Implementing State Policy: Effects on Enrollment at One University

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ABSTRACT: Statewide policies can impact enrollment patterns of students. At one Texas University, 11th-grade Texas Assessment of Knowledge and Skills scores were predictive of success in students' first college-level mathematics course, but many students—those most at risk of failure—seem to have avoided taking a mathematics course in their first year at the institution. When placement accelerates a student's path through precollege-level sequences, it is not clear that the reduction of time to college-level coursework is concomitantly achieved. We recommend emphasizing the importance of completing mathematics courses early in students' academic careers.

Many of the CCRC's research protocol and assessment method choices were not mutually agreed upon selections within the boundaries of the researcher-practitioner partnership.

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Students who have academic deficits enroll in developmental education courses to prepare them for college-level courses. Decreasing the cost and time needed to complete a college degree for students requiring academic remediation has become part of the national discussion. Developmental education is also referred to as postsecondary remediation. According to Bonham and Boylan (2012), developmental education courses were "once envisioned as a gateway to educational opportunity" but since "have become barriers to that opportunity for many students" (p. 18). Of the students who started their postsecondary education at a four-year institution in 2003-04, approximately 40% enrolled in at least one remedial course between 2003 and 2009 with the largest enrollment numbers in mathematics. However, only 58% of the students that required mathematics remediation completed all of their remedial mathematics courses (Chen & Simone, 2016). Furthermore, failure rates have been high in developmental education courses (see Bahr, 2008; Chen & Simone, 2016). High enrollment numbers and low success rates result in high financial costs needed for academic remediation for both students and institutions of higher education (see Bonham & Boylan, 2012; Pretlow & Wathington, 2011). Thus, the educational community should not be surprised that policymakers are becoming involved in establishing college-level placement criteria and encouraging accelerated pathway options.

A TAKS mathematics score of 2200 placed students into freshman-level college mathematics courses after House Bill 1244. We examined the impact of implementing the TAKS 2200 placement policy and implementing changes resulting from House Bill 1244 by comparing enrollment patterns in mathematics courses before and after policy implementation and examined the ability of TAKS categories to predict success in college-level mathematics at a single four-year institution in Texas.

Background

Mathematics Courses

Placement. Historically, colleges have utilized placement tests to determine if students are classified as ready for college-level work. Mathematics placement tests should accurately place students in courses that match their skills and create a classroom composed of students that are somewhat homogeneous in abilities (Armington, 2002). Placement based on test scores can be complicated for several reasons. Some students retake a test multiple times until they place into a higher-level course. Other students might not do well on a test one day and then opt not to retake the test. Still other students have had a time-delay between completion of tests and their previous mathematics course, or students might not be good test takers. Thus, a sole reliance on placement scores might lead to an inaccurate placement of students into developmental courses. In fact, Belfield and Crosta (2012) found that high school GPA was a better predictor of course grades than placement test scores. Zientek, Schneider, and Onwuegbuzie (2014) found that developmental mathematics faculty perceived a time delay from enrollment in a previous mathematics course and students' lack of basic mathematics skills as top reasons students were placed in developmental mathematics.

Success. Success rates in developmental mathematics courses have been low. However, Bahr (2008) concluded that when mathematics remediation worked, it worked well. In an attempt to hypothesize why remediation was not successful for some students, Bahr (2008) referenced three remediation success themes that had emerged from the literature, which were developmental mathematics students' grade in their first mathematics course and both depth and breadth of remediation needed upon entering college. Bahr (2008) stated that "one would expect that poor performance in first math (sic. developmental or college level) would discourage further pursuit of mathematical competency through the impact of the performance disappointment on academic self-efficacy" (p. 444). Self-efficacy was defined by Bandura (1997) as "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainment" (p. 3). Academic performance has been linked to academic and mathematics self-efficacy (see Chen & Kaplan, 2003; Garriott et al., 2014; Pajares, 2006; Robbins et al., 2004; Usher & Pajares, 2008). Furthermore, mastery experiences have been identified as the most influential source of self-efficacy. Students build mastery experiences from previous successes and failures (Bandura, 1997). For developmental mathematics students, Zientek, Yetkiner-Ozel, Fong, and Griffin (2013) found that previously repeating a mathematics course was a predictor of academic performance in developmental mathematics. Thus, the importance of students' early academic success in college mathematics is an important concept to recognize.

