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Teacher Technology Integration Professional Development Model (SMART Board), Pre-Algebra Achievement, and Smart Board Proficiency Scores

Marice Minor[1], Nonofo Losike-Sedimo[2], Gary Reglin[1], and Otelia Royster[3]

Abstract

The study investigated a teacher technology integration professional development model. The model focused on using SMART Board to improve pre-algebra achievement. The importance of the study was that the pre-algebra students at the middle school had a lower passing rate on the pre-algebra standard of learning (SOL) assessment for the past 3 years compared with other middle school students within the district and state. The methodology was guided by the single group pretest and posttest research design. Two research questions were investigated. Data were collected from four pre-algebra teachers and their combined 240 students using the pre-algebra SOL strand test and the SMART Board Technology Proficiency Survey. Results from the descriptive and inferential statistics showed the intervention increased students' mathematics scores and teachers' SMART Board proficiency scores from pretest to posttest.

Keywords

achievement, education, social sciences, academics, education, curriculum, diversity and multiculturalism, educational administration, leadership and policy

Introduction

Current studies show that the successful integration of technologies into classroom instruction not only increases students' test scores but also fosters students' personal autonomy and enhances teachers' proficiency with their technology skills (Bates, Hopkins, & Kratcoski, 2012; Marzano, 2012; O'Connor, 2012; Picciotto, 2012). Students today are more advanced in technology than the last generation of students. Cell phones, video games, iPods, kindles, netbooks, and SMART Boards are common items in the daily lives of today's youth.

The increased involvement in advanced technology contributes to the students' personal autonomy (Bates et al., 2012). Personal autonomy refers to the students' capacity to be self-governing, to develop their own views, and to make important decisions about the direction of their academic life with limited external manipulation by others such as teachers and parents (Marzano, 2012). Autonomy is not simply inscribed in a student's DNA. To become capable of exercising autonomy, a student must be equipped with a range of "inner capacities"—some cognitive, some social, and some affective—that enable independent thought and decision making. SMART Board lessons facilitate young students' efforts at personal autonomy. Furthermore, some of the inner capacities, though not all, fall under the domain of critical thinking or critical reasoning skills. Critical thinking has to do with the intellectual activity students' exercise or fail to exercise in belief formation and revision (Bates et al., 2012).

With SMART Board, learners not only acquire critical reasoning skills that are vital to solving pre-algebra problems, they also actively engage themselves in the pre-algebra learning process wherein this learning is viewed as processes embedded in cognitive and social contexts. Through socialization, the pre-algebra learners use the SMART Board as a cognitive tool to perform and assist each other to be successful in the classroom. The success enhances their personal autonomy and facilitates them to be less dependent on the teacher.

Teachers need to be proficient in the use of the latest technologies in classroom instruction such as the SMART Board (O'Connor, 2012). Teachers must be comfortable with technology, able to apply it appropriately, and conversant with new technological tools, resources, and approaches. If all the pieces are put into place, teachers find that they are empowered to advance their own professional skills through technology tools. Teachers must embrace advanced technologies

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and use them to make the learning environment come alive. For technology to make a difference in students' mathematical achievement, teachers must be knowledgeable concerning how to effectively use technology in the classroom (O'Connor, 2012).

Many teachers are not proficient in the use of technology integration into instruction. In fact, some teachers adamantly resist this change in teaching practice (Picciotto, 2012). Yet, a successful change in technology integration requires that school leaders convince teachers and other staff that there is a need for change. In addition, the change leader must base the recommendations on the data and the research of results of effective technology integration programs. Effective school leadership on technology issues is developed as teachers begin to trust the decisions that are made in the students' best interests (Huber, 2010) and teachers view student test scores are improved as a result of their proficiency in the use of technology in classroom instruction. Thus, trust is gained when the decisions for policy change on technology integration show signs of success.

When technology is used properly in the classroom, middle school teachers benefit from student-centered classrooms and accommodations of different learning styles of their students. In addition, teachers can also improve their accountability of providing feedback to students, parents, and the administration. Student achievement can also improve with proper use of technology.

