Longitudinal Effects of Technology Integration and Teacher Professional Development on Students' Mathematics Achievement

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ABSTRACT

MathForward is a program that provides teacher professional development and integrates the use of technology as a tool in the classroom. The present study examined students' mathematics growth from 2012 to 2013 and observed how students' mathematics scores changed after their school implemented the MathForward program. The sample consisted of two years of the State of Texas Assessments of Academic Readiness (STAAR) test data for a total of 563 students. The participants took the first STAAR examination in 2012 at the end of 7th grade and took the second examination in 2013 at the end of 8th grade. In general, regardless of background or student characteristic, pupils increased their mathematics STAAR test scores statistically significantly ($p < .05$) with the Cohen's d effect size of 0.26. Properly implemented, MathForward could be useful in raising the mathematics achievement of students.

Keywords: professional development, technology integration, mathematics achievement

INTRODUCTION

Mathematics teaching and learning have received much attention in recent years because international comparisons such as TIMSS and PISA have ranked U.S. students' performance below that of students from other developed countries (Bicer, Navruz, Capraro, & Capraro, 2014; Bicer, Navruz, Capraro Capraro, Oner, & Boedeker, 2015). Also, national indicators such as the National Assessment of Educational Progress (NAEP, 2006) showed that 8th graders were not proficient in mathematics. In particular, educators have identified algebra as a central theme in mathematics (McCoy, 2005). Early exposure to algebra courses was found to increase the opportunity for students to complete higher-level mathematics courses, thereby improving mathematical literacy (Spielhagen, 2006). To improve students' mathematical literacy, the National Council of Teachers of Mathematics (NCTM) standards have been revised to include rigorous and challenging mathematical tasks in middle school (NCTM, 2000). These new tasks suggested by NCTM (2000) included integrating technology into mathematics classrooms to

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State of the literature

- MathForward is a program to provide teacher professional development and integrate the use of technology as a tool in the classroom.
- Previous research suggested that teacher positive attitude toward technology and access to long-term professional development could be key components for the effective integration of technology into the classroom.
- The theoretical framework for the present study was based on the existing literature and indicated that increased mathematics performance could be accomplished by providing long-term, technology-relevant professional development to teachers, coupled with advanced technology resources. However, very few studies investigated the effects of teacher professional development and technology integration on students' mathematics achievement over time.

Contribution of this paper to the literature

- This paper provides a critical review of the effects of technology integration and teacher professional development on students' mathematics achievement. The present study found that MathForward intervention was effective and has the potential to improve middle school students' mathematics performance.
- The present study shows an increase in students' mathematics performance after a year receiving the MathForward program intervention, irrespective of their gender and ethnic background.
- Students from the low-SES group performed statistically significantly ($p < .05$) lower than students from the non low-SES group. However, both groups showed comparable gains in their mathematics performance on the STAAR test.

make students' mathematical learning more meaningful. The U. S. Congress Office of Technology Assessment (OTA, 1995) also emphasized the importance of technology in school life by stating, "effectively incorporat[ing] technology into the teaching and learning process is one of the most important steps the nation can take to make the most of past and continuing investments in educational technology" (p. 8) .

Technology in Classrooms

As technology use became ubiquitous, calculator use became common in mathematics classrooms. Educators were initially concerned that calculator use would lead to shallowness of learning due to dependence on devices for basic mathematical operations (Heid, 1997). However, graphing calculators (GC) were observed to develop higher order thinking in students by exposing them to various mathematical situations (Simonsen & Dick, 1997). GCs were ideal for students to learn algebra because the wide screen display of the GC helped students to keep track of multiple steps and to explore various patterns during problem solving (Merriweather & Tharp, 1999). In a meta-analytic study by Ellington (2006), the observation was made that under no circumstances did students taught without calculators perform better than students with access to calculators. Bouck (2009) investigated the effects of using GCs on students with special needs and reported a positive effect on their mathematics achievement. One of the factors that adversely affected integration of computers

and related technologies into the classroom was teachers' negative attitudes towards technological tools (computers, interactive whiteboards, and calculators) (Bullock, 2004; Huang & Liaw, 2005).

Teachers and Technology

A teacher's level of comfort with and ability to use technology could influence the degree to which technology was integrated into their classroom. Teachers' technological competency and attitude towards computing devices impacted student learning in technology-assisted classrooms (Panaoura, 2012; Tran et al., 2012) because teachers effectively decided where and how to use technology (Lawton & Gerschner, 1982; Woodrow, 1992). Teaching with technology was more effective when teachers recognized the importance of such teaching aids (Birgin et al., 2010). Because the teaching and learning opportunities presented by using technology depended on teachers' attitudes, investigating the factors influencing teachers' attitudes towards technology usage in the classroom was vitally important (Teo, 2006). There are many factors influencing teachers' attitudes towards technology usage in the classroom. These factors include but are not limited to comfort level with technology (Rovai & Childress, 2002), gender (Sadik, 2006), training or professional development in technology (Yuen, Law & Chen, 1999), and feelings (anxiety, confidence, and liking) towards technology (Yildirim, 2000).

