The purpose of this study was to determine if 1-week technology workshops can be an effective means for the professional development of music teachers in using technology for instruction. The results indicate that three indicators of effectiveness—teacher knowledge, teacher comfort, and frequency of teacher use—can be significantly improved in these settings. Participants (N = 63) were music teachers enrolled in summer music technology workshops. At the beginning of the workshops, participants completed a questionnaire designed to provide demographic information and assess their knowledge of music technology, degree of comfort with music technology, and the frequency with which they used music technology in their teaching. Following an intensive weeklong workshop dealing with strategies for teaching music to K–12 students using music technology, participants completed a second questionnaire that was parallel to the first. Participants completed another similar questionnaire 9 to 10 months after the workshop. Significant differences were found between the pre- and postworkshop questionnaires, between the preworkshop and follow-up questionnaires, and between the postworkshop and follow-up questionnaires in all three areas. There was also a moderate correlation (r = .43, p = .00) between participants' frequency of technological use and the degree to which they reported their access to technological resources.

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Transforming Music Teaching via Technology: The Role of Professional Development

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Professional development and teacher training are areas of inquiry that have concerned educational professionals for many years. In the past 15 years, the need for teacher training in technology across all subject areas has been increasingly discussed (Cuban, 2001; Jones, 2000). Along with this, Zuga (1994), in a review of educational technology research from 1987–93, indicated that instructional methods and strategies for using technology effectively have been given little, if any, real attention. This increased need for technology training and the lack of study regarding the most effective instructional strategies in actual use by teachers continues to be an important issue.

Music educators and researchers have examined both the applications of technology to music teaching and learning and the need for training focused on the use of technology. Peters (1984) stated that for teaching to be effective when using technology, a thorough understanding of hardware and software is needed. Authors have outlined how computer technology is enabling many new approaches to music learning (Williams & Webster, 1999), and the use of the Internet in music education settings has been examined (Bauer, 1999). Meltzer (2001), Ohlenbusch (2001), and Bauer (2003) have looked at aspects of music technology as it applies to preservice music teachers.

Two recent studies have illustrated the difference between what music teachers are actually doing with technology and its instructional potential (Reese & Rimington, 2000; Taylor & Deal, 2000). Both of these investigations found that a large majority of music teachers used technology for school-related purposes (between 75% and 92%); but these uses were primarily administrative, with less than 30% of teachers using computers during class time with students. Reese and Rimington (2000) learned that 94% of music teachers desired further technology training, but that only 13% of school districts offer music technology training once a year, and only 25% of teachers have received formal technology training at a university. In a national study, Taylor and Deal (2000) discovered that more than 90% of music teachers were willing to participate in technology training. Clearly, music teachers require training and assistance to make full use of the instructional potential of technology. In addition, there is a need to determine the types of music technology training that are effective so that school districts, universities, and professional organizations can increase efforts to make this training more accessible to music educators.

Examining this issue is becoming increasingly urgent with the establishment of new guidelines for teachers' knowledge and skill in using and integrating instructional technology into classroom practice. These demanding new standards are being generated for teachers of all subjects by state boards of education, by accrediting organizations such as the National Council for Accreditation of Teacher Education (NCATE, 2000), and professional organizations like the International Society for Technology in Education (ISTE, 2000).

Similar efforts in music education have led to technology competencies for music teachers such as those outlined by the Technology Institute for Music Educators (Rudolph, Richmond, Mash, & Williams, 1997). MENC: The National Association for Music Education has also established benchmarks for using music technology in regards to its impact on curriculum and scheduling, staffing, equipment, materials/software, and facilities (MENC, 1999).

In a review of the research related to professional development in technology, Schrum (2001) cites several factors that are necessary for technology training to be effective, resulting in the adoption of instructional technologies by teachers. First, 30 hours of instruction and work with new technologies are necessary before teachers will actually use them. An exposure to technology shorter than this is not usually sufficient to effect its eventual integration into instructional practice. Second, having equipment available at home and at school so that there is an opportunity for teachers to practice and develop a level of comfort is essential. Third, many people are somewhat apprehensive of technology, afraid they will embarrass themselves with it. Teachers need to feel comfortable with technological tools before they will actually use them. Finally, using technology may make teachers rethink instructional practice and transform the way they have done things for many years. Teachers can be reluctant to do this and must be made cognizant of the benefits resulting from the use of technology.

