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Middle School Mathematics: A Study of Three Programs in South Texas

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Abstract: The purpose of the study was to determine if there was a significant difference in three math programs within one school district and their impact on student performance as measured by the Texas Assessment of Knowledge and Skills (TAKS). All campuses involved in this study were designated as middle schools containing grade levels six through eight. Mathematics teachers at each of these middle school campuses teach students the mathematics objectives outlined in the Texas Essential Knowledge and Skills (TEKS) through their school's curriculum. Of the campuses in the study, one campus used the Texas MathWorks Program for every student in grades six and seven, two campuses used the Connected Mathematics Program in grades six through eight, and four campuses use the district approved state adopted textbook, Glencoe, in grades six through eight. The study determined if there were significant differences in test scores among these three math programs in grades six and seven for the academic school years 2008–2009 and 2009–2010. Campus scores on TAKS from the campuses involved in this study were reviewed using the Academic Excellence Indicator System (AEIS) provided by the Texas Education Agency for TAKS results as well data provided by the south Texas school district. From the analysis of data, it can be concluded that students enrolled in Connected Mathematics did better on the TAKS test than those in the two other instructional programs, Glencoe and Texas MathWorks.

Key words: mathematics, middle school math, MathWorks, standardized testing

1. Introduction

Presently, students are having difficulty meeting the standards set by the state of Texas in the area of mathematics (Texas Education Agency, 2008b). State and federal sanctions are imposed when students fall short of state and federal standards. High stakes testing has increased retention rates among students, contributed to student and teacher anxiety, and resulted in teacher burnout (Kohn, 2000). Senk and Thompson (2003) stated, "Research about the effects of mathematics curricula can potentially address questions about student' achievement relative to a particular curriculum, or comparisons of students' achievement relative to different curricula" (p. 18).

The passage of the No Child Left behind Act of 2001 (NCLB) changed public education. This sweeping legislation affected many policies in education, but especially those concerning student achievement and

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assessment. Under NCLB all states were mandated to develop a system for measuring the achievement of every student with expectation that 100 percent of students will pass set standards by 2014 (No Child Left behind Act of 2001). In the United States students are tested more often within a year than anywhere in the world (Meier, 2000). The U.S. is the only nation to attempt to educate everyone making attendance in school compensatory with penalties of court time and fines given to parents who are noncompliant. It becomes the responsibility of Texas school districts to make informed and data driven decisions when it comes to choosing a strong research-based mathematics program that positively impacts student learning (Jorgensen & Hoffman, 2003).

It is essential that districts choose a mathematics program that has proven to be successful in preparing students for the Texas Assessment of Knowledge and Skills (TAKS) test. Components of each math program should engage students in active learning through teacher to student and student to student interactions (National Council of Teachers of Mathematics, 1990). Any program chosen needs to be aligned to the Texas Essential Knowledge and Skills (TEKS), the Texas state curriculum. Alignment of content, instruction, and testing must be in place within the program in order for students to be successful on state criterion or national standardized testing (English & Steffy, 2000).

With these things in mind, decision makers within Texas school districts need accurate and the most up to date information through program evaluation so that informed decisions can be made concerning mathematics instructional programs. A concerted effort must be made to provide teachers, as well as administrators, with a clear and common understanding of program design, activities, lesson construct, supplemental materials availability, as well as planned implementation of instruction. Districts must make informed decisions concerning the most reliable and proven mathematics program for their middle schools in order for students to pass the state mandated testing.

1.1 Methodology

The study focused on three math programs. Middle school campuses within this study voluntarily chose and received approval to implement one of the three math programs for the academic years of 2008–2009 to 2009–2010. The Texas Assessment of Knowledge and Skills (TAKS) test was the testing measure of student mathematics progress and ability. All the data for the study was collected without bias and every effort was made to ensure that data was collected uniformly. The TAKS testing results data was received directly from the district under study after test results were given to the district from the Texas Education Agency.