Teacher positive attitude toward technology and access to long-term professional development could be key components for the effective integration of technology into the classroom. Most teachers had positive attitudes towards technology after they used it (Kumar & Kumar, 2003). However, reducing technology anxiety depended on the type of experience to which teachers were exposed (McInerney, McInerney, & Sinclair, 1994). For example, being exposed to at least 30 hours of technological instruction and application could reduce teachers' anxiety towards use of related technology. Reducing anxiety was the early step for teachers to comfortably use technology in their classrooms (Beasley & Sutton, 1993). Guiding teachers in how best to utilize technology through professional development could lead to reductions in anxiety and enable teachers fluidly and creatively integrate technology into their classrooms. Professional development to meet teachers' instructional needs was crucial to improving student performance (Kent, 2004). As opposed to disconnected, short professional development sessions, sustained programs with intensive subject content professional development were found to have a more lasting and positive impact on students (Garet, Porter, Desimone, Birman, & Yoon, 2001; Yoon, Duncan, Lee, Scarloss & Shapley, 2007). Professional development and related technology experience were consistent variables that reduced teachers' technology anxiety and supported the implementation of technology in classrooms.

The theoretical framework for the present study indicated that increased mathematics performance could be accomplished by providing long-term, technology-relevant professional development to teachers, coupled with advanced technology resources (See **Figure 1**). Once
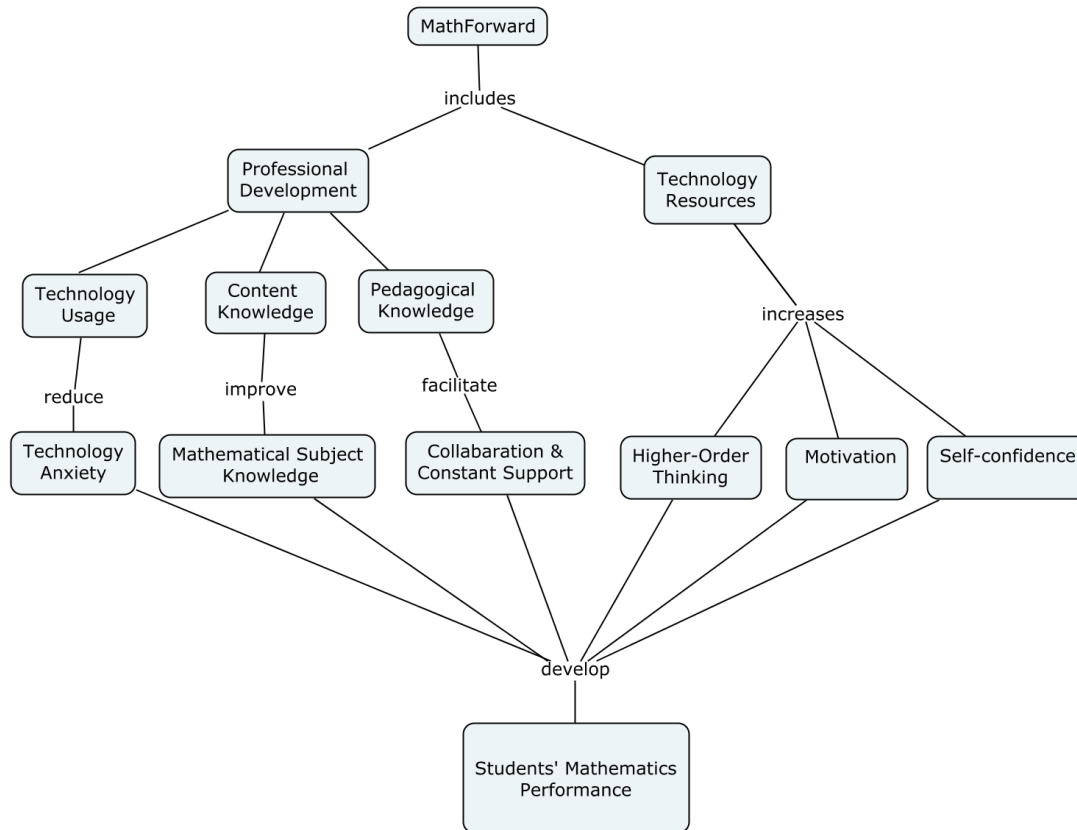
Figure 1. Conceptual framework for the present study

teachers believed technology needed to be integrated into their classrooms and they had access to advanced technological resources, their technology implementation in mathematics classrooms could be easy and quick.

Achievement Disparities by Groups

Not all students learn the same way as one another, and in a diverse country such as the United States, there will be some discrepancies between abilities. However, not all gaps are inherently due to differences in ability and should be minimized where possible. Areas of interest in the present study were achievement gaps moderated by gender, ethnicity, socio-economic status (SES), English proficiency, and student use of an individualized education program (IEP).

