

The Effects of Mentor-Supported Technology Professional Development on Middle School Mathematics Teachers' Attitudes and Practice

Bonnie Swan and Juli Dixon
University of Central Florida

Abstract

This study investigated the influence of a mentor-supported model of technology training on mathematics teachers' attitudes and use of technology in the classroom. The treatment included six training sessions, informal focus groups, and mentor-provided support.

The results indicated that mathematics teachers participating in mentor-supported professional development increased the amount and level of technology use in their practice. Teachers had a desire to learn about technology and understood it was important. Levels of accommodation, interest, comfort and confidence related to the use of technology improved. Teachers continued to be concerned with barriers such as lack of release time for training, planning and collaboration, and a need for ongoing support. It was also found that when teachers perceived there was not enough time for training or a lack of technological resources they did not make an effort to become technologically proficient.

Recommendations include providing teachers additional support when implementing new strategies and allowing more release time for training, planning, and collaboration. Recommendations for future research include investigating further the effectiveness of peer teachers and mentor teachers as trainers; ways to best change teachers' perceptions and attitudes about technology; and ways teachers best learn to integrate technology into practice.

Society has transitioned from an industrial age to an information age. As technology rapidly advances, it must become an integral part of the school curriculum. Billions of dollars have been spent by federal, state, and local governments since the 1990s to update schools with modern technology with the expectation that it would be used to improve student performance (Rosenthal, 1999). Yet, although technology is available in schools, it is not being used effectively in the classrooms (Hardy, 1998; Hunt & Bohlin, 1995; Jones, 2001; Marcinkiewicz, 1993/1994).

Because of increased access to technology both in the classroom and at home, there is a shift in emphasis from increasing the technology infrastructure to improving the ways teachers and students use technology in schools. According to the National Council of Accreditation of Teacher Education (NCATE, 1997), few teachers begin the profession with the competence to use technology effectively. A report released by the National Center for Education Statistics (NCES) indicated that, although 95% percent of schools were connected to the Internet, only one third of teachers felt prepared to use technology in their teaching (Smerdon et al., 2000). Another report, more recent and based on a nationwide survey of 87,000 schools for the 2003-2004 school year (Market Data Retrieval, 2004), showed little improvement—while nearly one in five teachers are still learning the basics, only 17% are considered to be at an advanced level (either using technology in curriculum or leading/instructing others).

Several entities have made recommendations related to technology use in schools. In a Legislative and Policy Update, the National Council of Teachers of Mathematics (NCTM, 2001) stated, “Professional development for preservice and inservice teachers must include opportunities to learn mathematics in technology -rich environments.” Although it had been recommended that school districts set aside 30% of their technology budgets for staff training and development, only 6% of total technology budgets were allocated for training for the 2003-2004 school year (Market Data Retrieval, 2004). A Web-based Education Committee identifying key barriers preventing technology from enhancing learning warned that without effective training billions of dollars spent on technology would be as useless as a “new generation of planes, without training pilots to fly them” (Office of Postsecondary Education, 2000, p.18).

Background Information

This article documents the efforts to develop and support mathematics teachers who participated in technology workshops related to their curriculum. In a relatively short period of time, the school in which these teachers taught spent over one-half million dollars on technology related materials. However, observations conducted by the author as a mathematics teacher and mentor in the district’s Alternative Certification Program revealed that most teachers were not using the available technology effectively to promote student learning.

An action research project was conducted to determine the effects of using a mentor-supported model of professional development on mathematics teachers’ attitudes and performance regarding the use of targeted technology in their classrooms. Specifically, the research sought to answer the following question: How does the practice of a teacher mentor and peer technology trainer affect teacher use and attitude toward technology in mathematics middle school classrooms?

Review of Literature

To guide the development of this research project, the extant literature related to influences on teachers' technology use was examined, resulting in the identification of the following broad categories: administrator and teacher attitudes and the effectiveness of mentor-supported technology training.

Administrator and Teacher Attitudes

Because of substantial expenditures for new technology in schools, teachers and administrators are under pressure to integrate these tools into the curriculum. Many studies indicate that a teacher's attitude is a strong factor in determining technology usage (Bradshaw, 2002; Davis, 1989; Hardy, 1998; Luke, Moore, Joi, & Sawyer, 1998; McFarlane, Hoffman, & Green, 1997; Marcinkiewicz, 1993/1994; Sarama, Clements, & Jacobs-Henry, 1998), so it was important to examine aspects of technology training that might best facilitate change in teachers' attitudes. Attitude in this study relates to several factors, including teachers' level of accommodation, interest, comfort, confidence, fear and concern, and whether teachers feel the use of technology improves practice. In addition to teachers' attitudes, this study also considered the attitudes and actions of administrators, because teachers are unlikely to change without clear expectations and encouragement (Chin & Hortin, 1994; Topp, Mortensen, & Grandgenett, 1995).