The National Education Technology Plan for K-12 (U.S. Department of Education, 2004) released for California Virtual Schools indicated that today teachers have more resources available through technology than ever before. Yet, some teachers have not received sufficient training in the effective use of technology and the implementation of technology into their delivery of instruction.

Statement of the Problem

The problem for this research study was that the 240 pre-algebra students in the targeted middle school had low passing percentages on the Virginia Department of Education Standard of Learning (SOL) pre-algebra strand. For the past 3 years, students enrolled in pre-algebra at the targeted middle school had SOL passing percentages that were lower than other pre-algebra students' percentages at both the district and state level. For example, 63% of the targeted schools pre-algebra students passed the math SOL assessment compared with 70% of the district's pre-algebra students and 85% of the state's pre-algebra students during the 2008-2009 school year (SOL; Virginia Department of Education, 2011). For the year 2009-2010, the students enrolled in pre-algebra at the targeted school passing percentage was 56%; the district passing percentage was 62%; the state passing percentage was 87% (SOL; Virginia Department of Education, 2011). The scores for the 2010-2011 school year continued this trend with only 54% of the pre-algebra students in the targeted middle school passing the SOL assessment. The middle school's low passing percentage for these 3 years was a source of dire concern for the school administrators and pre-algebra teachers. These educators suggested that a research-based intervention was needed, such as the Teacher Technology Integration Professional Development Model (TTIPDM) in this study. The TTIPDM consisted of training sessions (see appendix) on SMART Board technology basic, advanced, and interactive strategies. The TTIPDM's primary instructional strategies were modeling, demonstrations, reflections, and hands-on work on the computer terminals.

Background and Significance of the Problem

Billions of dollars have been spent in equipping schools with the latest in technological advances and computers. Although schools have more access to technologies today than in the early to mid-2000s, the level of technology use has made little change (U.S. Department of Education, 2004). This could have occurred for many reasons, and one reason for this being that few school districts have prioritized or initiated a plan for the integration of technology in instruction (International Society for Technology in Education, 2002). When school leaders fail to make technology integration a priority, teachers write it off as insignificant and maintain with their lecture style of teaching. Heuser (2005) argued that administrators must propose or create staff-development plans that embrace a variety of learning opportunities based on individual learning plans, because this is the most effective design for teachers to use if he or she is expected to transfer the use of technology classroom instruction.

Research Setting

The targeted middle school was located in a Southeastern Virginia urban school district. The district has 35 elementary schools, 8 middle schools, and 5 high schools. The total student body was 790, which included 224 eighth-grade students, 297 seventh-grade students, and 269 sixth-grade students. The composition of the school's student population was about 94% African American, 1% Asian, 1% Hispanic, and 3% White. The number of professional teaching staff was 69, in addition to 9 paraprofessionals.

Purpose and Research Questions

The purpose of this study was to determine to what extent a TTIPDM would increase middle school students' pre-algebra SOL strand test scores and pre-algebra teachers' proficiency in the integration of technology in the classroom instruction. In the study, the independent variable was the TTIPDM, and the dependent variables were the pre-algebra SOL scores and the teachers' SMART Board proficiency scores.

The research questions guiding this study are as follows:

Research Question 1: To what extent does the TTIPDM increase students' scores from pretest to posttest as measured by the online released version, pre-algebra strand SOL Test?

Research Question 2: To what extent does the TTIPDM increase teachers' perceptions of their proficiency level with SMART Board technology from pre-implementation to post-implementation as measured by the SMART Board Technology Proficiency Survey (STPS)?

Theoretical Framework and Literature Review

Mezirow's (1991) perspective transformation theory (PTT) served as the theoretical framework for this study. The theory is centered in meaning perspectives, or learning to understand one's self and one's paradigm. Mezirow postulated that adult learning results from transformation of perspective in response to unexpected events. Prior beliefs and old ways of thinking are examined when unexpected events or disorienting dilemmas (cognitive dissonance) occur in educational situations. For instance in the study, prior to the implementation of the TTIPDM, four pre-algebra teachers were not convinced that technology integration would increase pre-algebra students' test scores. Yet, according to PTT, critical reflection can be triggered and lead to insights and new or alternative ways of thinking (perspective transformation). This results in increased self-understanding and frees individuals to change and internalize new ways of thinking or emancipatory learning (Mezirow, 1991).