Gender could be traditionally thought of as a dividing line in mathematics ability. Historically, women were underrepresented in the areas of science, technology, engineering, and mathematics (STEM) (Eccles, 1989). In recent years, there was an increase in the number of women involved in these subjects, but they continued to be outnumbered by men pursuing

careers in STEM fields (Hill, Corbett, & St Rose, 2010). Environmental factors such as parents' or teachers' attitudes (Blickenstaff, 2005), and cultural stereotypes that mathematics and science are more natural to males than females had influenced the participation of women in STEM related fields (Kiefer & Sekaquaptewa, 2007). However, the results of recent studies showed that these stereotypes might not be warranted. Results from the 2003 TIMSS exam demonstrated that males did not consistently outperform females in mathematics and science; however, there was a high correlation between gender-stereotypes and students' STEM performance (Nosek et al., 2009). Based on a longitudinal study, even when performance of boys and girls in mathematics was similar during the early years of schooling, boys outperformed girls in the later years (Fryer & Levitt, 2009). Additionally, the performance gap has been closing over time, and girls were performing nearly as well as boys on standardized tests in mathematics (Mertz, 2009). Decreasing the gender gap in mathematics would be important in increasing the population of females in STEM related fields.

Disparities in performance by race was yet another concern. Asian and White students generally outperformed Hispanic and African American students in mathematics (Tate, 1997). In addition, the achievement gap tended to widen as students progressed through their education, causing underrepresentation of some ethnic groups at higher education levels (ACT, 2012). The performance gap was sometimes due to lack of access to resources and qualified teachers (Flores, 2007). Varying the composition of classrooms to include a considerable number of ethnic minority students, changing teaching styles, and using technology in classrooms were some suggestions to reduce the achievement gap (Brown-Jeffy, 2009; Flores, 2007). Another factor that could divide students was based on SES (Bicer, Capraro, & Capraro, 2013).

Research already noted that students who came from a low-SES background started school academically behind their peers from middle or high-SES backgrounds, particularly in mathematics (Jordan et al., 2007). Many interventions had been proposed to decrease the mathematics achievement gap between low-and high-SES students. These interventions included but were not limited to increasing parental involvement (Cross et al., 2009), encouraging parental support (Starkey & Klein, 2000), implementation of the Head Start program, and higher levels of parental communication and expectation (Bicer, Capraro, & Capraro, 2013). However, not all interventions resulted in decreasing the mathematics achievement gap among students who came from low-and high-SES backgrounds. For example, students who enrolled in the Head Start program did not statistically significantly increase their early mathematics achievement (U. S. Department of Health and human Services, 2005). Specifically, the students who attended Head Start programs demonstrated little gains in the topic of numbers and no gains in geometry (Clements & Sarama, 2007). Many interventions have sought to decrease the achievement gap between low-SES and high-SES students; however, further work is necessary to create useful solutions.

An identifiable gap in mathematics performance existed between students who were labeled as possessing limited English proficiency (LEP) and their English proficient peers. The

No Child Left Behind Act of 2001 classified a student as LEP if that child (1) was between the ages of 3 and 21; (2) was currently enrolled or preparing to enroll in elementary or secondary school; (3) was born in another country or lived in a home in which English was not the first language; (4) lacked the English language ability to be successful in school and society. An achievement gap between LEP students and non-LEP students was notable in mathematics, with 48% of LEP fourth grade students and 71% of LEP eighth grade students scoring below the basic level, lagging behind every ethnic group (National Center for Education Statistics [NCES], 2005). In the 2011-2012 school year, 4.4 million students in public education qualified as LEP, accounting for 9.1% of the public school student body (National Center of Education Statistics, 2014). Efforts to minimize this gap were faced with many challenges, such as a lack of stability in LEP populations, the poor measurement quality of instruments for LEP students, and inconsistent LEP classifications across states (Abedi, 2004). The population of LEP students was growing across the United States and as such greater research and analyses were necessary to meet the needs of larger numbers of LEP students (Payan & Nettles, 2008).

The final group of students of interest in this study was students who were learning based on an individualized education program (IEP). An IEP was developed for students who qualified for special education services (U. S. Department of Education, 2015a). Creating an IEP involved meetings between specialists and parents to determine measureable goals for academic and functional progress. Students who qualified for special education services could do so for a variety of reasons including but not limited to: learning disabilities, attention deficit hyperactivity disorder, cognitive challenges, autism, hearing impairment, visual impairment, or developmental delay (KidsHealth, 2015). These conditions could cause students to be academically and socially behind their peers. In the United States, 13.1% of students had an IEP in the 2012-2013 school year (U. S. Department of Education, 2015b). Further investigation and development of interventions could help to bolster these students' knowledge.

MathForward

Texas Instruments' (TI) handheld devices were advanced graphing calculators with multiple mathematical features. The TI MathForward program combined the use of TI calculators with professional development for teachers to improve algebra readiness among students and reduce the performance gap between various ethnic groups. The MathForward program aimed at bringing about a systematic and sustained change in mathematics teaching by targeting school districts instead of individual teachers and providing constant support for instruction (Penuel, 2008). The eight focal points of the MathForward program were 1) increased instruction time, 2) use of technology (such as a network of graphing calculators) to motivate students, 3) common aligned assessment strategies for teachers, 4) implementation of an accelerated curriculum and heightened expectations for all students, 5) increased teacher content knowledge and pedagogical skill, 6) collaboration and common planning time for teachers, 7) increased administrative and parental support of mathematics learning, and 8) on-going professional development and coaching for teachers (Schaar, n.d.; Winick & Lewis, 2007).