Resistance to change. Teachers must be willing to accommodate new skills into their practice in order for change to occur. Research on mathematics teachers' beliefs indicates they are resistant to change and alter their views slowly at best (Thompson, 1992). Teachers need time to receive the needed training to become and remain proficient with technology. Teachers who do not feel comfortable with technology are less inclined to incorporate it into their plans (Jones, 2001). Feelings of comfort and readiness to use technology come with time and instruction on how to use it (Brunner, 1990). Luke et al. (1998) stated that increasing teachers' awareness of how technology can help them perform their jobs better can improve attitudes. People tend to use or not use technology to the extent they believe it will help them perform their job better (perceived usefulness); even if they perceive technology as useful, they may still not use it if they believe the effort outweighs the benefits. Davis (1989) recommended education and training to influence these factors. Even though 42 states require teachers to demonstrate proficiency in technology as a competency for receiving certification, only four states require technology training for recertification of teachers (Lonergan, 2001). With the dynamic nature of technology, ongoing continuing education must be deemed important if teachers are to remain proficient.

A survey of in-service elementary and secondary teachers in four school districts in Texas found that a majority of teachers still instructed in the same nontechnology traditional manner even when computers had been supplied to their classrooms (Medcalf-Davenport, 1998). Teachers' resistance to change and "fear" of integrating computers into classrooms resulted from not recognizing the usefulness and necessity of technology to teaching and learning; teachers still viewed the computer as a part of the curriculum rather than as a tool for teaching (Medcalf-Davenport, 1998). Hardy (1998) attributed anxiety and fear to teachers' inability to connect new knowledge with past experiences. Helping teachers overcome their fears and concerns is crucial to the success of any program of professional development (Bitner & Bitner, 2002; NCATE, 1997).

Teacher confidence with technology. Perceived usefulness and ease of use are also important for building confidence, another factor related to teachers' attitudes about technology. Confidence building should be a major focus in professional development

programs (Mahmood, Burn, Gemoets, & Jacquez, 2000). A study based on statistics gathered by the National Center for Education Statistics concluded that one or more hours of recent training increased teachers' perceptions of their own preparedness (Rowand, 2000). Davis (1989), who studied user acceptance of information technology, found a significant correlation between perceived ease of use and current use. Marcinkiewicz (1993/1994) found that self-competence was closely related to teachers' computer use.

The influence of administrators. Administrators' attitudes and beliefs play a key role in whether technology is used. Research shows that technology is best integrated into the curriculum when it is part of a school's goals (Peterson, 1999; Pickens, 2001). School administrators' expectations and encouragement are vital to the infusion of technology into the educational process (Chin & Hortin, 1994; Topp et al., 1995). One way administrators can show their support is by increasing the amount of release time for training. According to a report on teacher use of technology (Smerdon et al., 2000), lack of release time to learn how to use computers or the Internet for instruction was one of the greatest barriers to their use. In addition to feeling they are being supported and encouraged to use technology, teachers must also believe their environment is supportive of the "risk taking" necessary for trying new techniques (Brunner, 1990; Topp et al., 1995). According to Brunner (1990), administrators must "encourage experimentation and collaboration among teachers, and not be afraid to risk disruption and even short-term failure in the interest of innovation and reform" (p. 14).

Summary. Because teachers and administrators are the ultimate decision makers on how and whether technology is used in the classroom, their attitudes and beliefs play a key role. When an understanding of how technology can be used effectively is achieved, teachers' attitudes are positively affected (Okinaka, 1992).

The Effectiveness of Mentor-Supported Technology Training

Research findings support the use of professional development as a way to increase teachers' use of technology in the classroom. However, little research has focused on how teachers best learn to integrate such technology into practice (Bransford, Brown, & Cocking, 1999). Professional development is a necessary but not sufficient condition for improving teacher attitude and use of technology. In fact, some would claim that "nothing has promised so much and has been so frustratingly wasteful as the thousands of workshops and conferences that led to no significant change in practice when the teachers returned to their classrooms" (Bradshaw, 2002, p. 131).

Using mentors or peer teachers as trainers. Mentor-supported professional development might be an appropriate method for meeting the needs of teachers. Additionally, mentoring that is provided by a peer might provide an advantage over mentoring provided by other professionals. According to Smylie (1989), teachers rated "learning from other teachers" as the second most valuable source of information about effective teaching over only their "own teaching experiences." Teachers reported that their colleagues were a more valuable learning source than university professors, administrators, consultants, or specialists. Amico (1995), who designed an in-service program for improving the integration of technology, found that utilizing the teachers in the training process and including them as trainers was valuable because they were familiar with the day-to-day problems of technology and could share the best way to approach specific use of technology in the classroom. Teachers' presentations focused more on applications that could be used in the classroom rather than presentations from other sources. The teacher trainers tended to be less theoretical and more practical in their presentations.