Texas Placement Policies

Because the monetary and personal costs of remediation can be high, reform movements in developmental mathematics have been introduced and promoted. In Texas, where the current study was situated, policymakers have advocated for the offering of noncourse based options (NCBOs), which include such approaches as modular models, corequisite courses, emporium models, and course pairings (see Morales-Vale, 2012; Texas Higher Education Coordinating Board [THECB], 2012). In addition, Texas adopted developmental education placement policies, which were outlined in the Texas Success Initiative (TSI). Implemented in 2003, the TSI replaced the Texas Academic Skills Program. Students who were not TSI exempt were required to have a TSI score on file before attending a college-level course. Students could receive a TSI exemption by receiving scores above a benchmark on various tests such as ACT, SAT, Texas Higher Education Assessment (THEA), or a 2200 on the 11th-grade high school assessment tests (formerly TAKS and currently STAAR; Exemptions, Exceptions, & Waivers, 2018); THEA and TAKS were the two statewide tests. Students could also receive TSI exemption by other criteria such as being in a certificate program that is less than one year in length, military exemptions for service, and previous credit for college-level mathematics courses.

High school TAKS scores. Our study focused on TAKS score policy changes. TAKS was the Texas standardized exit-level test for high school seniors from 2003 to 2011. All high school students were required to take and pass exit-level TAKS tests in English/language arts, social studies, mathematics, and science in order to receive their high school diploma. Students could take the tests multiple times. TAKS test item development was based on the Texas Essential Knowledge and Skills, which is a state-mandated curriculum. There were also key components of the Texas Essential Knowledge and Skills and the TAKS testing questions that fell under the college and career readiness standards component (Texas Education Agency, 2015).

State placement policy. Prior to House Bill 1244, exemption by TAKS, ACT, and SAT mathematics scores meant that students were ready for entry into college-level courses; however, state policy could have been confusing because institutions of higher education could require more stringent criteria for colleges.

> Prior to the passage of House Bill 1244, TSI statute and rules allowed Texas public institutions of higher education to raise the statewide minimum college readiness benchmarks for four assessments approved at the time for TSI purposes: Asset, THEA, Compass, and Accuplacer. The resulting practice was confusing since the same student could be considered college-ready at one institution but not college-ready at another. The passage of House Bill 1244 required an assessment that included diagnostics and one statewide set of college readiness benchmarks. The TSI Assessment (TSIA) launched in fall 2013 and included diagnostics and one set of college readiness benchmarks that could no longer be raised by institutions. (S. Morales-Vale, personal communication, July 19, 2018)

Thus, the importance of students' early academic success in college mathematics is an important concept to recognize.

Students who were not TSI exempt could take either the state THEA test or another approved test. A passing score on THEA was 230, but the THECB recommended a 270 for college algebra placement (THECB, 2004). A relationship between THEA and TAKS scores had been found: The probability of a student scoring greater than 270 on the THEA test was 26% if the student had scored a 2200 on the TAKS test, 77% for a 2300 TAKS score, and 100% for a 2400 TAKS score (National Center for Accountability, 2004). Accordingly, a 2200 TAKS score in mathematics indicated TSI exempt status and placed students in freshman college-level courses. Furthermore, the state determined TSI exempt status for ACT and SAT scores. For example, prior to March 5, 2016, students were TSI exempt if they made "a combined critical reading (formerly "verbal") and mathematics score of 1070" on the SAT "with a minimum of 500 on the mathematics test" or a composite ACT score of 23 with a minimum of "19 on the mathematics test" (Exemptions, Exceptions, & Waivers, 2018, p. 1).

Placement policy at participating university. Table 1 (next page) contains the policy changes over several years for THEA and TAKS scores at the university that participated in this study. Other placement test options were available (i.e., ACT, SAT). A student who was not TSI compliant in mathematics required continuous enrollment in developmental mathematics courses. At this university, the policy prior to Fall 2013 was that a 2200 TAKS mathematics score meant a student was TSI exempt, but that score was not a guarantee for admission into college-level mathematics; additional testing was required. In Fall 2013, placement by House Bill 1244 also was adopted, which includes placement by the TSA.