A causal-comparative research design was used for this study. The independent variables were the different programs in use at the seven middle school campuses, Connected Mathematics, Texas MathWorks, and Glencoe. The dependent variables for this study were the student TAKS scores for each of the sixth and seventh grade levels for the years 2008–2009 and 2009–2010. The scores indicated individual student mastery of the Texas Essential Knowledge and Skills (TEKS) mathematics curriculum objectives on the mathematics section of the TAKS test. The covariant was the student's prior year's TAKS test score. These scores were considered the pre-test for the purpose of this study and were treated as a covariate to control for pre-existing differences between the groups.

1.2 Population

The population for this study included middle school students between the ages of ten and fourteen. All students in this study live in south Texas. The students that participated in this study included 1384 sixth graders and 1426 seventh graders for the year 2008–2009 with 1463 sixth graders and 1418 seventh graders for the year 2009–2010. School size ranged from 650 to 1000 students per middle school campus. Hispanic students

comprised 85 to 99 percent of the student population across the seven middle schools with 41 to 89 percent designated as low socio-economic status. This south Texas area is considered a low socio-economic area with every middle school receiving school wide Title I funding (Texas Education Agency, 2008b). The Academic Excellence Indicator System (AEIS) reports of 2008-2009 for each of the seven middle schools show demographics that are similar to other districts within this south Texas region (Texas Education Agency, 2009a).

2. Procedures and Data Analysis

2.1 Data Preparation

Data files were requested from the district under study in order to answer the research questions. Requests included individual student TAKS test results from elementary and middle school campuses for school year 2007–2008 for grades five and six, school year 2008–2009 for grades five, six, and seven, and school year 2009–2010 for grades six and seven.

The school district provided student identifier records that were merged enabling two consecutive years of data to be viewed per student record. Student records were individually deleted if a student record lacked a complete list of all the variables needed for analyses.

2.2 Data Analysis

One-way Analysis of Covariance (ANCOVA) was conducted. The higher grade level math score was identified as the dependent variable. The mathematics program used was the fixed effect, or the independent variable. The lower grade math score was the covariate. Post-hoc analyses consisting of pairwise comparisons were conducted. The Bonferroni method was used to control type I errors for all pairwise comparisons when the level of statistical significance was determined to be less than 0.05. A probability level or alpha level of 0.05 was used as the measure to determine statistical significance.

2.3 Results

Assumption one was met for each research question. The covariate was measured prior to the intervention. The covariate for each research question was the prior year grade level's TAKS math scores. Assumption two was met for each research question. The covariate, prior year grade level's TAKS math scores are validated through rigid standards set by the Texas Education Agency, Assessment Division (Texas Education Agency, 2007). Assumption three was satisfied for each research question. Each covariate was independent and linked directly to the dependent variable within that particular research question. Each covariate stands alone. Assumption four was verified through the use of scatterplots to test linearity. Each was checked separately and no curvilinear relationships were observed. Assumption five required that the relationship between the covariate and the dependent variable for each of the groups are the same as indicated through similar slopes on the regression line for each group. This was done graphically by inspecting the scatterplot between the dependent variable and the covariate obtained when testing for Assumption four (Pallant, 2007). The homogeneity of regression slopes test evaluated the interaction between the covariate and the factor, the independent variable, in the prediction of the dependent variable. The results of the homogeneity of regression of slopes for each research question were non-significant and therefore, the assumption was not violated.

2.4 Research Question 1

RQ 1-Are there significant differences among the math programs Texas MathWorks, Connected Mathematics, and Glencoe on the grade six total TAKS math scores while controlling for the grade five total TAKS math scores

for year 2008–2009?

Research question one was analyzed using a one-way analysis of covariance (ANCOVA). The finding of the ANCOVA was significant indicating, $F(2, 1380) = 30.74$, $p < 0.01$, and the strength of the relationship between the programs and dependent variable was assessed by a partial η^2 of.04 indicating a small effect size. Only four percent of the variance was explained therefore, the significant differences may be due to a large sample size. The null hypotheses of no differences among the three math programs on the grade six total TAKS math scores while controlling for the grade five TAKS math scores for the year for year 2008–2009 was rejected.