In a study by Holahan, Jurkat, and Friedman(2000), 34 teachers from 33 New Jersey schools were trained not only to use new technology but also to serve as trainers of other teachers at their home schools. The results showed that a mentor-based teaching model permitted greater efficiency as compared to traditional training approaches. The program emphasized mutual sharing, learning, and collaboration versus superior-subordinate relationships between the mentors and those who attended training.

Follow-up mentor support. According to the President's Committee of Advisors on Science and Technology (PCAST, 1997), teachers should be provided with ongoing mentoring, consultative support, and opportunities for collaboration when attempting to incorporate technology into their lesson plans. Teachers need to reflect and collaborate together following training (Parsad, Lewis, & Farris, 2002; Raywid, 1993). This cannot be accomplished in a "one-shot" approach to staff development. In a survey of over 5,000 teachers, Parsad et al. (2000) found a positive relationship between the frequency of collaboration between teachers and the extent to which they believed professional development activities improved their practice. This same survey showed that only 27% of the teachers reported feeling very well prepared to integrate educational technology into the grade or subject taught. Only 23% of the respondents collaborated with another teacher by being mentored.

With a mentor-supported model of professional development, teachers can be provided with the support they need in order to facilitate change over a long period of time. Regarding a study on mentor supported professional development, Schaverien and Cosgrove (1997) concluded that teachers need an extended period of support when they return to their classrooms following training. The researchers stressed that this was necessary for the teachers to "make sense" of what they had learned and to change their practice. Hosack-Curlin (1988) also demonstrated that in-service peer coaching maximizes participant learning, and Showers (1982, 1984) concluded that coaching following training resulted in much greater transfer than training alone.

Methodology

The purpose of this action research was to determine the effects of using a mentor-supported model of professional development on mathematics teachers' attitudes and performance regarding specific technology in their classroom. The action research involved 8 mathematics teachers (the participants) at the site at which they teach.

Design of the Study

The researcher sought to gain insight, develop reflective practice, and effect positive change (Mills, 2000). Multiple data collection techniques were used, and Anderson, Herr, and Nihlen's (1994) Criteria for Validity in Action Research were applied to help guide the research and validate the results.

Setting. The study took place in an urban public middle school in the southeast United States. The school had a faculty of 79 teachers with a student enrollment of 1,248. The student population was 50% black, 35% white, 12% Hispanic, and 3% other. The children were from predominantly low to middle income urban families with at least 60% of them eligible for free and reduced lunch.

Participants. Eight of the 10 mathematics teachers volunteered to participate in the study; six had less than 4 years, teaching experience, and only one had a degree in education. (See Table 1 for teacher demographics.) Three of the 8 were out-of-field, indicating they had been hired without the basic qualifications required for certification in mathematics.

Table 1
Teacher Demographics

Name^a	Current Certification (In Field or Out of Field)	No. of Years Experience	Degree Program
Anne	Out	1	Criminology
Joe	In	2	Business
Kris	In	3	Chemical Engineering
Lisa	In	3	Mathematics
Kathryn	Out	3	Accounting
Darlene	Out	3	Business
Mike	In	7	Business and English
Christy	In	23	Elementary Education

^aAll names in this study have been changed to preserve anonymity.

Procedures

To aid teachers in incorporating technology into their practice, a program for teacher training was created (see [Appendix A](#)). Five 1-hour training sessions were scheduled during teachers' contracted day over a period of 3 months; two makeup sessions were also conducted. Three of the five training sessions began with informal focus groups, which were audiotaped and later transcribed. During these focus groups, which lasted approximately 10-15 minutes, participants had the opportunity to reflect on and discuss their feelings and experiences with technology. The researcher began each focus group by asking one of the following six questions. Each teacher was asked to respond to the first question and the remaining questions were open for discussion:

1. In what ways has your use of technology influenced your effectiveness as a teacher?
2. After your few initial attempts to integrate the technology, what things have you learned on your own? What things would you do differently?
3. What specific technology-related activities have been occurring in your classroom?
4. What grade levels do you think are developmentally appropriate for the use of _____ (name or description of technology)?
5. What barriers do you see in implementing this technology into your classroom practice?
6. Do you think this technology can be used to complement the curriculum you teach? If so, in what ways? If not, why?

The limited time for the focus groups allowed discussion of only three to four questions per session. All questions were addressed at least once during the study.

The topics of the workshops were based on teachers' ease of use of a specific technology, availability of the technology, teachers' interest, and the technology's applicability to the curriculum. Other factors influencing the workshop topics included the amount of time available, the likelihood of allowing teachers to see quick results, and the ease by which teachers could implement the technology into their practice. The selected topics were FCAT Explorer, Motion Detectors, Spreadsheet Development, Available Mathematics Software, Classroom and Materials Management, and One-on-One Training. Additionally, each participant selected an individualized topic for the One-on-One session. Each session was "hands-on," and teachers were encouraged to work with one another. A brief description of each session follows.