With the implementation of MathForward, mathematics classes were altered in several ways which resulted in beneficial outcomes. In order to increase the instruction time, classes were designed as 100-minute power-blocks with time allocated for warm-ups, standard lessons, and problem solving (Haney, n.d.). During class time, a network of handheld devices supported collaborative learning and provided the teacher with instant feedback to adjust the pace of the lesson (Penuel, Ferguson, Singleton, Shea, Borelli, & Korbak, 2008). Students felt safer in answering the questions as the responses were collected anonymously. Teachers reported that the use of technology had improved students' engagement in the classroom, motivation to learn, and retention of information (Schaar, n.d.). MathForward impacted more than the teacher-student interaction time in the classroom.

Teachers were provided constant support to integrate technology into lessons that aligned with state standards. Co-teaching, classroom observations, and reflections were an integral part of coaching that teachers received. Regularly scheduled planning times allowed teachers to exchange pedagogical strategies and content knowledge. Teachers were encouraged to develop mathematics content knowledge by interacting with mathematicians, either face-to-face, or through attending online seminars, and these professional development practices enabled teachers to integrate innovative instructional methods and technology into their classrooms (Erdogan, Corlu, & Capraro, 2013; Corlu & Corlu, 2012). Even though the implementation of the program was varied between different school districts, teachers highly valued the extensive professional development and the informal support they received through teacher collaboration (Penuel et al., 2008). Teachers' self-confidence, teaching effectiveness, and mathematics content knowledge improved after participation in MathForward (Winick & Lewis, 2006). The MathForward program has impacted both students and teachers positively (Penuel et al., 2008). As a result of using technology paired with professional development, students participating in the MathForward program performed better than the control group (Winick & Lewis, 2007). The program combined classroom transformation through restructuring and technology integration with continued professional development for teachers and yielded positive outcomes.

In the current study, 8th grade students were provided with handheld devices, the TI-Navigator and TI-Nspire, during mathematics instruction. The teachers received 48 hours of professional development in order to integrate the technology into their classrooms to meet the existing state curriculum standards. Teachers received guidance from TI MathForward consultants concerning specific teaching strategies and activities for algebra instruction complimented by the TI technology. Once a week, teachers had a three-hour common planning period to share lesson plans, pedagogical knowledge, and subject content knowledge. Teachers were encouraged to interact with mathematicians to improve their own mathematical content knowledge.

Research Questions

1) Do students' mathematics performances on the STAAR test statistically significantly change from 7th grade to 8th grade after receiving one year of MathForward intervention?
2) Do students' mathematics performances on the STAAR test statistically significantly differ by their gender, ethnicity, SES, LEP, and IEP status after one year of MathForward instruction?

METHOD

Data Sources

The sample consisted of two years of the State of Texas Assessments of Academic Readiness (STAAR) test data for a total of 563 students. The STAAR tests were a series of statewide standardized tests used in Texas public, primary, and secondary schools to evaluate students' mathematics, science, reading, social science, and English (Reading and Writing) achievement by grade level (Texas Education Agency (TEA), 2015). Among those students' achievement outcomes from the STAAR tests, only students' mathematics scores were gathered as the focus of the present study.

The participants took the first STAAR examination in 2012 at the end of 7th grade and took the second examination in 2013 at the end of 8th grade. The present study examined mathematics growth from 2012 to 2013 at one urban school in Texas and observed how students' mathematics scores changed after their school implemented the MathForward program. In order to understand whether students' mathematics growth from 2012 to 2013 was more or less than expected, two comparison schools were selected by applying propensity score matching techniques. Nearest neighbor propensity score matching technique was conducted by using the following variables: total number of students in one school; % of economically disadvantaged students, % of minority subgroups, % of English second language students, and school mobility rate. Total number of students from two matched schools was ($N = 700$; 372 female and 328 male).

In both intervention and matched schools, students who had not taken the STAAR mathematics test in 2012 were excluded from the study. The present study included a diverse background of students in terms of their gender, ethnicity, socio-economic status (SES), individualized educational plan (IEP), and limited English Proficiency (LEP). Students' ($N = 563$) background information was as follows: 276 female, 287 male (see in **Table 1**); 13

Table 1. The number of female and male students in the intervention and matched groups

Gender	Intervention Group	Matched Group
Female	276	372
Male	287	328
Total	563	700

American Indian, 12 Asian, 143 African American, 1 Native Hawaiian, 14 two or more races, and 380 White; 156 high or middle SES, 407 low SES; 53 LEP, 510 non-LEP; 82 IEP and 481 non-IEP.

Analysis

In order to understand how students' mathematics performance on the STAAR test changed overall by their teachers receiving the MathForward intervention, repeated measures ANOVA was employed. Effect sizes and confidence intervals were also provided to examine the practical importance of findings (Capraro & Capraro, 2012).