Technology Integration

Keengwe (2007) indicated that technology permeated all sectors of our lives. Educators have been under pressure to reform schools through technology. Over the past decade, educational stakeholders including administrators, parents, and even politicians have pushed toward the use and integration of educational technology in the classroom. Public and political support for technology use has generated billions of dollars toward increasing its availability to universities and corporate organizations. However, according to Keengwe, there is an alarming gap between technology's presence in higher academic institutions and its effective integration into classroom instruction.

Matzen and Edmunds (2007) explained that an inherent flaw in professional development in technology was not on instructional practices, but rather on when teachers were taught mainly technical skills, they may fall back on technology because they had not been provided with an alternative vision for the use of technology. The researchers, however, believed when the right professional development was presented within concepts geared toward student-centered instructional practices, teachers were more likely to integrate technology into their classrooms thus changing their attitudes toward technology (Matzen & Edmunds, 2007).

Technology Training

Most teachers who are interested in learning more about technology are interested in technology classrooms (Dexter, Anderson, & Becker, 1999). According to the quick facts and stats page located on the Technologies website, SMART Board interactive whiteSMART Boards are used in "more than 1.6 million K-12 classrooms, by more than 40 million students globally" (Heuser, 2005). The school district in Michigan, Wayne-Westland Community Schools, purchased 685 licenses from Blossom Learning to provide their teachers with an online SMART Board course as part of its commitment to the integrate technology into the classroom. Instead of offering professional development training on SMART Board, the district chose to provide an eight-chapter, self-guided course to teachers to complete on their own. The district strongly believed that, once the teachers had completed the course, they would have advanced their knowledge of the SMART Board components.

Participants

The participants were four teachers and their 240 students. The four teachers at the targeted middle school taught the pre-algebra course to the 240 students. All four teachers were female and certified to teach middle school mathematics. One teacher had 24 total years teaching experience, one teacher had 10 years, and two teachers had 4 years of teaching experience. All 240 students were African American students with 95% of the students receiving federally funded free or reduced-price lunch benefits. Of the 240 students, approximately 84 students were African American male students, and 156 students were African American female students. Relative to grade level, 75 students were in Grade 8, and 165 students were in Grade 7.

Instruments

Two data collection instruments were used to collect data to respond to the research questions. For Research Question 1, the data collection instrument was the online released pre-algebra strand test. The released form test was a recently retired Virginia SOL pre-algebra strand test. The test is also known as the Mathematics 8 SOL Assessment. The test was administered as a pretest and a posttest. According to Mott and Flanagan (2009), the state of Virginia-sponsored SOL tests measure some attribute of academic proficiency. Mott and Flanagan reported that reliability was established on all SOL tests and subtests using the Kuder-Richardson Formula 20 internal consistency reliability estimates. Reliability estimates were calculated for the SOL tests using several grades and covered the five content areas (reading, writing, mathematics, science, and history and social science). The overall reliability estimate for the mathematics tests for Grades 7 and 8 were computed to be .88. Therefore, the SOL tests are considered to be highly reliable (Mott & Flanagan, 2009).

The primary validity evidence appropriate to the various SOL tests was content validity. Mott and Flanagan revealed content validity was established in the beginning of the inception of the mathematics tests by having authors keep the standards directly in their view as they wrote, reviewed, and revised test items (Mott & Flanagan, 2009). To enhance content validity of the mathematics tests, Bradford and Bradford had teachers, administrators, and curriculum specialists carefully review all mathematics tests. Any item that appeared upon review not to match its stated standard was removed from the mathematics test. Thus, the SOL test has good content validity (Mott & Flanagan, 2009). For Research Question 2, the data collection instrument was the STPS. To enhance the validity of the STPS, content validity was established with the help of a panel of eight experts (Gall, Borg, & Gall, 2007). The expert panel consisted of three pre-algebra teachers, three instructional technology coaches, one assistant principal, and one counselor. The panel was asked to stringently review the instruments for unclear directions, vague statements and questions, vague words, and appropriate scale.