FCAT Explorer. [FCAT Explorer](#) is a free online educational program for Florida students that reinforces reading and mathematics skills outlined in the Sunshine State Standards (educational standards for the state of Florida) and that helps prepare students for Florida's high-stakes accountability test (Florida Comprehensive Assessment Test [FCAT]). (**Editor's Note:** Web site URLs are provided in the [Resources](#) section at the end of this paper). In the computer lab, teachers learned how to set up their class rolls, as well as edit and delete information so their classes could use the program. Teachers experimented with the different programs and learned how to run reports, including student and class performance reports by benchmark. In the following 3 weeks, most of the teachers were provided with one-on-one support. The teacher and researcher discussed the lesson beforehand and then worked together with the students during the lab.

Motion detector with middle -grades appropriate graphing calculator. Teachers worked with a motion detector and a graphing calculator to create distance/time plots when moving relative to the motion detector. Teachers hypothesized about how they could match a displayed graph, experimented, and then discussed the results. Concepts included exploring slope, characteristics of lines, scale, and y-intercept. Following the session, the researcher set up a motion detector with overhead graphing calculator in each of the teachers' rooms and co-taught a lesson with them. Teachers kept the equipment at least 1 week following the lesson to experiment with their other classes.

Spreadsheet development. Teachers worked in pairs and learned to create spreadsheets and charts, use formulas, and experiment with changing font, style, and size commands. Benefits and applications were discussed, and teachers brainstormed about real-life data they might use with their students. Half of the teachers had prior experience using spreadsheets, so they were able to help the others. Teachers shared how spreadsheets had been used as a support tool for them, as well as how they thought it might enhance the mathematics curriculum. Other discussion topics included creating graphs, making predictions, and integrating other subjects.

During the workshop, teachers completed two mini-lessons. From a bag of multicolored candy, teachers worked collaboratively to predict how many of each color would be in the bag and then counted and recorded the actual numbers. Teachers made a double bar graph comparing their predictions and the actual results. The group then discussed using the data to make other types of graphs. During the second lesson the teachers were asked to set up a school clothing budget for \$200. They listed details of clothing and used formulas to find totals. The group discussed the activities that might lead up to or be extended from having students make spreadsheets, as well as how this technology might fit into their curriculum.

Mathematics software and classroom and materials management. Teachers had access to several mathematics-related software programs that were underutilized at the school according to an analysis of resources and an evaluation of the library records. Some of those programs included the [Mighty Math](#) series, [KaleidoMania](#) interactive statistics software, and dynamic drawing software. It was thought that teachers might be more inclined to use the programs if they had exposure to them. During the session, suggestions on how to manage student use of hardware and software were discussed. Topics included distribution and collection of supplies and the importance of demonstrating and giving directions prior to labtime with a class. Teachers discussed how checklists might assist students in using the programs and making students accountable for their own learning. Some time was spent on how teachers might assess student work in a lab setting.

Individualized training sessions. Each participant was contacted for an individualized mentoring session at least once during the professional development period. Several sessions involved aiding teachers in their classrooms while conducting activities related to a prior professional development session. Most teachers accepted assistance related to using the CBR and FCAT Explorer with their students. An attempt was made to provide ongoing assistance until the teachers were comfortable with the targeted technology. Additionally, the researcher worked individually in the classrooms of four teachers on dynamic drawing software, one on spreadsheets, and one on Kaleidomania. One teacher asked for help with the “basics” of how to use her computer for administrative purposes (i.e., grading, writing memos and letters, etc).

Methods of Data Collection and Analysis

Sources of data included Training and Development Activity Evaluations, Technology Use Logs, Pre- and Post-Technology Attitudinal Scales, Computer Lab Schedules, anecdotal notes of interviews with the school principal and the technology support representative, follow-up conversations with participants, and focus group audio recordings.

Technology Attitude Scale. To determine whether an increase or a shift in teacher attitude related to technology occurred, the Technology Attitude Scale (TAS; see [Appendix B](#)) was used. TAS was developed at the University of Colorado to assess the positive and negative aspects of teachers’ attitudes toward technology and has been found to have high reliability (McFarlane et al., 1997). In this study, pre and post responses to the Likert-scale statements in the TAS were analyzed, with responses rated from a low of 1 to a high of 7.

Focus groups. Three separate focus groups were conducted. These sessions were audiotaped and transcribed. The transcripts were then indexed and analyzed, using guidelines from *The Art of Classroom Inquiry* (Hubbard & Power, 1993). These data were used to determine teacher needs as they related to technology, teacher attitude with regards to technology, and level of use of technology.