RESULTS

Before investigating results, assumptions were checked to make sure the results were accurate and differences were not due to violation of statistical assumptions. Investigating the data revealed that all statistical assumptions were met (normal distribution, dependent variable was continuous, and no outliers present) to run repeated measures ANOVA. Because there was no between-group investigation in the model for research question 1, the homogeneity assumption was ignored. For all results, statistical significance was determined between group means with a $p_{critical}$ of .05. Cohen's d effect sizes were also calculated to analyze the practical difference between two group means. Finally, 95% confidence intervals of the group means were displayed for visual representation. These confidence intervals represent the mean of the sample with the sample's margin of error.

Repeated measures ANOVA was used to answer the first question concerning the possible existence of a statistically significant change in students' mathematics performance after their school implemented the MathForward intervention. The results from the present study yielded that regardless of students' backgrounds, students whose teachers received the MathForward intervention increased their mathematics scores statistically significantly ($p <$ .05), with the Cohen's d effect size of 0.26. A 95% confidence interval (see **Figure 2**) was also provided to visually examine all students' mathematics performance on the STAAR test from 7th grade to 8th grade.

In order to understand whether students' mathematics growth from 2012 to 2013 was more or less than expected, mathematics scores of students from two matched schools were collected. The results (see in **Figure 3**) showed that students who come from matched schools statistically significantly decreased their mathematics scores from 2012 to 2013. These scores from the matched schools indicate that the increase in mathematics scores of students who received mathforward intervention was not a naturally occurring growth.

To answer the second question concerning whether the change in students' mathematics scores differed by their background information (gender, ethnicity, SES, LEP, and IEP), statistical significance, effect sizes, and 95% confidence intervals were provided for each background category.
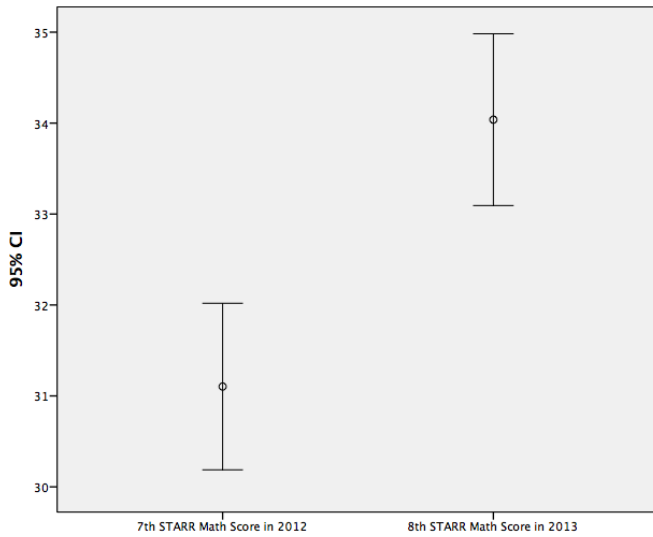
Figure 2. A 95% confidence interval for all students' mathematics performance from 7th grade to 8th grade
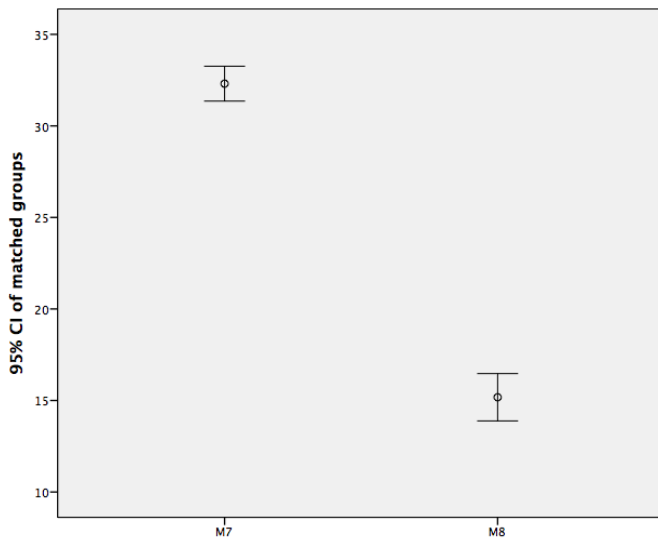

Figure 3. A 95% confidence interval for matched students' mathematics performance from 7th grade to 8th grade