One of the most extensive, longitudinal examinations of the integration of technology into school curricula was the Apple Classrooms of Tomorrow (ACOT) Project sponsored by Apple Computer (Apple Computer, 2003; Sandholtz, Ringstaff, & Dwyer, 1997). Researchers associated with this project discovered that teachers move through five stages during the successful adoption of technology-based instructional procedures. In the entry stage teachers are concerned with managing a technology-oriented classroom, struggling with the control of students in this type of environment. They often find themselves reacting to classroom problems instead of being able to anticipate and avoid them. During the adoption stage, teachers begin to use technology to support traditional instruction. Students often use the computer in seclusion, sometimes as a reward for having completed other class activities. The adaptation stage is entered into when the technology is no longer a hindrance to a well-run classroom, but rather teachers begin to be able to make use of the technology to simplify classroom management and affect student learning. Teachers begin to realize that the computer will allow them to complete some tasks more easily and efficiently, while they also begin to achieve more integration of technology into regular classroom activities. When reaching the final stages, appropriation and invention, teachers no longer have classroom management concerns Technology is used not only to simplify classroom management, but it also is integrated seamlessly and naturally into instruction. Teachers become excited about the instructional possibilities tech-

nology avails, and design lessons that include learning goals that would not have been possible without the use of technology. The teachers' teaching has undergone a transformation of sorts. To learn to use technology, ACOT researchers found that it was important for teachers to be able to observe experts modeling instructional practices and that the teachers were involved in activities that were learner-centered and interactive.

In discussing teachers and the use of technology, Schrum (2001) wrote, "More research must focus on alternative ways to provide effective professional development for our current and future educators" (p. 88). Despite the growing realization that there is a need for music teacher training in the use of technology, no research exists that assesses the effectiveness of such training. Little is known about whether music teachers' knowledge of technology and their comfort level with using technology actually improves following technology training. Another important area for inquiry concerns whether music teachers actually use technology in their teaching and their students' learning to a greater extent following technology training. This study investigated these areas for music teachers who had received in-service training on the curricular uses of technology in music education.

Research Questions

Three research questions were formulated. (1) Does music technology training change teachers' knowledge of music technology? (2) Does music technology training change teachers' degree of comfort with using technology for music learning? (3) Does music technology training change the frequency with which teachers use technology for music learning?

METHOD

Participants

Participants (N = 203) were music teachers enrolled in summer music technology workshops held at 19 locations, primarily universities, in the eastern and midwestern United States. The participants taught at all grade levels, K–12. Teaching areas included general music (37%), vocal/choral music (17%), instrumental music (38%), and other types of classes (8%). A bachelor's degree was the highest academic credential held by 60% of the participants, whereas 38% had earned a master's degree, and 2% held doctorates. Of the subjects, 42% were men and 58% were women. Overall, participants were moderately experienced teachers, with 19% having taught 1–3 years; 31%, 4–10 years; 26%, 11–20 years; 18%, 21–30 years; and 6%, more than 30 years. Ages of participants were as follows: 26% were between the ages of 20 and 29; 23% were 30–39; 34% were 40–49; 16% were 50–59; and 1% were 60 years or older. Generally, then, the

participants were a representative cross-section of K–12 music teachers.

Measurement Instrument

A questionnaire was designed by the researchers to examine the background of the participants, their knowledge of music technology, their degree of comfort in using technology, and the frequency with which they used music technology in their teaching. The questionnaire was developed based on a review of the literature, a study of questionnaires used in related studies, an examination of the objectives of the workshops, and the researchers' personal experience with music technology and its use by K–12 music teachers. Participants responded to 4-stem multiple choice questions to examine their knowledge of music technology. Knowledge questions were related to MIDI, music software, the Internet, and digital media, all of which were topics covered in the workshops. Degree of comfort was assessed using a 4-point Likert-type scale ranging from "uncomfortable" to "very comfortable." Participants rated their degree of comfort in areas such as developing lessons that integrate instructional software into the music curriculum, finding music resources on the Internet using search engines, and working with digital audio and MIDI. A 5-point Likert-type scale ranging from "never" to "frequently (nearly every day)" was used to assess the frequency of use of music technology. Participants were queried as to how often in the past year they had used instructional software with students, integrated Internet resources into the music curriculum, used the Internet and other types of multimedia to address the National Standards for Music Education (MENC, 1994) with students, and so on.