Technology use logs. Technology use logs were distributed and collected at the beginning of each training session. On the logs teachers listed descriptions of technology-related activities that had occurred, along with general comments, including how they might adapt an activity or how their students reacted. They also recorded the amount of time they spent on planning and preparation and length of time their students were engaged. These logs were indexed and analyzed to determine the types and frequency of computer-related activities. Teachers using the school computer labs were required to schedule their classes in advance. The schedule, kept and monitored by the school librarian, was analyzed as an additional indicator of lab use.

Training and Development Activity Evaluations. To determine whether a shift in teacher attitude related to technology occurred as a result of the training, the responses to the questions on the Training and Development Activity Evaluations were reviewed. These were completed anonymously by the teachers at the end of each training session. The forms included two short-answer questions and nine Likert-scale statements. The two short answer questions were “How do you plan to do things differently on the job as the result of this in-service training?” and “How might this activity be improved to make it a richer learning experience?” The Likert items are as follows:

1. Overall rating of the activity (assess the total effectiveness of the training)
2. Organization and preparation (format, sequence, materials)
3. Objectives (clearly stated, appropriate)
4. Content level (appropriate, consistent)
5. Participant involvement (quality, quantity)
6. Application value (practical, applicable to classroom and/or workplace)
7. Evaluation (matched to objectives, content and format)
8. Instructor/Facilitator (knowledge, expertise on content)
9. Accommodations (location, facilities, group size)

Each response was rated using a point value: *excellent* = 4; *good* = 3; *fair* = 2; and *poor* = 1.

Field notes. Other data were analyzed, including the researcher’s field notes on informal follow-up sessions with participants and interviews with the principal and the technology support personnel at both the school and district level.

Findings

Teachers in the study continuously questioned the researcher and one another about the fit of technology into their classroom practice. Four major themes emerged: teachers were concerned with barriers related to the availability of technology; teachers found training useful and desired to use technology more frequently; teachers desired and needed continued and ongoing technology training; and teachers were concerned about the lack of release time for training, planning, and collaboration.

Teachers’ Concern with Barriers Related to the Availability of Technology

At the onset of this study, both the researcher and the technology specialist at the school deemed the lack of availability of technology as not a real barrier to teachers integrating it into their practice; rather, they viewed technology integration as more of a matter of teacher choice and determination. The conversations during the focus groups and comments on the in-service evaluation forms revealed otherwise. Teachers perceived a lack of technology availability to be a great barrier to its implementation into the curriculum. Even the teachers who were skilled in using technology were concerned that their classrooms were not outfitted with the latest equipment.

Christy, the teacher with the most experience, said that the last school at which she had worked had more technology available. She felt that many of the skills that she had developed prior to coming to this school were being lost: “If you don’t use it, then you lose it.” At her last school, the principal and other teachers would communicate on the Internet, and it was expected that everyone would be involved in this process. She felt having the Internet available at her desk, along with the encouragement from her principal, “forced her to learn and stay current” with using technology. In another

informal conversation between training sessions, Mike indicated that using technology was “just not going to happen” until his room was updated with more current equipment.

Every teacher felt that it was difficult for students to benefit from what they perceived as limited software, hardware, and connections. During this study, the teachers were somewhat limited in their use of technology because of a lack of availability. For example, the Internet was not available in their classrooms. During the year-long process, the school had begun to retrofit the classrooms. Nevertheless, the teachers were not convinced that the school’s plan to have four student computers wired to the Internet in each classroom would meet their students’ needs. They expressed concern that having just four computers per class made effective use by students difficult. Only three of the teachers had classrooms equipped with TV monitors that would allow students to view teacher demonstrations, and the school owned only one projector. One teacher commented,

I don’t feel that my classroom has the technology available to really implement the kind of programs that I would like to implement. All I have is four old computers with limited, if any programs, and that’s not enough to get the kids on there to play with it to learn it. We just don’t have the technology available in the classroom that is required.

Another teacher said, “I just feel like we are in the dark ages. Everybody has gone and left us behind.”

During data analysis, it was difficult to distinguish between what teachers perceived to be a lack of resources and the reality of the situation. There were two computer labs available if the teachers were able to plan a week or two in advance. Teachers complained that scheduling was difficult. Part of the difficulty in their ability to plan in advance was due to their limited teaching experience or their out-of-field certification. Teachers with less than full preparation tend to struggle with planning curriculum (as pointed out by Darling-Hammond, 1992).

Perceptions about the difficulty of technology use are important. Research shows that teacher perceptions affect how much technology will benefit students. Teachers cannot come to the realization that technology can help them perform their job better unless they perceive it as both useful and easy to use (Davis, 1989). According to a report released by the U.S. Department of Education, National Center for Education Statistics (Smerdon et al., 2000), 78% of teachers surveyed felt the lack of computers was a barrier to their use of technology. This study also found that teachers who perceived the lack of computers and time for students to use them as barriers were less likely than others to assign students to use computers or the Internet for instructional activities.