The results associated with students' gender showed that both female and male students' mathematics scores on STAAR statistically significantly increased ($p < .05$) from 7th grade to 8th grade with the Cohens's d effect sizes 0.28 and 0.26, respectively (see **Figure 4**). Both male and female students performed almost at the same level on 7th and 8th grade STAAR mathematics test. The Cohen's d effect size for 8th grade mathematics performance differences between male and female was 0.05.
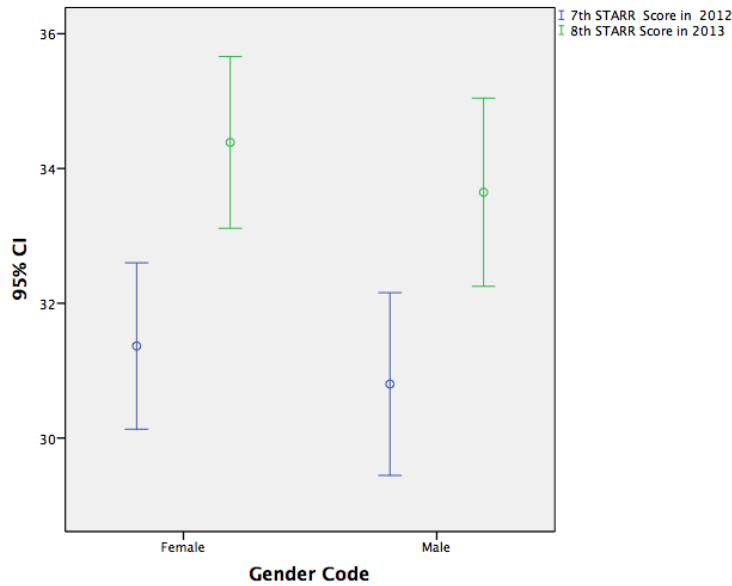
Figure 4. A 95% confidence interval for students' mathematics performance from 7th grade to 8th grade by gender
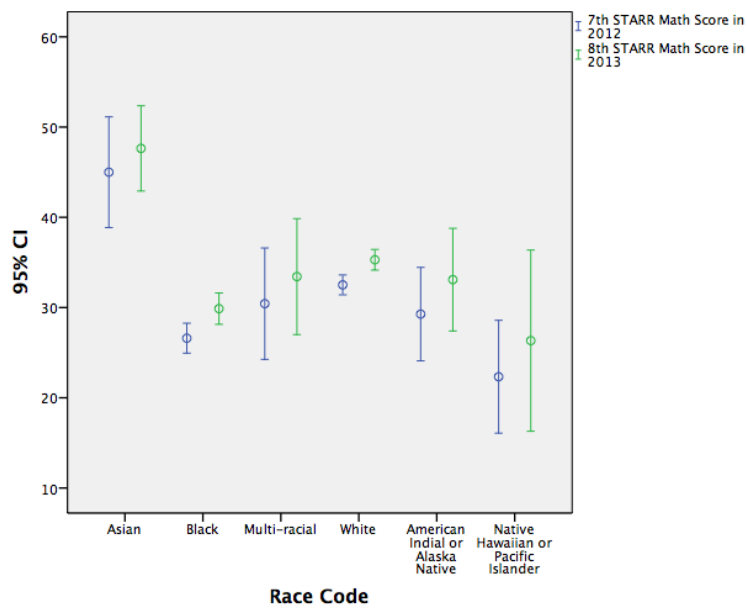

Figure 5. 95% confidence intervals for students' mathematics performance from 7th grade to 8th grade by ethnic background

To investigate the question concerning whether the change in students' mathematics scores differed by their ethnic background, 95% confidence intervals (see in **Figure 5**) were drawn. The results associated with students' ethnic background showed that only two groups,
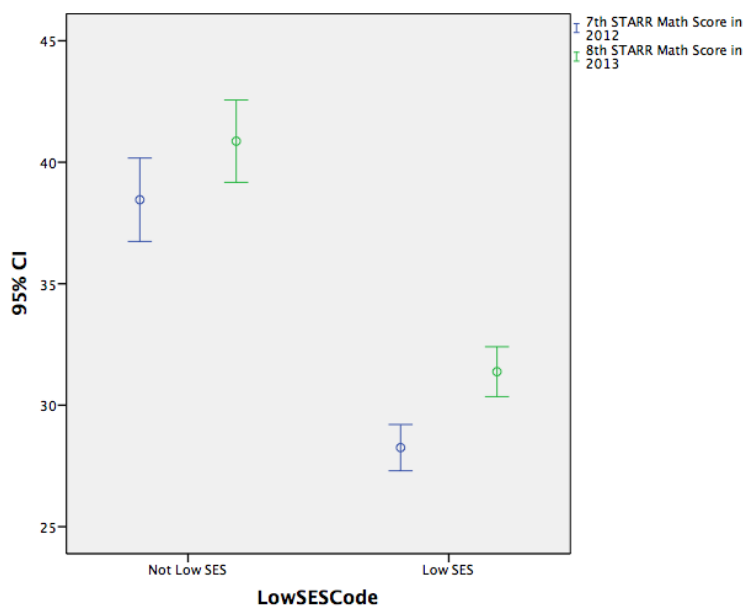
Figure 6. A 95% confidence interval for students' mathematics performance from 7th to 8th grade by students' SES background

White and African American, statistically significantly ($p < .05$) increased their mathematics scores from 7th grade to 8th grade with the Cohens's d effect sizes of 0.25 and 0.31, respectively. However, the results associated with other groups needed to be evaluated cautiously as the sample sizes for Asian, Multi-racial, American Indian or Alaska Native, and Native Hawaiian or Pacific Islander students were relatively small for quantitative analyses. Due to the small sample sizes for these ethnic backgrounds, the results from students who come from ethnic backgrounds other than White and African American were not considered for interpretation in this study. Results also revealed that White students performed statistically significantly better than Black students in the 8th grade STAAR mathematics test. The Cohen's d effect size for this difference was found as 0.51.