Parallel pretest, posttest, and follow-up versions of the questionnaire were developed. The posttest questionnaire differed slightly from the pretest version. For example, the demographic information from the pretest was not included in the posttest. Another change was in the part of the questionnaire dealing with frequency of use. In the pretest, participants indicated the frequency with which they had engaged in music technology activities during the past year while the posttest version asked them to project how frequently they anticipated they would engage in the activities during the next school year. The follow-up questionnaire, which was administered approximately 9 to 10 months after the teachers had completed the workshops, asked participants to indicate the actual frequency with which they had used music technology during the previous year. It also included a series of questions related to the Opportunity to Learn Standards for Music Technology (MENC, 1999) designed to gauge the degree to which participants' needs related to curriculum and scheduling, staffing, equipment, materials/software, and facilities in relation to technology were being satisfied. Finally, the questionnaires were placed on the World Wide Web as Web-based "forms" that individuals completed and then submitted electronically.

Pilot Study

The questionnaire, all procedures, and analysis of data were tested during a pilot study. Participants in the pilot study were in-service teachers who were enrolled in summer music technology workshops during the year previous to the present study. No major changes were made in the study design following the pilot study.

Procedure

Near the beginning of each workshop, participants completed the pretest version of the questionnaire. Participants accessed the questionnaire via the World Wide Web. Participants then took an intensive 1-week workshop dealing with strategies for teaching music to K–12 students using music technology. The curriculum for all of these workshops was standardized, developed by a major professional organization dedicated to providing in-service training in music technology to teachers. The workshops' structure was student-centered and included modeling by the instructor, hands-on work with the technology by the workshop participants, and class discussions. As one of the final activities of the workshop, participants accessed and completed the posttest version of the questionnaire. Approximately 9 to 10 months after completing their workshop, participants were contacted by either e-mail or U.S. mail and asked to complete the follow-up questionnaire. The primary researcher downloaded the data collected and analyzed it using the Statistical Package for the Social Sciences (SPSS) computer program.

RESULTS

Pretest and posttest versions of the questionnaire were completed by 203 participants. In addition, 63 of the original 203 participants (31%) completed the follow-up questionnaire. Because the return rate for the follow-up was lower than desired, the data were examined closely in several ways to provide added confidence in inferring the results from the 63 individuals to the entire 203 participants.

The demographic characteristics of participants who completed the follow-up questionnaire (Follow-Up Complete/FC), those who did not complete the follow-up questionnaire (Follow-Up Incomplete/FI), and the entire population of participants (FC and FI combined) were inspected (see Table 1). In general, it seems that the three groups were similar as to workshop locations represented, grade levels taught by the participants, areas of music teaching represented, academic degrees earned by the participants, number of years the participants had taught, and their ages. There were some gender differences between the groups: the FI group contained a higher percentage of women than did either of the other two groups, whereas the FC group had a fairly equal distribution of men and women.

Table 1
Demographic Characteristics of Entire Population, Follow-up Complete (FC) Participants, and Follow-up Incomplete (FI) Participants

Characteristic	Entire Population	FC	FI
Number	203	63	140
Workshop Locations Represented	19	19	19
Grade Levels Taught Represented	K–12	K–12	K–12
Teaching Areas Represented			
General Music	37%	40%	36%
Vocal/Choral Music	17%	19%	16%
Instrumental Music	38%	36%	40%
Other Class Types	8%	5%	8%
Degrees Held			
Bachelor's	60%	63%	61%
Master's	38%	33%	37%
Doctorate	2%	4%	2%
Gender			
Men	42%	49%	39%
Women	58%	51%	61%
Teaching Experience			
1–3 years	19%	21%	18%
4–10 years	31%	35%	31%
11–20 years	26%	27%	28%
21–30 years	18%	14%	17%
More than 30 years	6%	3%	6%
Age			
20–29 years	26%	25%	27%
30–39 years	23%	27%	23%
40–49 years	34%	35%	32%
50–59 years	16%	13%	16%
60 years and older	1%	0%	1%