Teachers found training useful and, as a result, desired to use technology more frequently. Even though teachers were concerned with the lack of availability of resources, the data indicate that they still had the desire to use technology more frequently. One statement on the TAS was, “I now use my knowledge of technology in many ways as a teacher.” The mean score for this item increased from 3.88 to 5.62 after the training, providing some evidence that teachers increased their technology use (See Table 2). Another statement, “I don’t expect to use technology much at work,” resulted in a post mean score of 1.88, with a score of 1 indicating the statement was not at all true. According to the scale, teachers also wished they could use technology more frequently.

Table 2
Technology Attitude Scale Pre and Post Mean Scores

Item	Pre	Post
I now use my knowledge of technology in many ways as a teacher.	3.88	5.62
I like using technology at my work.	5.38	6.50
I wish I could use technology more frequently.	6.50	6.62
I don't expect to use technology much at work.	1.62	1.88

Note. Range of Degree of Application: 1= *Not all true*; 7= *Very much true of participant*

Data for this table was taken from a summary of the Pre and Post Technology Attitude Scale (see [Appendix C](#)).

Several comments were made on the Training and Development Activity Evaluation forms that indicated an increase in the frequency of use or a desire to use technology more frequently. Darlene responded, "I plan to get my Intensive Math class accustomed to using the computer more frequently," and "I plan to use more technology in the classroom that I feel will benefit my students." Christy, when asked how she planned to do things differently as a result of the training, wrote, "Have students go to the lab on a regular basis for more practice in preparation for the FCAT," and "I plan to implement the things I learned [in the training] in the classroom." Another teacher wrote, "I have incorporated use of the FCAT Explorer in several of my classes." Kathryn and Mike took their students to the lab to work on spreadsheets. Another teacher wrote that she planned to let her students try using spreadsheets soon. Later, when given support, she did. Even with the limited access to the computer labs, all of the teachers took their students there at least once, and all of them used the labs more than they had in the previous year. This was evident in comparing the computer lab schedules from year to year.

The teachers felt that the technology to which they were exposed in the training was useful. The increase in use indicates that teachers believed the technology was useful enough to incorporate it into their lesson plans. Also, the conversations in the focus groups indicated that the teachers' perceptions about the usefulness of the technology were good. In each case, when the teachers were asked whether the technology could be used to complement the mathematics curriculum, they responded positively. Furthermore, the training and development evaluations completed at the end of each session showed that teachers' overall ratings of the application's value were excellent.

Teachers had a desire and need for continued and ongoing technology training and support. The desire of teachers for technology training was contrary to what was thought to be true prior to the study. The technology support representative reported that several technology workshops had been given at the school during the previous year on such topics as Reading Counts software, SuccessMaker, Inspiration, PowerPoint, using Access with downloaded student information, Gradebook Plus, Windows Basics, and Paragraph Power. Trainings were voluntary and scheduled during the teachers' contracted hours at a time that did not conflict with teaching responsibilities. She had been disappointed with the participation: "People say they want training and then they don't come." Of the 8 participants in this study, Kathryn seemed the most interested and had attended several classes. To determine whether the lack of attendance by the others was due to content, each of the participants was questioned in informal conversations. Many felt that there was not enough time in their busy schedules to attend the training; several felt the classes were not appropriate to the mathematics curriculum.

Free technology classes were also offered through the school system within a few miles of the school; a local vocational school also offered adults training in technology for a small fee. Schedules of these classes were posted on bulletin boards and made available in teachers' mailboxes. None of the 8 participants had attended any of these classes. In fact, few had ever received any formal training in technology at all. Most of what they knew was self-taught, was learned in previous jobs unrelated to teaching, or was learned in college. Yet, teachers said they desired more training in technology. According to the Technology Attitudinal Scale data, teachers understood that learning about technology was important and necessary, felt that they needed to learn about it, and were willing to do so (Table 3).

Table 3
Technology Attitude Scale Pre and Post Mean Scores

Item	Pre	Post
Knowing how to use technology is a necessary skill for me.	6.00	6.38
Learning about technology is a worthwhile and necessary subject for all prospective teachers.	6.88	6.88
I know if I work hard to learn about technology, I will do well.	6.50	6.62
Once I start using technology, I will find it hard to stop.	5.62	6.88
<i>Note. Range of Degree of Application: 1= Not all true; 7= Very much true of participant</i>		

The first three items in the table showed little or no change. The teachers gained enthusiasm about the use of technology following the mentor-supported training.