Statewide testing in K-12. Legislation that led to the THECB's ability to prescribe one standard for freshman college-level coursework came after a lengthy history of K-12 statewide testing. In K-12 settings, the popularity of formal testing grew in the 1980s and 1990s (Natriello & Pallas, 1999). The No Child Left Behind Act of 2001, (2002) required accountability performance-based measures to be developed. However, states had flexibility in designing parts of their plan. According to Perna and Thomas (2009), arguments in favor of statewide testing included a belief by some teachers that statewide testing could be beneficial because an emphasis on academics, in general, was increased. Arguments against statewide testing included a belief that statewide testing could reduce academic rigor when students began to learn testing strategies and teachers limited their focus to content covered in the exit exam (Perna & Thomas, 2009).

High school exit exams. In 1999, prior to the adoption of the No Child Left Behind Act of 2001 (2002), 22 states required students to pass a placement test in order to receive a high school diploma (Natriello & Pallas, 1999). However, passing state high school exit exams had not ensured that students were college ready (see Perna & Thomas, 2009; Venezia, Kirst, & Antonio, 2003). Perna and Thomas (2009) found that "the ways that state testing policies shape college opportunity vary across and within states" (p. 472). Perna and Thomas (2009) found that testing policies were greater consequences in schools that had "the lowest average performance on state-mandated exams and schools that face sanctions for low performance" (p. 473). Those schools tended to serve a disproportionate number of students from a low socio-economic background. Thus, Perna and

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Table 1

THEA and TAKS Placement Policies of the Participating University by University Changes

Test Scores	Course Placement		TSI Compliant		Continued Enrollment in DM Required	
	2010-2012	Fall 2013	2010-2012	Fall 2013	2010-2012	Fall 2013
THEA Score 1-229	Lowest DM	Lowest DM	No	No	Yes	Yes
THEA Score 230-269	Highest DM	Highest DM	No	Yes	Yes	No
THEA Score 270 or higher	College Level	College Level	Yes	Yes		
2200 or > on 11th Grade Level TAKS	More Testing Required	College Level	Yes	Yes	No	

Note. DM = Developmental mathematics. ACT and SAT scores were used for placement if a student was TSI compliant.

Thomas concluded that "the intense pressure at these schools to 'meet state standards' appears to effectively recenter school culture on state testing goals rather than activities that are known from research to promote college enrollment" (p. 473). Furthermore, Perna and Thomas (2009) concluded the threat of lower graduation rates and being labeled as a failing school might divert the focus to high school exams rather than increasing college enrollment rates (see also Craig, 2004; Dworkin, 2005).

Purpose and Research Questions

Our goals were to identify changes in enrollment practices after a state-mandated policy was implemented and to retrospectively determine characteristics of students who might have been affected applying the policy. In particular, we were interested in enrollment practices. Our hypotheses were that (a) TAKS score levels predicted course grades in college-level mathematics courses and (b) some students who previously would have placed into developmental mathematics courses might choose to defer enrollment in mathematics courses. The research questions are: 1. Did enrollment patterns and pass rates in developmental and college-level classes change between Fall 2011 and Fall 2014?; 2. Do differences exist between students who obtained TAKS score levels on the following variables: gender, ethnicity, Pell-grant status, enrollment in developmental mathematics courses, or transfer of college-level core mathematics courses?; and 3. Was passing college algebra or college mathematics predicted by the following variables: being African American, White, or Hispanic, by TAKS mathematics score levels, qualifying for a Pell grant, being female, or enrolling in a developmental course?

Method

Data were collected from the Office of Institutional Effectiveness at a university in the Southwest. The study was approved by the university's Institutional Review Board. Enrollment numbers were collected for developmental mathematics courses and all college-level mathematics courses with a prerequisite of passing the TSIA or equivalent. College-level courses included college mathematics, college algebra, precalculus, trigonometry, managerial decision mathematics, elementary statistics, introductory biomedical statistics, and a course for prospective elementary/middle school teachers.

Data

The university in this study changed their internal policy and placed students according to the state-mandated TSI exempt TAKS, ACT, and SAT scores and other policy changes resulting from House Bill 1244. We collected aggregate data and student-level data.

Aggregate. Data on enrollment and pass rates were collected for developmental mathematics and select core mathematics courses. These data were analyzed to determine enrollment and pass rate patterns. Fall 2011 academic year data were chosen as a baseline measure.