The data from pretests and posttests of both the FC and the FI group were analyzed to further determine the equivalency of the two groups. An independent samples *t*-test was calculated between the pretest scores of the two groups, as well as between the posttest scores. No significance differences were found between the FC and FI groups' pretest knowledge (FC $M = 63.65$, FI $M = 60.38$, $p = .25$), comfort (FC $M = 49.27$, FI $M = 41.96$, $p = .06$), and frequency of use (FC $M = 38.49$, FI $M = 38.08$, $p = .52$) scores. Likewise, examination of the posttest scores of the FC and FI groups revealed no significant differences in the participants' knowledge (FC $M = 81.43$, FI $M = 81.22$, $p = .93$), comfort (FC $M = 81.68$, FI $M = 77.21$, $p = .06$), and frequency of use (FC $M = 69.19$, FI $M = 67.17$, $p = .08$). Finally, a paired-samples *t*-test was calculated between the pretest and posttest scores of the FC and FI groups. The analysis of the FC group's scores revealed significant differences between pre- and posttest scores of knowledge (Pre $M = 63.65$, Post $M = 81.43$, $p = .00$), comfort (Pre $M = 49.27$, Post $M = 81.68$, $p = .00$), and frequency (Pre $M = 38.49$, Post $M = 69.19$, $p = .00$). There were also significant differences observed between pre- and posttest scores of the FI group in knowledge (Pre $M = 60.38$, Post $M = 81.22$, $p = .00$), comfort (Pre $M = 41.96$, Post $M = 77.21$, $p = .00$), and frequency (Pre $M = 38.08$, Post $M = 67.17$, $p = .00$). Thus, in terms of knowledge about music technology, comfort with using technology for music learning, and the frequency with which participants reported they used or planned to use technology for music learning, there were no significant differences prior to the workshop, or after the workshop's conclusion. Both groups seem to have improved similarly during the training.

To answer the first research question, participants' scores on the knowledge-based questions of the questionnaire were tallied, providing an overall knowledge score. Pretest, posttest, and follow-up knowledge scores were compared using a repeated measures analysis of variance (ANOVA). A significant, $F(2, 61) = 28.59$, $p = .00$, main effect difference was found. The main effect difference was examined through a post-hoc pairwise comparison of the means, using the Bonferroni adjustment. Significant differences were found between the pretest ($M = 63.65$) and posttest ($M = 81.43$) scores ($p = .00$), the pretest and follow-up ($M = 75.08$) scores ($p = .00$), and the posttest and follow-up scores ($p = .03$).

The second research question was investigated by summing the participants' responses to the questions from the section of the questionnaire where they had indicated their degree of comfort for various activities to arrive at an overall score. Pretest, posttest, and follow-up comfort scores were compared using a repeated measures ANOVA. A significant, $F(2, 61) = 144.97$, $p = .00$, main effect difference was found. The main effect difference was examined through a post-hoc pairwise comparison of the means, using the Bonferroni adjustment. Significant differences were found between the pretest ($M = 49.27$) and posttest ($M = 81.68$) scores ($p = .00$), the pretest and follow-up ($M = 70.3$) scores ($p = .00$), and the posttest and follow-up scores ($p = .00$).

Participants' responses to the questions relating to the frequency with which they engaged in music technology activities were combined to arrive at an overall score to answer the third research question. Pretest, posttest, and follow-up frequency scores were compared using a repeated-measures ANOVA. A significant, $F(2, 61) = 108.763$, $p = .00$, main effect difference was found. The main effect difference was examined through a post-hoc pairwise comparison of the means, using the Bonferroni adjustment. Significant differences were found between the pretest ($M = 38.49$) and posttest ($M = 69.19$) scores ($p = .00$), the pretest and follow-up ($M = 49.63$) scores ($p = .00$), and the posttest and follow-up scores ($p = .00$).

Finally, means were determined for each of the responses related to the *Opportunity to Learn Standards for Music Technology* (MENC, 1999). These responses were then ranked from high to low (see Table 2). In addition, a Pearson correlation coefficient was calculated to examine if there was any relationship between participants' frequency of use of technology and the degree to which they reported their access to technology resources. Of special concern was whether participants' needs as to curriculum and scheduling, staffing, equipment, materials/software, and facilities were being met. A significant ($p = .00$), moderate correlation ($r = .43$) was found between these two factors.

DISCUSSION

The purpose of this study was to determine if 1-week technology workshops can be an effective means for the professional development of music teachers in using technology for instruction. The results indicate that three indicators of effectiveness—teacher knowledge, teacher comfort, and frequency of teacher use—can be significantly improved in these settings. Furthermore, 9–10 months later, these indicators of effectiveness all remained significantly higher than they were prior to the training. It is encouraging that these results were achieved across 19 training locations with differing instructors and a cross-section of music teacher participants.

There was, however, a significant drop in all three areas from posttest (end of the workshop) to follow-up (9–10 months later). This raises the common concern regarding how long the effects of teacher training will last. As discussed earlier, Schrum (2001) found that with 30 hours of training, teachers will begin to use technologies in their classrooms. These workshops met that criteria and demonstrated that teachers did gain knowledge and comfort with technologies and increase their frequency of use of technologies. These changes were sustained over a moderate period of time, although at a lower level than immediately following the workshop. A closer look at the data shows that teacher knowledge and comfort were sustained better than frequency of use over the follow-up period. Even after 10 months (follow-up period), the mean knowledge score remained at 75.08, with the mean comfort score at 70.3—both respectable levels.