On several of the Training and Development Activity Evaluation forms, teachers commented that they wanted more sessions and wanted them to last longer. Lisa wrote that the one-on-one session with dynamic drawing and Kaleidomania software could be improved if she "could receive more training on the software" so that she "would be able to use it to its fullest capacity." Darlene wrote, "I would probably have to get more training before I presented this material to my classroom." In the focus groups, teachers also remarked on the need for more training. Christy said, "It is very difficult for us to teach with this stuff because we really don't even understand it ourselves. At least maybe the way we should with the real-life connections." Later she said, "I think one of the things is more teacher training. More in-service for teachers." Kathryn said, "We are going to have to do a lot of training, with the children as well as with the staff." Teachers' ratings of the training and development sessions were excellent.

Still there was the question of why the teachers had neglected to attend trainings in the past when they knew training was important. Why did they attend the trainings offered during this study? The answer appears to be a combination of several factors, including that the subject material was presented by a peer mathematics teacher and mentor, that the training was relevant to the teaching of mathematics, and that support was provided throughout the process.

Research shows a need for support when teachers are attempting to integrate technology into practice (Office of Postsecondary Education, 2000; PCAST, 1997), so one of the objectives of this mentor-supported model was to provide extended support. Each session was followed up with informal conversations to encourage use and answer questions. There was collaboration between the teachers, and the trainer spent time in their

classrooms and co-taught lessons. Although the teachers were anxious at first, they were relieved when things went smoothly. The students, teacher, and researcher all worked together to solve problems as they arose. Throughout the process, several teachers commented on how they would not have been able to use the technology without the extended period of support. It was apparent that the process was more effective with coaching following training than without the follow-up, as supported by research (Hosack-Curlin, 1988; Schaverien & Cosgrove, 1997; Showers, 1982, 1984).

Lack of release time for training, planning and collaboration. As evident by the schedules posted in each school in the district, technology classes were held on a regular basis for teachers and other school staff. However, in order to attend these classes, teachers had to schedule themselves during their own personal time or ask for permission for leave time and obtain coverage for their classes. The participants in this study did not attend these sessions, nor was there encouragement from administration for such involvement. From interviews with the technology support representative and the participants, it was found that previous technology training had been offered at the school, but most of it was not relevant to teaching mathematics and all of it was done after school.

Data analysis showed that teachers lacked sufficient time for training, planning, and collaboration. In the focus groups the topic of time arose repeatedly. Teachers expressed concern for the time needed for planning and preparing for lessons using the skills and technology they learned about in the sessions. Comments were made on the Training and Development Activity Evaluations about the need for more training time. The part of the teacher work day that was not consumed by mandatory meetings and teaching duties was only a few hours a week. Mathematics teachers spent only 30 minutes together at the monthly department meeting, so there was little time for collaboration.

Discussion

In his book *Change Forces, Probing the Depths of Educational Reform*, Michael Fullan (1993) wrote, "You can't mandate what matters," and "the more complex the change the less you can force it" (p. 22). Teachers are not being provided with support and sufficient release time for effective technology-based professional development, planning, and collaboration to occur. Without attending to these issues, increasing teachers' effectiveness and use of technology will continue to be a difficult and slow process. "New ideas of any worth to be effective require an in-depth understanding and the development of skill and commitment to make them work" (Fullan p. 23). The common one-shot approach to staff development was not working for the mathematics teachers at this school.

In order for the benefit of new technological innovation to be realized, this study, like many others, indicates that mathematics teachers need continuous and relevant training and support, especially when teachers are teaching out-of-field or are new to the profession. As technology rapidly advances, this need will no doubt continue. If teachers do not perceive that there is enough time for training or that the availability of technological resources is appropriate, they will not make an effort to obtain the technology training they need and desire. Furthermore, there must be an obligation to plan and coordinate staff development in ways that will promote change in teacher practice.

Teachers do not have sufficient time in their busy schedules to attend the training they need. There is no question that teachers need more time out of their busy days for professional development. Japanese teachers spend approximately 40% of their paid time

on collaboration and professional development compared to approximately 14% for U.S. teachers (Pons, 1999). According to a report released in 1995, only 39% of the professional development teachers received was done on paid time, compared to 90% for the professional and private sector (Office of Postsecondary Education, 1995).

It is important to open teachers' eyes to the many technologies that are available for them and their students. This can be accomplished through mentoring and support during and following professional development. Teachers cannot come to the realization that technology can help them perform their jobs better unless they perceive it as both useful and easy to use (Davis, 1989). If these perceptions are not altered, then teachers will not make an effort to change. Effective mentor-supported professional development can be successful in increasing the integration of technology in the mathematics classroom when the training is relevant and encourages the integration of technology into the curriculum.