Student-level. We restricted student-level data to students who had a TAKS score on file and were admitted prior to Fall 2012 (n = 5,959), which was prior to the university's TAKS phase-out stage. The present study focused on TAKS scores because sufficient data were not available to examine the relationship between STAAR test scores and college course work. Approximately 70% of student-level data were from students admitted to the university from Fall 2010 to Fall 2012. Mean age of students was 18.5. TAKS scores were scaled scores that "take into account the difficulty level of the specific set of questions on a particular test" and "quantifies a student's performance relative to the passing standards or proficiency levels" (Texas Education Agency, 2016, p.1). Because we wanted to distinguish students near the college placement score of 2200, TAKS mathematics scores were divided into three categories: below 2200, 2200-2299, and 2300-2400, which we named respectively as below college ready (CR), CR, and High CR. Those categories were chosen because they were the same categories utilized in the National Center for Accountability (2004) study that linked THEA and TAKS scores.

Student-level data were collected on three freshman college-level courses that are a part of the institution's core and three developmental mathematics courses. In Texas, "all public institutions have an approved list of courses as part of their core curriculum of the" Texas Core Curriculum (Exemptions, Exceptions, & Waivers, 2018, p. 1). Students choose from an institution's core but must consider the prescribed requirements of the degree they are seeking. At this institution, there were six core courses that did not have as a prerequisite the passing of another core math course. We included the courses with the largest enrollments (i.e., College Mathematics, College Algebra, and Precalculus rather than trigonometry, business math, or elementary teachers' math course).

Math CM is College Mathematics and is required for nonbusiness and nonscience majors. Math 1314 is College Algebra. Precalculus is a 4-credit mathematics course that was introduced in Fall 2011 and can be taken instead of College Algebra. The developmental mathematics courses were Math 1, Math 2, and an accelerated NCBO. Math 1 and 2 were traditional semester-length courses. The Math NCBO was first implemented in Fall 2014 and as an NCBO consisting of 4 weeks of intermediate algebra content followed by 11 weeks of college mathematics.

Demographics. Gender was coded as Female = "1" (n = 3,613) and Male = "0" (n = 2,346). There were more Whites (n = 3,335) in the sample compared to African Americans (n = 1,424) and Hispanics (n = 931). First-generation status was not included because of the large percentage of missing data on this item.

Table 2

Student Enrollment in Developmental and Mathematics Courses by Semester

Semester	Enrollment Numbers				Percent Change in Enrollment					
	DM	Math Courses with TSI Prerequisite			From Fall 2011			From Spring 2012		
	NCBO, Level 1, Level 2)	(Precalculus, 1314, 1332)	Remaining Credit Courses	BOTH DM and TSI Prerequisite Courses	DM	MATH Courses with TSI Prerequisite	BOTH DM and TSI Prerequisite Courses	DM	MATH Courses with TSI Prerequisite	BOTH DM and TSI Prerequisite Courses
Fall 2011	**1,768**	710	834	3,312						
Spring 2012	870	878	830	2,578						
Fall 2012	1,848	883	768	3,499	4.52	6.93	5.65			
Spring 2013	819	951	560	2,330				-5.86	-11.53	-9.62
Fall 2013	1,806	1,198	852	3,856	2.15	32.77	16.43			
Spring 2014	257	1,260	794	2,311				-70.46	20.26	-10.36
Fall 2014	393	1,255	772	2,420	7.77	31.28	-26.93			
Spring 2015	197	1,183	802	2,182				-77.36	16.22	-15.36

Note. DM = Developmental mathematics; TSI = Passing score on the Texas Success Initiative Assessment. Fall semesters comparisons are made with Fall 2011 enrollment numbers (i.e., –77.77 = [393–1768]/1768*100); spring comparisons are made with Spring 2012 enrollment numbers (i.e., –77.36= [197–870]/870*100).

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Analysis and Results

Research Question 1: Enrollment Patterns and Grades

Enrollment patterns analysis. Enrollment numbers were compared before and after the university implementation of the state-mandated placement scores. Enrollment data for 2014 were utilized for comparison purposes because some students learned during the Fall 2013 semester that they were not required to enroll in developmental mathematics courses. Therefore, data from that semester were not reliable for our purposes. Because fall and spring semesters are not necessarily comparable, fall semester comparisons were made to Fall 2011, and spring data comparisons were made to Spring 2012.