TTIPDM Intervention

The TTIPDM intervention activities occurred in the school's technology laboratory each week during the 12-week treatment period. These activities followed the time line of SMART Board technology activities delineated in the appendix. All topics in the appendix were covered in the training, with about four topics during each of the 24 training sessions. All activities took place on a Tuesday and Thursday after the end of the school day.

The primary instructional strategies for the TTIPDM were in the forms of presentations and demonstrations and hands-on work using SMART Board technology. The four teachers worked individually on the computer terminals learning the SMART Board technology basic, advanced, and interactive strategies. Modeling was conducted to demonstrate how to integrate the strategies into the daily pre-algebra instruction. Each Thursday, the teachers were paired on the computer terminals wherein they could share information and work as a team. During the last 10 min of each of the 24 sessions, the teachers worked in pairs discussing and collaborating, peer reviewing, and reflecting on what had been learned from the session and summarizing the "lessons learned" in their reflective journals. The TTIPDM intervention activities occurred each Tuesday and Thursday for 1 hr each day. Therefore, the total exposure of the four pre-algebra teachers to the TTIPDM training was 2 hr each week during the 12-week treatment period. There was 24 hr of exposure to the intervention's treatment effect during the 24 sessions.

Procedures

The research design that guided the procedures was the single group pretest and posttest design. There was meeting with the four teachers in the technology laboratory at the end of the school day and administered the STPS. The next 3 days, consisting of Tuesday, Wednesday, and Thursday, a researcher also met with the 240 pre-algebra students, 80 students per day, for them to complete the online released pre-algebra SOL test. The test consisted of 30 pre-algebra problems and took 1 hr to complete. Next, the implementation of the TTIPDM commenced for the 12-week period. Post-implementation data were collected the week following the 12-week treatment period. Post-implementation data collection closely followed the same format for the pre-implementation data collection procedures.

The descriptive statistics calculated were the pretest means, posttest means, standard deviations, and effect sizes. The inferential statistical model used was the *t* test for paired samples. From the *t* test, the *t*-value and probability value, and degrees of freedom were reported in the findings (Creswell, 2008). The two research questions were tested at an alpha level of .05.

Findings for Research Question 1

Research Question 1 asked, "To what extent does the TTIPDM increase students' scores from pretest to posttest as measured by the online released version, pre-algebra strand SOL Test?"

Table 1 findings show that the pretest mean was 363.25 with a standard deviation of 77.26; the posttest mean was 405.45 with a standard deviation of 80.98. The posttest mean was greater than the pretest mean by 42.20 points. The effect size was calculated. Results yielded a Cohen's $d = .533$ with an effect size of .258, depicting the strength of the difference between the pretest and posttest means was small with statistical significance (Johnson & Christensen, 2011). Gay, Mills, and Airasian (2009) indicated that the effect size indexes of about .20 are typically regarded as small effects, of about .50 as medium or moderate effects, of about .80 or above as large effects.

In the second procedure, the difference between the pretest and posttest means was 42.20. The *t* test for paired samples calculations showed p value = .000 (see Table 1). Applying the statistical significance decision rule (Creswell, 2008), as the p value (.000) was less than the alpha value (.05), the difference of 42.20 was a statistically significant difference at an alpha level of .05 (Gall et al., 2007).

To answer Research Question 1 with the findings, these findings showed the highest posttest score was 600; the highest pretest score was 564. The findings showed that the posttest mean (405.45) was in the range of pass proficient. The pretest mean (363.25) was in the range of failing. Furthermore, these students increased their scores from pretest mean (363.25) to posttest mean (405.45) by 42.20 points; the

Table 1. Students' Pre-Algebra SOL Descriptive and Inferential Statistics.

N	Pretest *M*	Posttest *M*	*t*-value	*M* difference	*df*	*p* value
240	363.25	405.45	22.33	42.20	239	000

Note: SOL = standard of learning; *N* = number of students; *df* = degrees of freedom; *p* = probability value.

Table 2. Teachers' STPS Pre-Implementation, Post-Implementation, and Change Scores.