To determine the possible change in student performance moderated by SES, 95% confidence intervals for test outcomes were drawn (see **Figure 6**). The results associated with students' SES showed that students who come from low-SES backgrounds statistically significantly ($p < .05$) increased their mathematics scores from 7th grade to 8th grade, yielding a Cohens's d effect size of 0.31. Similar results were not found for middle and high SES students. Students who came from middle or high SES backgrounds did not statistically significantly ($p > .05$) increase their mathematics scores from 7th grade to 8th grade with a Cohens's d effect size of 0.22. Results from the present study also revealed that students who came from middle or high-SES backgrounds statistically significantly outperformed students who came from low-SES backgrounds on 8th grade STAAR mathematics test. The Cohen's d effect size for this difference was 0.9.
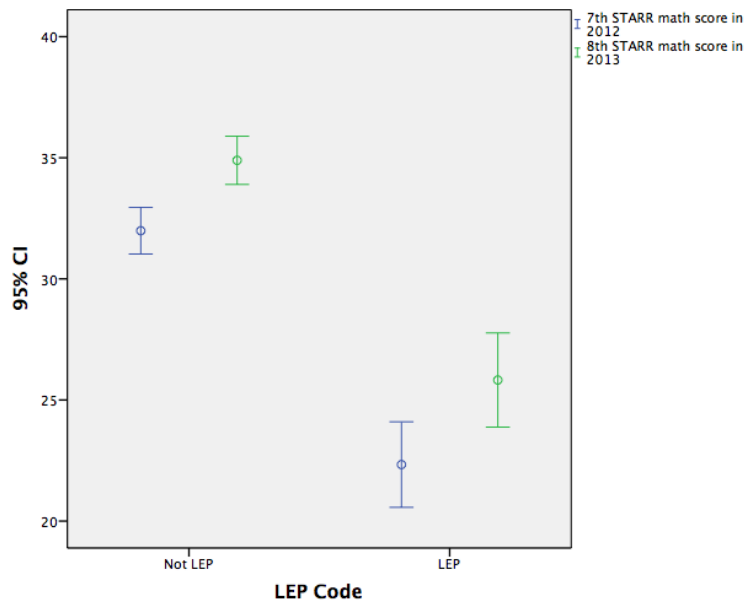
Figure 7. 95% confidence intervals for students' LEP status on students' mathematics performance from 7th grade to 8th grade

To examine the question concerning whether the change in students' mathematics scores differed by their status as LEP or non-LEP, 95% confidence intervals (see **Figure 7**) were drawn. The results associated with students' LEP status showed that both LEP and non-LEP students increased their mathematics performance statistically significantly ($p < .05$) from 7th grade to 8th grade with the Cohens's d effect sizes of 0.25 and 0.56, respectively. Results also noted that in the mathematics part of the STAAR test, students who had limited English proficiency performed statistically significantly ($p < .05$) lower than students who were categorized as Engligh proficient on 8th grade STAAR matheamtics test The Cohen's d effect size for this difference was 0.89.

To answer a final question concerning whether the change in students' mathematics scores differed by their special education status as IEP and non-IEP, 95% confidence intervals (see **Figure 8**) were drawn. The results associated with students' special education status showed that both IEP and non-IEP students increased their mathematics performance statistically significantly ($p < .05$) from 7th grade to 8th grade with the Cohens's d effect sizes of 0.46 and 0.28, respectively. The results also showed that students who were categorized as special education students performed statistically significantly ($p < .05$) lower than students who did not need special education interventions on 8th grade STAAR mathematics test. The Cohen's d effect size for this difference was 0.27.
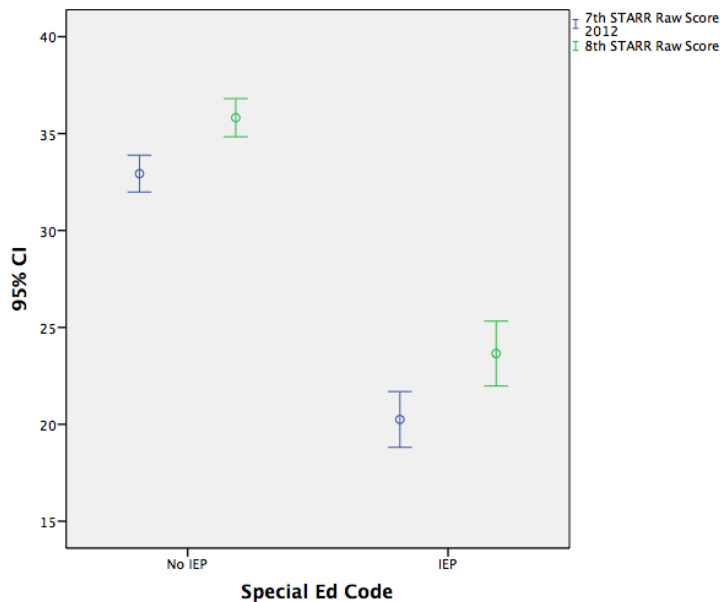
Figure 8. 95% confidence intervals for students' mathematics performance from 7th grade to 8th grade by IEP status

DISCUSSION

The MathForward program is the combination of long-term professional development for teachers and technology integration in the classroom. These activities can be beneficial and lead to student success on standardized tests and other measures. With the implementation of MathForward, achievement gains were found in many of the areas in which the researchers of the present study were concerned.