Enrollment patterns results. As seen in Table 2 (Page 13), enrollment in developmental mathematics decreased by 78% from Fall 2011 to Fall 2014, but the difference in enrollment numbers was not accounted for in other TSI prerequisite mathematics courses at the rate we would have anticipated. For fall semesters, a decline in overall enrollment in mathematics courses began in Fall 2014, which is the same year that developmental mathematics enrollment decreased by 78%. For spring semesters, enrollment in freshman-level mathematics courses declined for each spring semester, but the percent change was largest in Spring 2015. The decline in mathematics enrollment occurred over a time period when the university had an increase in enrollment. In the academic year 2011-12, enrollment of full-time freshman was 2,003, and those numbers increased by 445 in 2014-15. In the academic year 2011-12, total enrollment of undergraduates was 14,921, and those numbers increased by 1,898 in 2014-15. The department chair verified that students were not denied enrollment in courses. Enough sections were offered to compensate for the policy change, and a lack of expected increase in enrollment was due to student choices versus caps in enrollment of sections.

Grades analysis. Two-sample two-tailed z-tests were conducted to examine difference between grade distributions between Fall 2011 and Fall 2014 with an a priori alpha level chosen at .05. Students who were in the Developmental Math 2 were in one sample; students in the NCBO were included in a second sample.

Grades results. As seen in Table 3, statistically significant differences existed between the percentage of students who passed Developmental Math 2 with an A, B, and C from 2011 to 2014; a smaller percentage of students passed in 2014 compared to 2011. However, differences detected were from a lower percentage of students earning a B in Fall 2014 compared to Fall 2011. When NCBO Math students were included, there was no statistically significant differences in pass rates for developmental mathematics. Even though statistically significant differences did not exist between the percentage of students who passed Math 1314 between Fall 2011 and Fall 2014, there were more As in Fall 2014 compared to Fall 2011.

Table 3

Comparisons On Pass Rates Between Fall 2011 and Fall 2014 For Developmental Mathematics and Select Core Mathematics Courses

	Percent Passed With An A, B, or C								
	Fall 2011			Fall 2014			CI Difference		
	N	%	CI	*n*	%	CI		*p*	*z*
MATH 1	269	67.29	(0.617, 0.729)	116	58.62	(0.497, 0.676)	(-0.017, 0.191)	0.103	1.6
MATH 2	1,499	61.04	(0.586, 0.635)	228	52.19	(0.457, 0.587)	(0.020, 0.157)	0.011	2.5
ALL DM[a]	1,768	61.99	(0.597, 0.643)	393	60.05	(0.552, 0.649)	(-0.034, 0.073)	0.474	0.7
CL CM	554	73.47	(0.698, 0.772)	538	73.05	(0.693, 0.768)	(-0.048, 0.057)	0.876	0.2
CL 1314	156	54.49	(0.467, 0.623)	490	62.04	(0.577, 0.663)	(-0.013, 0.164)	0.093	1.7
All CL[b]	710	69.30	(0.659, 0.727)	1,255	65.10	(0.625, 0.677)	(-0.001, 0.085)	0.058	1.9

Note. CI = Confidence interval; CL = College Level; CM = College Mathematics; University enrollment increased from Fall 2011 to Fall 2014; MATH 1 and MATH 2 are developmental mathematics courses.ALL DM includes MATH 0112, which became a course option in Fall 2014; [b]All CL includes Precalculus, which was not a course option in Fall 2011.

Research Question 2: Differences by TAKS Categories

TAKS categories analysis. To determine the impact of the factors, gender, ethnicity, and Pell-grant status on determining the TAKS score, an ordinal logistic regression analysis was conducted treating TAKS category (below CR, CR, and high CR) as the response variable and gender, ethnicity, and Pell-grant status as the predictor variables. Students with unknown ethnicity, Asian, and multicultural status were deleted from the analysis. White was used as the reference category for ethnicity.

TAKS categories results. As seen in Table 4 (page 15), compared to being White, being African American was a statistically significant factor deciding the TAKS category. The odds ratio was 0.465, which indicates that, for African Americans compared to Whites, we expect the odds of being in higher category would be 0.465 times lower. Compared to Whites, Hispanics showed lower odds of being in a higher TAKS category. However, this indication was not statistically significant. In regards to gender, odds of being in a higher category was 0.796 times lower for females compared to males. Students with Pell-grant status had slightly higher odds to be in the higher TAKS category, but this relationship was not statistically significant.

