on a high stakes test. STEM schools typically provide students with better access to college campuses, exposure to university professors, more connections to STEM industry, and certifications upon graduation that can be used, such as CNC operator. An important study that needs to be conducted is an examination of economic viability that compares the earnings of students from STEM and non-STEM schools four years

after high school graduation to see if these added factors have a meaningful impact on the U.S. economy or for individuals themselves.

Conclusion

Our results show that there is no significant growth difference between T-STEM academies and non-T-STEM schools between the years 2008 and 2011. Our study only covers the first four years of T-STEM academies. Future studies are needed to make more concrete conclusions about the effects of T-STEM academies on students' achievement in science, math, and reading. As researchers proposed (SRI, 2010), schools designated as T-STEM may need more time to fully implement the curriculum given by the state in order to reap what they sow academically. So future studies with student level data would shed more lights on the issue whether T-STEM designation creates difference for schools in mathematics and science achievement.

Limitations and Future Studies

We calculated the passing percentages of the schools for each year with the existing students in the data. However, between the years, the number of students slightly differs because of the external reasons such as drop-offs and attendance. According to the SRI study, there were a total of 27 schools opened up as T-STEM academies by year 2009. The limited number of T-STEM academies available made it difficult to obtain more statistically solid results.

Students in Texas were tested on reading and math achievement in ninth, tenth, and eleventh grades between 2008 and 2011. However, they were only tested on science achievement in tenth and eleventh grades. To observe the growth of science achievements of the schools, math passing percentages of the students in ninth grade were used instead of science passing percentages to analyze the difference between two groups. Although research suggests (Cetin, Corlu, Capraro & Capraro, 2015; Offer & Mireles, 2009) that science passing rates of the students are very close to math passing rates, differences between science and math passing rates might slightly influence the results of the analyses.

Propensity score matching (Guo & Fraser, 2010) method was implemented to create a group of non-T-STEM schools to find similar schools in determining the effect of T-STEM schools on schools' mathematics, science, and reading passing percentages. Each T-STEM school with two or more comparison schools had the closest propensity scores. However, an equal number of public schools were not available due to the distribution of the propensity score.

A quantitative approach was chosen to investigate the impact of T-STEM academies on students' achievements. However, this approach may not reveal the true impact of T-STEM academies on the students especially in the first years of implementations. Besides the academic achievement scores of the students, T-STEM academies can influence various psychological, and academics constructs. Therefore, a qualitative analysis (e.g., focus group interviews with teachers and students) of T-STEM academies may reveal some of the impacts that cannot be explained with quantitative approaches.

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