Teacher	Pre	Post	Change	% change
1	23	63	40	173.91
2	25	60	35	140.00
3	27	66	39	144.44
4	18	61	43	238.89

Note: Pre = pre-implementation score; Post = post-implementation score; Change = pre-implementation score subtracted from the post-implementation score; % change = percent of change from the pre-implementation score to the post-implementation score.

increase was caused by the effects of the TTIPDM and not by chance factors (see Table 1). Consequently, the 42.20 increase was statistically significant at an alpha level of .05. Last, the difference of 42.20 had a small effect size of .258.

Findings for Research Question 2

Research Question 2 asked, "To what extent does the TTIPDM increase teachers' perceptions of their proficiency level with SMART Board technology from pre-implementation to post-implementation as measured by the STPS?"

Table 2 displays the pre-implementation scores, post-implementation scores, change from pre-implementation to post-implementation, and the percent of change. An inspection of Table 2 showed the highest pre-implementation score was 27; the lowest score was 18. The range was 9. The highest post-implementation score was 66; the lowest score was 60. The range was 6. Teacher 3 had the highest post-implementation score (66). Table 2 shows Teacher 2 had the lowest post-implementation score (60).

A further examination of Table 2 showed Teacher 4 experienced the largest increase (43) from pre-implementation score to post-implementation score. Teacher 1 had the second highest increase (40). Teacher 2 had the smallest increase (35) from pre-implementation score to post-implementation. Teacher 4 had the largest percent of change (238.89%) from pre-implementation to post-implementation. Teacher 2 experienced the smallest change (140.00%). SPSS calculated a pre-implementation mean of 23.25 with a standard deviation of 3.86. The post-implementation mean was 62.50 with a standard deviation of 2.65. The mean difference was 39.25.

Responding to Research Question 2, the findings showed each of the four teachers increased the SMART Board proficiency scores from pre-implementation to post-implementation. Teachers 1 and 4 had the highest posttest increases of 43 and 40 points, respectively. The mean post-implementation score was 62.50 with a small standard deviation of 2.65. The score of 62.50 was in the range of high or outstanding SMART Board proficiency scores.

Discussion of Findings for Research Question 1

The findings showed each of the 240 students increased their pre-algebra SOL scores from pretest to posttest. The findings showed that the posttest mean (405.45) was in the range of pass proficient. The pretest mean (363.25) was in the range of failing. As a result of the TTIPDM, students mean score increased from failing to pass proficient. Furthermore, these students increased their scores from pretest mean (363.25) to posttest mean (405.45) by 42.20 points; the increase was caused by the effects of the TTIPDM and not by chance factors. The 42.20 increase was statistically significant at an alpha level of .05. The 42.20 increase had a small effect size of .258.

The findings were interpreted to mean that SMART Board's activities and training increased students' scores from pretest to posttest as measured by the online released version pre-algebra SOL test. The findings were consistent with the literature that reported structured and research-based effective interventions and strategies do increase mathematics achievement for middle school students (Flores, 2007; Heuser, 2005; Miller, 2005; Strutchens, 2000).

Upon reflection, there were many factors associated with SMART board lesson that played a major role in the increase in mathematics scores from pretest to posttest. For example, students were observed having high time-on-task with few off-task behaviors. Students and their four teachers were observed to be actively engaged in the learning process. One of the researchers witnessed the teacher and student enthusiasm for teaching and learning pre-algebra problems. One teacher stated that she felt the students were enthusiastic about the lesson and were intrinsically motivated to work math problem. Another teacher commented that the students liked working on the computers and enjoyed teaching each other in small groups. All teachers were observed showing high expectations for success in having the students solve math problems. The students were observed showing confidence in their abilities to meet the high expectations.

Flores (2007) reported that high-achieving schools that served low-income students set high expectations for their students to increase mathematics scores. Flores further contended that the teachers with high expectations view teaching and learning as their top priority; they constantly innovate and integrate technology into their mathematics instruction. These middle school teachers provided supplemental support for student learning through innovative technologies such as SMART Board; furthermore, they regularly reviewed the basic objectives and material with the students to facilitate understanding by the students. Flores indicated that high expectations, an emphasis on the importance of learning, technology integration, and other types of supplemental support contributed to the increase in students' math achievement.