Research Question 3: Success in College Algebra and College Mathematics

Success analysis. A binary logistic regression model was created to determine if being African American, White, or Hispanic; being in a certain TAKS score category (i.e., below CR, CR, or high CR); qualifying for a Pell grant; gender; or enrolling in a developmental mathematics course predicted success in college algebra or college mathematics. Passing college algebra or college mathematics with an A, B, or C was the response variable. Results were combined for both courses because similar results were obtained when analyses were conducted separately with college algebra and college mathematics each as the

Table 4

Student Characteristics Relationship to 11th Grade TAKS Score Categories For All Students Admitted Prior to Fall 2012 With a TAKS Mathematics Score On File (N = 3845)

Characteristics	Estimate	Odds Ratio	*p* value	CI
Ethnicity				
White	-	-	-	-
African American	-0.7663	0.465	<0.001	(0.399, 542)
Hispanic	0.0703	0.930	0.389	(0.787, 1.098)
Qualified for Pell Grant	0.0344	1.035	0.597	(0.911, 1.176)
Females	-0.2281	0.796	<0.001	(0.706, 0.898)

Note. CI = Confidence Interval.

response variable. As suggested by Allison (2001), a multiple regression model was run using PROC REG procedure and calculated the variance inflation factor (VIF) to look for any multicollinearity (i.e., VIF values were well below 5).

Success Results. As seen in Table 5, gender, Enrolled in Developmental Math, and TAKS category were statistically significant factors. Please not that we used the "CR" as our reference category to compare the TAKS categories. Odds of passing the College Algebra or College Mathematics was 1.425 times higher for the students in the High CR TAKS group compared to those in the CR TAKS group. Odds of passing the College Algebra or College Mathematics was 0.608 times lower for the students in Below CR TAKS group compared to the CR TAKS group. There were no statistically significant differences in passing odds for African American or Hispanic compared to Whites. A female student had increased odds of passing the courses by 1.525 times compared to male students.

We further disaggregated the CR category into two separate categories, which were 2200-2249 and 2250-2299. We named those categories as Low CR and Medium CR. Table 6 contains student characteristics disaggregated by TAKS categories. Prior to the implementation of the policy change, 75% of students in the Low CR and 65% of students in the Medium CR categories were enrolled in developmental mathematics courses. Furthermore, 28% of the students in the Low CR category enrolled in College Algebra as their first core course, and 57% passed College Algebra the first time; 29% of the students in the Medium CR category enrolled in College Algebra as their first core course, and 72% passed College Algebra the first time. Pass rates were higher the first time students enrolled in College Mathematics (i.e., 69% of Low CR students and 80% of5e6 Medium CR students).

Discussion

Given the potentially costly nature of remediating students, educators and policymakers have been interested in determining how to increase success rates in college-credit courses while reducing the remediation completion time. Our case study examined enrollment patterns before and after the implementation of a statewide college-ready criterion established under House Bill 1244 policy that also included placement by a new state test. The TAKS test was replaced by the State of Texas Assessments of Academic Readiness (STARR). We then examined TAKS categories as predictors of college-level mathematics success. Our results from a university suggest the following: 1. Changing college-level mathematics entrance scores might result in some students successfully completing their college-level courses in a shorter amount of time, but many students with TAKS mathematics placement scores near the state-mandated TSI exempt level of 2200 might view non-mandatory enrollment as an invitation to postpone enrollment in college-level mathematics course. 2. Prior to the placement change, 75% of the students in this university sample with scores just above the freshman-level mathematics TAKS cutoff score of 2200 were enrolled in developmental mathematics, and today those students would be informed they are ready to enroll in freshman-level mathematics. 3. The 11-th grade TAKS score categories were predictive of student success in college algebra and college mathematics courses; students with TAKS scores above 2300 have more success in entry college courses than students with scores below 2300. 4. More research needs to be conducted to determine which students benefit the most from NCBO options.