Table 2
Selected Opportunity to Learn Standards for Music Technology

Standard	Mean/*SD*
• I have easy access to email and other Web services for professional and curricular development, research, and other communication needs at school.	3.79/1.45
• Sequencing software for recording, arranging, improvising, and composing music is available in my school; as well as notation software for notating, editing, and printing music.	2.56/1.43
• Software and hardware selections for use in music classes in my school are made based on the learning goals established for the students.	2.50/1.42
• My students have the same degree of access to school computer equipment for instruction in music as for instruction in other disciplines.	2.16/1.45
• My school provides music classroom space with appropriate furniture, power, and Internet connections for each computer station(s).	2.14/1.44
• The music software library in my school includes instructional software that reinforces listening, understanding, and responding to music.	2.10/1.35
• The music software library in my school includes multimedia software that enables children to create and perform music, and permits musical exploration and game playing.	2.08/1.35
• A plan to purchase new music software titles each year is in place, and existing software is upgraded on a regular basis.	2.06/1.22
• I am provided with the necessary development time for creating new curriculum materials and instructional strategies that make effective use of music technology.	2.00/1.18
• Every music classroom in my school contains at least one multimedia-ready computer that is Internet-capable and includes: audio in/out capability, General MIDI sound generation, powered speakers, CD- or DVD-ROM player, and a MIDI keyboard connected to the computer.	1.89/1.21

Note. 1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree.

The mean frequency of use score, however, had fallen to 49.63, which can be interpreted as a moderately low level of use. This relatively low level of classroom use of technology, as opposed to administrative uses, reflects the earlier findings of Reese and Rimington (2000) and Taylor and Deal (2000) in their surveys of teachers. This is the most troublesome result, since it is frequency of use of technology that leads to better quality of usefulness.

Plainly, this gradual reduction of effect could be lessened with appropriate follow-up support for teachers in their schools. They need opportunities to discuss their efforts with colleagues, strategies for technology-based learning, resources to answer technical, pedagogical, and classroom organization questions, and prompt and knowledgeable technical support. Ideally, this support would happen in an informal "just-in-time, over-the-shoulder" kind of manner. Achieving this level of support is a serious challenge when the music teacher may be the only teacher in the school grappling with exactly how to use these technologies for music learning. Perhaps the growth of online professional forums and Web sites devoted to technology for music teachers will partially address this need for follow-up support. Another source of support may be the development of professional organizations devoted to instruction with music technology, such as the Technology Institute for Music Educators.

In addition to the need for follow-up support, access to technology resources seems critical to maintaining better frequency of technology use. Part of the less frequent use of technology by the teachers may be attributed to the lack of technology resources that are in place in their schools (see Table 2). With the exception of "I have easy access to e-mail and other Web services for professional and curricular development, research, and other communication needs at school," all of the participants' responses to items were very low, in the disagree to neutral range. Also, the correlation score ($r = .43$) indicates that the more teachers are using technology, the higher their reported availability of the essentials called for by the Opportunity to Learn Standards (MENC, 1999). Having access to resources seems to make a difference in sustaining the gains of teacher training.

This discussion of the follow-up findings of the study should be viewed with caution due to the return rate for the follow-up questionnaires. It may be that only those teachers who continued to be interested in and use technology regularly are the ones who made the effort to respond. The more balanced gender distribution of the participants who completed the follow-up questionnaire, compared to those participants who did not return the questionnaire, may be related to gender differences in self-efficacy (Bauer, 2003) and familiarity (Fung, 2003) with technology.

The long-range goal of this type of technology training for music teachers is not only to help teachers make incremental gains in efficiently implementing traditional teaching approaches but also to work toward transforming the nature of teaching and learning in classrooms. The Apple Classrooms of Tomorrow research (Dwyer, 1991) has shown that these kinds of transformations can take place. In that study, the investigators found that, with regular access and support for technology in their classrooms and with extended experience, teachers not only mastered the technology but also made significant changes in their instruction. However, this process of instructional change evolved over several years and was characterized by

inner conflict for teachers over deeply held beliefs about schooling. Transformative uses of technology required much more than merely inserting technology into traditional classroom settings and instruction.

As discussed earlier, this transformation can be a long-term effort involving professional growth through stages of entry, adoption, adaptation, appropriation, and invention. The present study has demonstrated that the initial phases of this process can be accomplished through teacher training workshops. Support, resources, and further informal and formal learning, however, seem essential to achieving long-term transformation of teaching through technology.

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