In this study, to increase the pre-algebra SOL scores, SMART Board fostered shifts in learning from teacher-centered to student-centered classroom environments (Smith & Pecore, 2008). These shifts in learner direction are likely explained by students' increased personal autonomy with the lesson. SMART Board activities allowed students to dictate the speed of the lesson giving them personal autonomy over the lesson. Therefore, a correlation between learning direction and personal autonomy was evident in the study. The correlation suggested that as the learning director shifts on the continuum from teacher-driven to student-driven; students' personal autonomy was increased. In this way, SMART Board aligned well with constructivist framework, allowing for strong student personal autonomy, student-centered classroom environments, and more student pre-algebra achievement

Discussion of Findings for Research Question 2

The findings showed each of the four teachers increased the SMART Board proficiency scores from pre-implementation to post-implementation. Prior to implementation of the professional development, three of the four teachers' STPS scores were in the range of low proficiency in SMART Board skills. The fourth teacher's STPS score was rated as adequate proficiency. As a result of their participation in the TTIPDM, after the end of the implementation period, all teachers' STPS scores were rated as high or outstanding proficiency in SMART Board skills.

Teachers 1 and 4 had the highest posttest increases of 43 and 40 points, respectively. The mean post-implementation score was 62.50 with a small standard deviation of 2.65. The mean score of 62.50 was in the range of high or outstanding SMART Board proficiency scores. These findings were interpreted to mean that the TTIPDM training increased teachers' STPS scores from pretest to posttest. The findings for this research question were consistent with the majority of the literature (Glazer & Hannafin, 2008; Lowden, 2005; Smith & Shoffner, 2001) indicating classroom teachers can be convinced to overcome obstacles and to want to integrate technology into mathematics instructions.

Technology integration efforts in K-12 schools faced many obstacles, including lack of human and physical support and insufficient learning opportunities (Glazer & Hannafin, 2008). Reluctance to change instructional practices has prompted resistance to technology use in schools and has become a contributing factor to the problem. Even when learning opportunities are provided through workshops, and in-service day venues, which are the widely used methods of staff development, many teachers reported that technology activities do not transfer to classroom practices.

Implications

Today, 98% of all schools and 77% of classrooms are connected to the Internet (National Center for Education Statistics, 2001). With all this connectivity in our schools, the findings from the study suggested teachers must be trained to understand this connectivity; they must be trained to create intellectually powerful and technology rich learning environments for students while maintaining sound pedagogical practices (Anderson & Becker, 2001). The U.S. Department of Education, through its Office of Educational Technology, acknowledged this need for training by designating that trainers should increase the quantity, quality, and coherence of technology-focused activities aimed at the professional development of teachers (Office of Educational Technology, 2003) as a national goal in its National Technology Plan (Office of Educational Technology, 2003). Furthermore, the National Center for Education Statistics (2001) found that only 33% of teachers feel prepared to use computer-related tools in their teaching.

To assist in the development of effective teacher training regarding technology integration, Congress created the Department of Education's Preparing Tomorrow's Teachers to Use Technology (PT3) grant program. PT3 was built on the premise that educators must understand how to create and deliver high-quality, technology-infused lessons that engage students and improve learning. The PT3 premise served as the foundation for the TTIPDM SMART Board training.

As cultural shifts due to technology occur, this study's findings implied that teachers must be adequately prepared in technology at the school level; schools should become the leader, rather than merely a participant in technology reform efforts. Children, schools, and society cannot afford for teachers not to be the critical players in the current efforts to prepare our classrooms for technology. If the goal is to create learner-centered classrooms where technology is embedded, technology must be embedded in the training of teachers. Technology must become not just a tool in the transformation of schools, but the engine of change for the schools (Sparks & Hirsh, 1997). If technology is the engine of change, then teachers must be the agents of that change in the classroom.

Consequently, findings in study imply it is no longer appropriate to suggest that teachers' low-level uses of technology are adequate to meet the needs of the 21st-century mathematics learner. Using technology simply to support lecture-based instruction falls far short of recommended best practice (Lawless & Pellegrino, 2007). To achieve the kinds of technology integration uses required for 21st-century teaching and learning (Thomas & Knezek, 2008), researchers need to help teachers understand how to use technology to facilitate meaningful learning, defined as that which enables students to construct deep and connected knowledge, which can be applied to real situations. This help can best come from professional development training similar to the training in this study.