Enrollment Patterns

Collectively, our study results suggest that some university students who met the TSI exempt criteria set by the state, but prior to the university placement changes would have tested into developmental mathematics, might postpone enrollment in core mathematics courses. We anticipated an increase in enrollment in entry college-level mathematics courses

Table 5

Binary Logistic Regression Results for Relationship to Success in College Algebra and College Mathematics

Characteristics	Estimate	Odds Ratio	*p* value	CI
Ethnicity*				
African American	−0.1134	0.893	0.2208	(0.745,1.071)
Hispanic	−0.0655	0.937	0.5242	(0.766, 1.146)
Qualified for Pell Grant	−0.0692	0.933	0.3805	(0.799, 1.089)
Gender***	0.4220	1.525	<0.001	(1.319, 1.763)
Enrolled in Developmental Math	−0.7502	0.472	<0.001	(0.398, 0.561)
TAKS Mathematics Group**				
High CR	0.3545	1.425	<0.001	(1.187, 1.712)
Below CR	−0.4973	0.608	<0.001	(0.514, 0.719)

Note. *Compared to Whites; ** Compared to CR TAKS group; *** Females compared to males. CI = Confidence interval. College algebra grade was from course grade for the first time a student completed the course. Success was defined as earning an A, B, or C.

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Table 6

Student Characteristics Relationship to TAKS Mathematics Score Categories For All Students Admitted Prior to Fall 2012 With a TAKS Score On File

	TAKS SCORES			
	Below 2200 $N = 1564$	2200-2249 $N = 1089$	2250-2299 $N = 1386$	2300-2400 $N = 1920$
Ethnicity				
White	48.3	53.9	58.9	61.3
African American	33.5	28.2	20.4	16.1
Hispanic	14.8	14.0	15.9	17.0
Unknown	0.7	1.7	1.7	1.7
Qualified for Pell Grant	51.4	50.0	48.8	46.1
Females	65.2	62.8	58.9	56.9
Enrolled in Developmental Math	87.8	74.9	64.7	48.5
Enrolled in MATH 1	17.2	5.5	4.3	2.0
Enrolled in MATH 2	70.6	69.4	60.5	46.5
First Core Course[a]				
Math 1314 – College Algebra	29.7	28.0	28.9	28.4
% of Those Students that:				
Passed 1314 1st Time	49.6	57.1	72.1	77.4
1314 was Transfer Course	77.2	69.1	69.8	71.7
College Math (CM)	40.3	39.8	39.0	35.5
% of Those Student that:				
Passed CM 1st Time	62.0	69.3	79.7	81.4
CM was Transfer Course	5.6	6.2	7.2	5.4
Math Precalculus[b]	0.3	0.6	0.4	0.8
Study Skills	20.7	20.1	15.2	15.5

Note. The sample size in Table 3 does not equal sample sizes in Table 5 because all ethnicities were included in Table 6. MATH 1 and MATH 2 are developmental mathematics courses. [a]Enrollment data available only for 1314, 1332, Precalculus. MATH Precalculus was introduced into the curriculum Fall 2012.

enrollment in entry college-level mathematics courses to match or exceed the decrease in enrollment in developmental mathematics courses. Differences in enrollment numbers were not accounted for in core mathematis courses at the proportion of students we would have anticipated, particularly given that the student population at this university increased during this time period. As seen in Table 2 (page 13), enrollment in developmental mathematics decreased by 78% from Fall 2011 to Fall 2014. The lower enrollment numbers appeared to begin occurring 1 semester after the university fully implemented the policy changes.

Moore and Shulock (2010) identified an association between students obtaining mathematics credits within their first two years of enrolling at California community colleges and earning a certificate, degree, or transfer. Fike and Fike (2012) concluded that "allowing students who need developmental mathematics to delay enrollment may not be in the best interest of the students" (p. 5). Furthermore, Fike and Fike found that developmental mathematics students who completed a mathematics course during their first semester achieved equivalent success in their first semester grade-point-average and retention rates from fall-to-spring and fall-to-fall as students who were considered college ready. However, delayed enrollment might not postpone students' goals as noted by a case highlighted by Henson, Hern, and Snell (2017). The student postponed mathematics enrollment to focus on his strengths and thus secured a good grade-point-average and made progress towards his goals (Henson et al., 2017). Such research findings suggest that adequate academic support systems need to be in place for accurate placement and to prevent students from waiting to complete their mathematics course during their final semesters of their degree.

Grade distribution. We defined passing as receiving an A, B, or C. As seen in Table 3 (page 14), for the Level 2 developmental mathematics course, failure rates were higher in Fall 2014 compared to Fall 2011. For college-level courses, no statistically significant differences existed between the percentage of students who passed in Fall 2014 compared to Fall 2011, and enrollment in college-level courses increased. Even though the fulltime freshman student population grew by approximately 450 students from the 2011 to 2014 academic years, the increase of 550 students who enrolled in college-level courses suggests that some students benefited by the new placement changes. One hypothesis for no statistically significant differences in pass rates is that students who postponed enrollment were not included in the analysis. Research should continue to examine grade distributions in future years to test this hypothesis.