A post hoc analysis using the Bonferroni was conducted to determine which means(s) were significantly different. Table 1 reflects each of the three math program comparisons. Each mathematics program showed a significant difference when compared to the other two mathematics programs.

Table 1 Pairwise Comparison Post Hoc Test for Grade Six in School Year 2008–2009

Program	to Programs	*MD*	*ρ*
Connected Math	TX Math Works	93.771	0.000*
	Glencoe	52.685	0.000*
Glencoe	TX MathWorks	41.086	0.002*

Note: $^*p < 0.01$, $N = 1384$

All p values are less than 0.01 indicating that there were significant differences among the adjusted means. Sixth grade students in 2008–2009 using the Connected Math program ($M = 2360.67$) scored significantly higher than both sixth grade students taught with the Glencoe program ($M = 2307.99$) with a mean difference of 52.69 and sixth grade student taught with the TX MathWorks program ($M = 2266.90$) with a mean difference of 93.77. Sixth grade students in 2008–2009 using the Glencoe program ($M = 2307.99$) scored significantly higher than the six grade students taught with TX MathWorks program ($M = 2266.90$) with a mean difference of 41.07. The results show that the Connected Mathematics Program ranked first among the three math programs for sixth graders in 2009–2010 with Glencoe second and Texas MathWorks third.

2.5 Research Question 2

RQ 2-Are there significant differences among the math programs Texas MathWorks, Connected Mathematics and Glencoe on the grade six total TAKS math scores while controlling for the grade five total TAKS math scores in the school year 2009–2010?

In research question two, the ANCOVA was significant, $F(2, 1459) = 18.19$, $p < 0.01$, and the strength of the relationship between the programs and dependent variable was assessed by a partial η^2 of .02 indicating a small effect size as only two percent of the variance was explained. The significant differences may be due to a large sample size. The decision was made to reject the null hypotheses of no difference among the three math programs on the grade six total TAKS math scores while controlling for the grade five TAKS math scores for the year 2009–2010.

A post hoc analysis using the Bonferroni was conducted to determine which means(s) were significantly different. Table 2 reflects each of the three math program comparisons. Each mathematics program showed a significant difference when compared to the other two mathematics programs.

Sixth grade students using the Connected Math program in 2009–2010 ($M = 729.96$) scored significantly higher than the students taught with Glencoe program ($M = 719.70$) by a mean difference of 10.26 and the students taught with Texas MathWorks ($M = 699.14$) by a mean difference of 30.82. Sixth grade students using the Glencoe program in 2009–2010 ($M = 719.70$) scored significantly higher than sixth grade students taught with the

Texas MathWorks program (M = 699.14) by a mean difference of 20.55.

Table 2 Pairwise Comparison Post Hoc Test for Grade Six in School Year 2009–2010

Program	Programs	*MD*	ρ
Connected Math	TX Math Works	30.818	0.000*
	Glencoe	10.264	0.024*
Glencoe	TX MathWorks	20.554	0.000*

Note: *p <0.05, N = 1463.

The results show that the Connected Mathematics Program ranked first among the three math programs for sixth graders in 2009–2010 with Glencoe second and Texas MathWorks third. As with research question one, the effect size was very small and the sample size was large. These similarities may be explained due to the large sample size. However, the pattern of differences remain the same in both years, even though the effect size is small, meaning these differences do exist and, as such, must be accepted as true.

2.6 Research Question 3

RQ 3-Are there significant differences among the math programs Texas MathWorks, Connected Mathematics, and Glencoe on the grade seven total TAKS math scores while controlling for the grade six total TAKS math scores in the school year 2008–2009?

Research question three was also analyzed using the ANCOVA. The ANCOVA was significant, F (2, 1422) = 13.46, MSE = 10288.26, p < 0.01, and the strength of the relationship between the programs and dependent variable was assessed by a partial η^2 of 0.02 indicating a small effect size Only two percent of the variance was explained therefore, the significant differences may be due to a large sample size. The decision was made to reject the null hypotheses of no difference among the three math programs on the grade seven total TAKS math scores while controlling for the grade six TAKS math scores for the year for year 2008–2009.