Recommendations for Future Research

More research studies are required to investigate the need for teachers to overcome barriers of using technology to include the lack of time to learn technology and a lack of technology support and access (Fletcher, 2006). Simply becoming more comfortable with the technology and understanding a tool does not equal nor ensure effective technologically integrated teaching (Harris & Hofer, 2009). Therefore, future researchers must implement and investigate models of professional development in the area of technology integration beyond the traditional 2-hr workshops that are designed to help teachers become comfortable with using technologies such as SMART Board. They must investigate "here is how to use it" models that are sustainable models and models from which teachers can systemically change instruction and learn from others' failures and successes over a period of time (Brock, 2009).

There are more recommendations for future research. One area is the need for continued research on pre-algebra teachers' proficiency, confidence, skills, and attitudes as these factors relate to technology integration, particularly with SMART Board technology and professional development. In particular, greater clarity about the contextual and experiential influences that are needed to promote positive teachers' attitudes and increased teachers' proficiency is an important focus for future research.

Despite differences in preparation, many pre-algebra teachers experience struggles with using technology to assess mathematics achievement and to foster enhanced mathematics achievement in the classrooms. Given this common experience, it is likely that there are other contextual and experiential influences that affect the formation and transformation of teachers' attitudes and proficiency, influences that were not captured in the study.

Research studies (Miller, 2005; Salomon, 2002) supporting pre-algebra teachers who include special education students with mild-to-moderate disabilities in the regular education classrooms are worthy of investigation by future researchers. The area of dealing with many special education students who have severe challenging behavior in a pre-algebra classroom is another area worthy of additional research. Over time, changing conditions in the classrooms (e.g., increases or decreases in a student's challenging behavior) not only may influence these teachers' attitudes toward technology integration but also may influence the types of supports they need (Miller, 2005). Subsequently, the types of supports they receive or do not receive, in turn, may influence the teachers' attitudes toward technology integrations. Future quantitative and qualitative studies can target various types of supports (Salomon, 2002).

Conclusion

The study's major conclusion was that the SMART Board training enhanced students' personal autonomy and collaboration by fostering a constructivist learning community among the middle school students. Another conclusion was teachers' participation in the training resulted in them perceiving themselves to be more proficient in the use of the SMART Board technology in classroom pre-algebra instruction. For instance, through an essential pre-algebra problem displayed on the SMART Board as a group goal, SMART Board fostered a community environment. In the community environment, students were effective in working together to solve problems. In addition, SMART Board fostered student-to-student discourse. The discourse aided in the formation of classroom collaborative learning communities. Students experienced high active engagement during SMART Board lessons that were developed by the four pre-algebra teachers. Instructional techniques—such as student interaction, student-to-student discourse and the use of technology—all played significant roles in high student engagement and increased pre-algebra scores.

There were many additional examples of personal autonomy observed by the researchers or reported to one of the researchers by the students during the TTIPDM treatment period. When asked by the pre-algebra teacher whether the SMART Board was useful to them, most students agreed that they enjoyed using it; they were comfortable independently using the technology with little help from the teacher. Most students were observed to react positively to the SMART Board pre-algebra activities; they reported that the activities enhanced the development of cognitive skills important to solving math problems. One instance of personal autonomy was indicated when several students were observed collaborating on SMART Board pre-algebra problems with an upbeat attitude toward technology; they expressed interest in continuing to use the SMART Board technology in the future and in other classes if given the opportunity to do so.

There were other signs of personal autonomy. For instance, several students indicated that the increased range of learning skills would help them in other classes in the future. These students revealed to one of the researchers that SMART Board forced them to be efficient and self-disciplined; students claimed they previously were not very good at technology, tended to procrastinate, but now are self-directed learners needing little direction from the pre-algebra teacher. Comments from the students suggested that learners' self-sufficiency and independency play a crucial role in SMART Board instruction and were facilitated by the TTIPDM treatment. In other words, SMART Board activities in the TTIPDM, as reported by the students, contributed to them being in charge of their own learning and becoming actively involved in the learning process. Students' experiences gave them the personal feeling of accomplishment and had a very positive impact on how they perceived pre-algebra instruction.