Accelerated NCBO. The THECB has advocated for NCBOs (see Morales-Vale, 2012; THECB, 2012). In our study, the sample size in the accelerated NCBO course was small (i.e., $n = 49$ in Fall 2014). However, when those 49 students were included, there were no statistically significant differences in percentage of students passing developmental mathematics compared to when NCBO students were excluded. More research needs to be conducted to determine the students who will benefit the most from NCBO options.

Predicting Success

College-level mathematics. Student-level data were limited to students who had TAKS scores on file. As seen in Table 5, previous enrollment in a developmental mathematics course, TAKS category, and gender (being female) were predictors of success in college-level mathematics, but ethnicity was not a statistically significant predictor. Females were more likely than males to have passed college-level mathematics the first time. Enrollment in developmental mathematics was associated with lower odds of passing college-level mathematics.

However, odds ratios were higher for TAKS category, which suggested that scoring in a higher TAKS category increased the odds of passing college-level mathematics with an A, B, or C.

Limitations

One limitation of this study is that participants were limited to students who had TAKS scores on file. Therefore, students with other test scores are not represented in our study. Also, we did not have interval-scaled TAKS scores, which might have been preferable. However, our categories did correspond to TAKS categories in the National Center for Accountability (2004) study that linked THEA and TAKS scores. We also acknowledge that TAKS scores can be complicated because knowledge between 11th-grade and college enrollment can be increased or forgotten, and scores were reported on the highest TAKS score without a reference to the number of testing attempts. Furthermore, we did not have document advising protocols that might explain reasons for students' deferral of mathematics enrollment. Conclusions about NCBOs cannot be drawn from this study because of the small sample size, and we realize that other factors such as outside tutoring might impact the success in those accelerated options.

Implications and Future Research

Not only Texas but states elsewhere are mandating policies to improve developmental education and reduce student time in developmental courses. While this study focused on one 4-year institution in Texas, educators outside of Texas should be interested in the impact of legislative influences on college practices in Texas because policies in one state might influence policies in other states. Institutions of higher education and practitioners alike have the responsibility of utilizing data to determine the effect these policies have on their student population.

A positive consequence of lowering placement scores for college-level courses is that more students have an opportunity to complete a college-level mathematics course without remediation, and thus can save both time and money. Further studies should investigate the effect of deferring enrollment in college-level courses. Further studies could also compare anxiety levels in entry-level courses to newly populated courses. Students who would have benefited from remediation might become frustrated in their college-level mathematics courses. Attitude and anxiety have been shown to impact academic success (see Bandura, 1997; Fong, Zientek, & Phelps, 2015; Zientek & Thompson, 2010; Zientek et al., 2013), and research indicates that developmental mathematics students tend to, on average, exhibit higher levels of mathematics anxiety (Ma, 1999; Zientek, Yetkiner, & Thompson, 2010). These frustrations might transfer into college-level classrooms. Finally, future research should also examine if grade distributions in freshman-level mathematics courses and college retention rates change after students who postponed enrollment in mathematics take college mathematics courses.

Given the changes in placement policies that shift more students into college-level courses, we propose that higher education policies should stipulate an enrollment requirement of completing college-level mathematics before students earn a specific number of credit hours and continual enrollment thereafter until degree requirements are completed. This would prevent students from postponing mathematics until the last couple of semesters of their degree.

Conclusion

An ideal placement system would accurately place students into the appropriate mathematics course, but no ideal system exists, and many factors account for student success. Texas implemented a standard placement policy to determine college-readiness

Students who would have benefited from remediation might become frustrated in their college-level mathematics courses.

(Texas Legislative. Council, 2011). A consistent policy that applies for all institutions reduces confusion for students. However, understanding the student population to which policies are applied is important to designing and predicting success of policies. Collecting empirical evidence is also important. Our study had mixed results. Our findings suggest that some students, at one university, who previously would have placed into developmental mathematics under a more stringent university placement policy might interpret college-ready placement as an invitation to postpone enrollment in math. Based on the findings of our study and of various studies in the literature, we recommend that postsecondary institutions require students to enroll in their first college-level mathematics course before earning a specified number of credit hours and that follow-up studies should examine the effectiveness of policy changes on student success and enrollment patterns.

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