A post hoc analysis using the Bonferroni was conducted to determine which means(s) were significantly different. Table 3 reflects each of the three math program comparisons. Each mathematics program showed a significant difference when compared to the other two mathematics programs.

Table 3 Pairwise Comparison Post Hoc Test for Grade Seven in School Year 2008-2009

Program	to Programs	*MD*	ρ
Connected Math	TX Math Works	43.408	0.000*
	Glencoe	18.531	0.006*
TX MathWorks	Glencoe	-24.876	0.006*

Note: *p < 0.05, N = 1463

Seventh grade students using the Connected Math program in 2008-2009 (M = 2253.25) scored significantly higher than the seventh grade students taught with Glencoe program (M = 2234.72) and those students taught with Texas MathWorks (M = 2209.85). Seventh grade students using the Glencoe program in 2008-2009 (M = 2234.72) scored significantly higher than seventh grade students taught with the Texas MathWorks program (M = 2209.85). As with research question one and two, the effect size was small and the sample size was large. These similarities may be explained due to the large sample size. However, the pattern remains the same with Connected Mathematics Program ranking first among the three math programs for sixth graders in 2009–2010, Glencoe second and Texas MathWorks third.

2.7 Research Question 4

RQ 4-Are there significant differences among the math programs Texas MathWorks, Connected Mathematics, and Glencoe on the grade seven total TAKS math scores while controlling for the grade six total TAKS math scores in the school year 2009–2010?

A one-way analysis of covariance (ANCOVA) was conducted. The independent variable included three levels: Texas MathWorks, Connected Mathematics, and Glencoe math programs. The dependent variable was the grade seven TAKS math scores for 2009-2010 and the covariate was the prior year grade six TAKS math scores for 2008–2009. The ANCOVA was not significant, $F(2, 1412) = 0.415$, $p = 0.66$. As a result, the decision was made to fail to reject the null hypotheses of no difference among the three math programs Texas MathWorks, Connected Mathematics, and Glencoe on the grade seven total TAKS math scores while controlling for the grade six TAKS math scores in the school year 2009–2010. In ranking order of adjusted means, the pattern remains the same with the Connected Math Program first among the three math programs, Texas MathWorks is second, and Glencoe is last.

3. Discussion and Implications

In the age of accountability, school districts need to make informed decisions when it comes to choosing a strong research-based mathematics instruction program that positively impacts student learning (Jorgensen & Hoffman, 2003). Moses and Cobb, in their book *Radical Equations*, explain that math literacy has the same importance as reading and writing literacy. Students should study mathematics each year of their elementary, middle school, and high school years, better preparing them for community college or a university, the workplace, and life (National Research Council, 1990). The call for mathematics education reform (National Council of Teachers of Mathematics, 2000), the controversy that surrounds returning to basic skills (Walmsley, 2003), the consequences of high stakes testing (Kohn, 2000), and the importance of algebra as a gateway to success (Moses & Cobb, 2001), all make it imperative that school districts choose a math program that has a positive impact on student learning.

4. Data Analysis Summary

The null hypothesis of no significant differences between math programs, Texas MathWorks, Connected Mathematics, and Glencoe was rejected for each of research questions one, two, and three. The findings indicated that sixth graders for years 2008–2009 and 2009–2010 and seventh graders for 2008-2009 do significantly better on the TAKS test by participating in the Connected Mathematics Program over Glencoe and Texas MathWorks. In research question four, the decision was made to fail to reject the null hypothesis of no difference among the math programs Texas MathWorks, Connected Mathematics, and Glencoe for seventh grade students in 2009–2010. However, it is important to note that even though effect sizes were small and the sample sizes were large, similar patterns in the ordering of the programs were found across both sixth and seventh grade for both 2008–2009 and 2009–2010 with Connected Mathematics Program ranking first among the three math programs.