Furthermore, the researchers observed that SMART Board pre-algebra learning significantly enhanced the personal autonomy of the shy students by offering affective support so they could carry out the shared task of working pre-algebra problems without feeling pressure as intensively as they would in front of the class. The board helped to increase these shy students' autonomy, confidence, and encouraged them to participate in oral discussions and to speak up in class.

With the No Child Left Behind Act (U.S. Department of Education, 2004) providing impetus, states are now placing strong emphasis on recruiting and retaining high-quality mathematics teachers. In addition to possessing content and pedagogical mathematics knowledge, recent definitions of high-quality teachers include being able to support differentiated instruction and data-based decision making, efforts that benefit immensely from the use of new technology integration tools (Means, Padilla, DeBarger, & Bakia, 2009). According to the U.S. Department of Education (2004), technology integration is now considered by most educators and parents to be an integral part of providing a high-quality mathematics education.

The teachers who participated in the TTIPDM treatment perceived themselves as being high-quality math teachers who were proficient in using the SMART Board technology with the pre-algebra lessons. Through their responses on the STPS, teachers reported they were proficient in the use of the floating tools and the handwriting recognition feature. They could easily format text and objects and group and order objects on the SMART Board. Teachers were proficient at creating templates and exporting and printing SMART Board files. They could easily use the gallery items to create exciting and interesting SMART Board pre-algebra lessons. Their perceptions of having proficient skills were additionally reflected in the responses on the STPS. For instance, one teacher described the SMART Board technology as a tool that challenged students to think and use critical reasoning skills. Several teachers reported that with the SMART Board, their role now was to be a coach and an advisor, not a drill sergeant. Teachers perceived it was easy to get students to work collaboratively on pre-algebra problems.

The STPS responses revealed teachers had a confident and a positive attitude toward the use of boards in the instruction. Teachers' proficiency in the use of the SMART Boards was further confirmed by their statements praising the boards. The boards were praised because they could be used in different ways with the instruction. Interesting, one teacher confidently shared her experiences using the SMART Board for pre-algebra multiple-choice questions. On the STPS, this teacher indicated she now knew the rate at which students were answering the multiple-choice questions. Knowledge of the rate allowed her to look at the questions that the students were devoting the most time on, so she could go back and explain those questions.

There were numerous positive feelings teachers had toward the boards. The integration of SMART Board into the instruction not only increased the teachers' proficiency level, it also facilitated student-centered instructional practices and appeared to change many veteran teachers' attitudes toward technology (Huber, 2010). As a result of the teachers' participation in the TTIPDM, they reported through the STPS that technology integration became a part of the culture of the school. Teachers' proficiency in the use of the SMART Board resulted in them teaching other teachers how to use it and inviting other teachers into their classrooms to observe the students' working with the SMART Board.

Appendix. Training Topics

Weeks	Training topics
1 and 2	SMART Board basics to support pre-algebra instruction
	Orienting SMART Board
	Changing SMART Board orientation settings
	Customizing the Start Center
3 and 4	Using the floating tool
	Properly working the mouse with your fingers
	Moving items on SMART Board with fingers
	Changing pen colors
5 and 6	Using the handwriting recognition feature
	Locking text and objects
	Formatting text and objects
	Grouping and ordering objects
7 and 8	SMART Board Advance Functions support of pre-algebra lessons
	Rotating objects
	Erasing a single object or a group of objects
	Saving, exporting and printing SMART Board files
	Using Microsoft Word and PowerPoint to construct pre-algebra SMART Board class lessons and presentations
9 and 10	SMART Board: Interactive Activities
	Creating pre-algebra templates
	Creating a hyperlink out of pre-algebra text or images
	Adding mathematics attachments and handouts
	Adding pages to a pre-algebra notebook project
11 and 12	Using EXCEL with the SMART Board pre-algebra lessons and presentations
	Using Gallery items to create a SMART Board pre-algebra lessons
	Adding teachers personal mathematics support material to the Gallery
	Using the Screen Capture toolbar
	Using the window shade feature
	Overview of weeks 1 to 12
	Questions and debriefings

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