Implications

Schools, districts, and researchers should consider several implications of this research:

1. Administrators' attitudes and beliefs play a key role in whether technology is used in the classroom. One way that administrators and principals can show their support is by allowing and encouraging release time for training. More research needs to be conducted related to ways of improving administrators' attitudes and beliefs in this area.
2. "The development of a knowledge base for change is a powerful potential asset for altering the quality and the status of teacher preparation" (Fullan, p.120). It is recommended that the amount of paid time for training be increased and included in the teacher work schedule.
3. To keep teachers technologically proficient, ongoing professional development should be included as a requirement in a state's plan for recertification, with the number of hours clearly stated.
4. Teachers need time to reflect and collaborate together following training. "People learn new patterns of behavior primarily through interactions with others" (Fullan, 1993). The more frequent the collaboration, the more teachers believe professional development activities improve their practice (Parsad et al., 2000). Training should be structured in a way that encourages and allows for collaboration with peers.
5. Technology integration into the curriculum needs careful consideration when planning professional development. Training should support the innovation of technology as a tool that makes teaching more efficient and not as another layer in the curriculum.
6. A mentor-supported model should be used for professional development in technology to enable teachers to receive the additional support they need to facilitate change when implementing new strategies. Research needs to be conducted over a longer period to check sustainability, as well as to investigate the types of follow-up support desired and pursued by teachers.
7. Although much research has been documented on proving that teachers' attitudes and perceptions are important, more should be done on how to change them.

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Resources

FCAT Explorer - www.fcatexplorer.com

KaleidoMania - www.keypress.com/catalog/products/Prod_KaleidoMania.html

Mighty Math - www.riverdeep.net/products/mighty_math/index.jhtml

Author Note:

Bonnie Swan
University of Central Florida
BSwan@mail.ucf.edu

Juli Dixon
University of Central Florida
jkdixon@mail.ucf.edu

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Appendix A

Timeline for Action Research

Description	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Schedule training sessions.	X									
Meet technology specialists (school and district) to discuss plans and get recommendations. Meet with principal.	X									
Locate and analyze previous years computer lab use log and library records of technology checked out. Obtain a list of technology related materials at the school.	X									
Present details of study and identify prospective participants at mathematics department meeting.		X								
Distribute schedule and obtain adult letters of consent.		X								
Administer and collect Pre-attitudinal and Level of Use Surveys.		X								
Finalize training schedule and notify participants.		X								
Technology Professional Development Sessions (5).			X	X		X	X	X		
Focus groups (audiotape).				X		X	X			
Administer and collect Training and Development Activity Evaluations.			X	X		X	X	X		
Distribute and collect Technology Use Logs.			X	X		X	X	X		
Informal follow up and support.			X	X		X	X	X	X	
Analyze Technology Use Logs and Focus Group transcripts as they are obtained to refine research and professional development throughout the project.				X	X	X	X	X		
Obtain and analyze Computer Lab Use Logs.					X			X		
Administer Post-Attitudinal and Level of Use Survey.									X	
Data Analysis.			X	X	X	X	X	X	X	
Submit recommendation to administration and follow up.										X

Appendix B

TECHNOLOGY ATTITUDE SCALE

Below is a series of statements. There are not correct answers to these statements. They have been set up in a way which permits you to indicate the extent to which the idea expressed is true or not true of you. Please use the following scale:

1 = Not all true of me. 7 = Very much true of me.

By technology, we mean computers, CD-ROMs, laserdisc players, databases, etc.

		NOT TRUE					VERY TRUE	
		1	2	3	4	5	6	7
1.	Knowing how to use technology is a necessary skill for me.	1	2	3	4	5	6	7
2.	I like using technology.	1	2	3	4	5	6	7
3.	I feel confident with my ability to learn about technology.	1	2	3	4	5	6	7
4.	Working with technology makes me nervous.	1	2	3	4	5	6	7
5.	I now use my knowledge of technology in many ways as a teacher.	1	2	3	4	5	6	7
6.	I like using technology in my work.	1	2	3	4	5	6	7
7.	I wish I could use technology more frequently.	1	2	3	4	5	6	7
8.	Technology makes me feel stupid.	1	2	3	4	5	6	7
9.	A job using technology would be very interesting.	1	2	3	4	5	6	7
10.	I don't expect to use technology much at work.	1	2	3	4	5	6	7
11.	I'm not the type to do well with technology.	1	2	3	4	5	6	7
12.	I feel uncomfortable using most technology.	1	2	3	4	5	6	7
13.	Working with technology is boring.	1	2	3	4	5	6	7
14.	Learning about technology is a worthwhile and necessary subject.	1	2	3	4	5	6	7
15.	It is important to know how to use technology in order to get a teaching position.	1	2	3	4	5	6	7
16.	I know that if I work hard to learn about technology, I will do well.	1	2	3	4	5	6	7
17.	I am able to do as well working with technology as my fellow <u>school name</u> teachers.	1	2	3	4	5	6	7
18.	I think using technology will be difficult for me.	1	2	3	4	5	6	7
19.	Technology makes me feel uneasy and confused.	1	2	3	4	5	6	7
20.	Once I start using technology, I will find it hard to stop.	1	2	3	4	5	6	7