5. Conclusions

From the analysis of data, it can be concluded that students enrolled in Connected Mathematics did better on the TAKS test than those in the two other instructional programs, Glencoe and Texas MathWorks. This may be because Connected Mathematics program presents a better understanding of the mathematics concepts that are

needed to pass the TAKS tests. Time may be a factor in the success of the Connected Mathematics program. Connected Mathematics has been in place in this south Texas school district since the fall of 2003 (McAllen Independent School District, 2003). The program also has a strong staff development component. Research indicates that Connected Mathematics is a strong inquiry based instructional program where students are given time to delve, discuss, and think through problems. In this program there are small and large group activities that allow for exploration and discovery (Prentice Hall, 2004). Training for classroom teachers, a vital component of this program, was provided to better understand inquiry based learning versus the direct teaching method so prevalent in schools where students received a lecture from the teacher for a majority of the class period followed by guided practice and homework (J. Acosta, personal communication, September 21, 2007). This approach supports the literature. The National Research Council publications, *Everybody Counts* and *Reshaping School Mathematics,* support a concentrated effort to reach beyond mere paper pencil activities and encourage teacher to student and student to student interaction (National Research Council, 1990). Connected Mathematics seems to base much of their pedagogy on constructivism, where students create meaning of their world from their personal experiences (Gutek, 2004). The other two programs, Glencoe and Texas MathWorks, have similar activities and teacher staff development, though not to the extent seen in the Connected Mathematics Program in this south Texas school district.

The issue of alignment of content, instruction, and testing also plays a role in the results obtained from the data. Alignment of these three areas is essential in student success within the classroom as well as on a state exam (English & Steffy, 2000). Each mathematics program in this study focused on aligning topics within their programs to the state curriculum objectives outlined in the Texas Essential Knowledge and Skills (TEKS). Considering the importance of this element in instruction, more research is needed in this area.

In summary, various studies on pedagogy support this approach to teaching mathematics as seen in the research that spans four decades (Ball, 2003; Barnes et al, 1998; Dillon, 2009; Edmonds, 1973, Garcia, 2002; Great Schools, 2010; Goodlad, 1976; Gutek, 2004; Hoover, 2000; Jackson and Davis, 2000; Lappan, 1997; Marsh & Willis, 2003; Mitchell, 1992; National Mathematics Advisory Council, 2008; National Research Council, 1990; Senk and Thompson, 2003; Silver & Stein, 1996; Sobel, 1981; Stone, 2004). More hands on learning with manipulatives, more time spent in discussion with peers as well as the teacher, teachers acting in a facilitator role rather than totally dominating instruction through direct teaching methods are components of all three programs. This study is able to offer school administrators and teachers the research to make choices to select a mathematics program that supports an active, hands-on, inquiry method of teaching mathematics to middle school students in south Texas.

6. Recommendations

Based on the results of this study, Connected Mathematics is the strongest of the three math programs studied. This study supports choosing a program such as Connected Mathematics that provides multiple activities to engage students in active learning through teacher to student and student to student interactions (National Council of Teachers of Mathematics, 1990). In addition, it emphasizes selecting a mathematics program that has a strong staff development component as part of the program package so that teachers and administrators are fully able to understand and implement the program. The study also encourages reviewing the mathematics program under consideration to ensure alignment of content, instruction, and testing are present to the extent that will result in a

successful mathematics curriculum with positive testing results on state criterion or national standardized testing (English & Steffy, 2000). The study also suggests that school districts consider selecting a mathematics program that has a proven record of success on the TAKS test.

In summary, this study will help districts choose a strong research-based mathematics program that positively impacts student learning. The data from this study provides information for selecting a strong mathematics program. Selection of a research-based mathematics program increases TAKS math scores and prepares students for future success in higher mathematics. Selecting a strong mathematics program benefits a district by being cost effective and sustains student learning as they progress into higher mathematics courses helping to make them more competitive in the world marketplace.

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