The first research question was asked to investigate the change in mathematics performance from 7th to 8th grade on the STAAR test for students whose teachers had received the MathForward intervention. In general, regardless of background or student characteristic, pupils increased their scores statistically significantly. While the actual score increase may appear small and seem insignificant, a small result for a very important outcome may be none the less important. Increasing the mathematics achievement level of students is important, especially during this time when students in the United States have fallen behind their international peers in mathematics (Bicer, Navruz, Capraro, & Capraro, 2014). To further understand the possible impact of implementing MathForward, STAAR results were moderated by student background and characteristic.

Mathematics has been traditionally seen as a male subject; however, this perception may be less accurate now than in the past (Hyde & Mertz, 2009; Nosek et al., 2009). The present study investigated the differences in performance between males and females and found that there was not a statistically significant difference in mathematics scores. These results are in line with the growing achievement of females in mathematics. While stereotypes might label

females as inferior mathematicians, the present study shows that females' mathematics abilities are, at least on this standardized assessment, on par with or even greater than their male peers. After the MathForward intervention both males and females increased their scores to a statistically significant degree. The improvement of both groups was almost identical. This shows that implementation of MathForward could equitably yield positive gains for both males and females. Neither group gained to the detriment of the other, an important key in finding an intervention that works in a diverse society.

The diversity found in the United States makes achievement by race an important and interesting topic. The 7th grade scores of students mirrored the findings of Tate (1997), in which White and Asian students outperformed students of other racial categories. Due to the sample size of many of the racial subpopulations being limited, the results focused on White and Black student performance only. These two groups increased their scores between 7th and 8th grade, when the MathForward intervention was taking place. The STAAR score gains by White and Black students were comparable. This indicates that MathForward implementation may play a positive role in helping students increase their scores regardless of ethnicity and do so in an equitable manner. The performance gap between White and Black students did not decrease but instead shifted, following the gains of both groups.

Students' financial position, their SES, can play an important role in their development as students. In the present study, results indicated that students from low-SES backgrounds performed at a lower level on the STAAR test when compared to their middle or high-SES peers. This is consistent with the findings of Jordan et al. (2007) who showed that low-SES students start at a lower mathematics level of achievement than their peers. The outcome associated with implementation of MathForward yielded that both groups of students increased their scores, but results were especially interesting for low-SES students. Their gains were statistically significant, and their practical gains were slightly higher than the group of students from middle or high-SES backgrounds. The exposure to technology they may not be able to afford on their own could be part of the reason why they benefited the most from the program. Further research into the effect of technology interventions, specifically for students with low-SES backgrounds, could provide further insight as to how the achievement gap between these two groups could be closed.

Students with LEP are at a disadvantage because they lack the English language skills they need to fully achieve their potential in the United States. The mathematics achievement gap may be a result of an inability to understand the language of a question and not the concept that the question is trying to evaluate. Students who were classified as LEP scored at a lower level in mathematics when compared to the scores of their non-LEP peers. This lower score performance in mathematics was consistent with the NCES (2005) findings. MathForward may have been an influential factor in increasing student scores between their 7th and 8th grade years. Students labeled as LEP did have a practical increase in their scores but they did not have as drastic an increase in their average scores as the non-LEP group. The finding is interesting because the MathForward program, which does not include language

components, may have helped students struggling with the English language. This may be a result of the increased use of technology which could help those struggling with the English language understand the mathematics that they are being taught. Visually interpreting images graphed on a calculator may help students circumvent the need to fully comprehend a verbal explanation.

Finally, students who qualify for an IEP and receive special education services were of interest in the present research. These students may have behavioral or developmental issues that make learning and school more challenging for them than for their peers. The findings of this study indicated that students with an IEP scored much lower than their non-IEP peers in both the 7th and 8th grades. However, both groups did see statistically significant growth between the two years. Considering effect sizes, the IEP students benefited most in growth from 7th to 8th grade. The MathForward program may have played an important role in these gains. The technology made available in the classrooms may make concepts more accessible and understandable, especially for students with an IEP. The professional development provided to teachers may have helped them determine new ways of teaching content that was more readily learned by students with special needs.

Mathematics achievement has become a critical issue for educators in the United States as students have fallen behind on international tests (Bicer, Navruz, Capraro, & Capraro, 2014). As these facts have been made known, calls for the increased integration of technology into the classroom have gone out (NCTM, 2000; OTA, 1995). MathForward is a program that provides teacher professional development and integrates the use of technology as a tool in the classroom. This study has shown that MathForward may be an important part in the notable success of students regardless of background or characteristic. Properly implemented, MathForward could be useful in raising the mathematics achievement of students.

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