Music Teachers' Experiences:
Learning through SMART Board Technology

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Many technological innovations for teaching and learning that have been introduced with great fanfare have fallen by the wayside because teachers did not have a good image or model of how to integrate them into their teaching practice. In order to be successful at using technology in their teaching, teachers need to know how to use it effectively and how to incorporate it into their lesson planning on a daily basis. They also need to believe the incorporation is valuable and believe that the technology will fit with their vision of what constitutes good teaching (Windschitl & Sahl, 2002).

In this study, we created a learning environment for music teachers in which their own learning experiences could provide an image or model of how a tool such as a SMART Board could be used in teaching and learning. We engaged in qualitative analysis of data representative of the experiences of these teachers, taking into account the perspectives of the participants, in an attempt to generate emergent themes that might be meaningful in other music teaching and learning settings.

The Context of the Study

The Department of Music, Theatre and Dance at Oakland University has a music teacher education program that serves about 85 undergraduate music education majors and about 80 practicing music teachers in both master's and post-master's professional development courses. At both the undergraduate and graduate levels, the music education program has taken a leadership role in educating teachers to teach music from a constructivist perspective – based on the assumption that learners need to construct their own understanding of music in order to learn to function in music. As a result, the educational community surrounding this regional university includes quite a rich population of music teachers who believe in and utilize constructivist music teaching practice.

In addition to regular course offerings, as part of outreach efforts to support music education professionals, the department runs short-term technology workshops for music teachers. Participants in these workshops tend to be music teachers who are interested in using some technology in their teaching, but are seeking guidance about what steps to take. Graduates of Oakland's music education programs who attend these workshops are generally looking for ways that technology can fit into constructivist music teaching practice. The workshops also attract many teachers for whom this workshop is their first experience with the Oakland university program, and therefore have other goals. Participants at all levels and in all types of workshops and classes have varying levels of familiarity with music technology and teaching technology. Most have only just begun to conceive of how new technologies could be used as part of effective music teaching.

Theoretical Framework

The original intent of this study was to look at the nature of collaboration and peer support as it occurred in learning situations that incorporated a SMART Board as an integral part of the learning environment. Collaboration and peer support are important aspects of the learning process. The importance of collaboration and peer support during learning is rooted in a social constructivist vision of teaching and learning. This vision was first suggested by Vygotsky (1978) and has been brought to the attention of American educators and teacher educators by the work of writers such as Wertsch (1985) and Rogoff (1990; Rogoff & Lave, 1984). Social constructivist learning theory has been interpreted for music education in the work of Wiggins (2001).

In a social constructivist view, all knowledge is constructed by the learner as a result of interaction with others (interpersonal plane) or by the individual functioning independently drawing on knowledge gained through prior interaction with others (intrapersonal plane). This vision of learning assumes that all participants bring knowledge to a learning situation, which means that the teacher is not the only bearer of knowledge. It emphasizes the importance of peer interaction in an individual's learning processes. In many cases, because peers have more of a common knowledge base than exists between the students and teacher (what Rogoff, 1990, would call a higher level of intersubjectivity or shared understanding), peers may actually be stronger mentors and mediators than the teacher. Students learning collaboratively have opportunities to seek peer advice, explanations, interpretation, translation, and affirmation of ideas. This support that learners provide for one another has been called scaffolding (originally labeled as such by Wood, Bruner, & Ross, 1976). Social constructivists describe scaffolding as any process used by a more knowledgeable other that enables learners to function at a higher level of proficiency than they might be able to accomplish on their own. In this view, one of the teacher's primary roles is to provide scaffolding for students.

Intent of the Study

When a group of teachers comes together to learn to use technology, one of the barriers to effective collaboration and peer support is the difficulty in communicating with others while working at an individual computer or workstation. If it were possible for teachers to learn to use technology in a situation where they had ample opportunity to interact while working, one would assume that the effectiveness of the learning situation would be greatly enhanced. Further, we felt that if teachers could experience first-hand what it is like to collaboratively learn to use technology in music teaching, it is more likely that they will be able to make that transfer to their own teaching. The intent was to design a learning situation that would provide a model for what would be possible in their own classrooms. We expected that integration of a SMART Board into the learning environment would foster and facilitate interactive and supportive learning. Further, we felt it would be particularly valuable to use a piece of interactive technology as a tool for teaching teachers how to teach interactively using technology.

For the purposes of this study, we used a SMART Board as a tool to support instruction in some undergraduate and graduate music education classes, and as the primary platform for the outreach technology workshops whenever possible. Although we did not originally plan to do so, we also collected data as we used the SMART Board as part of conference presentations for music educators in local, state, and national settings. Before engaging in the study, we assumed that the nature of the SMART Board would facilitate interaction among participants as they learned. We expected that teachers learning to use technology through a SMART Board would have more opportunities for collaboration and peer support. We also expected that learning in this way would help teachers develop a better understanding of the capacity for student interaction that a SMART Board might generate in their own classrooms. The intent of the study was to document and describe participants' learning processes and the nature and importance of collaboration and peer support in their learning.

Methodology

Research Design

The nature of student learning is best studied through qualitative methods because qualitative analysis enables a researcher to illuminate all aspects of the situation from a variety of perspectives. This study utilized data collection and analysis techniques described by Lincoln and Guba (1985) and Denzin and Lincoln (2000). Data were collected through videotape as participants engaged in the workshops, classes, and presentations. Participants in all sessions that were videotaped granted permission for the data collection. Additional data were in the form of videotaped post-session discussions with participants, in which we elicited participants' feelings and impressions about what they noted about their own learning and, in the case of practicing teachers, how they might utilize the medium in their own classrooms. The resultant videotapes were transcribed and analyzed for emergent themes related to the nature and role of collaboration in the participants' learning processes. In addition, because the instructors had taught the same workshops and classes and made similar conference presentations without a SMART Board, additional data consisted of their reflections on the differences they experienced and noted in reflective journals throughout the study. Also, whenever possible, when one investigator was teaching a workshop or class, the other acted as observer, taking field notes.

Credibility was established through (a) triangulating the data, (b) our attempts to capture multiple perspective, (c) peer debriefing, and (d) negative case analysis (Denzin & Lincoln, 2000; Lincoln & Guba, 1985). Data were triangulated through the use of multiple collection sources: videotape, observer field notes, teacher reflections, and follow-up interviews with participants. Two outsiders, one with expertise in music teaching and one with expertise in music education technology, served as peer debriefers – meaning that data were shared with them to ascertain their viewpoints on the plausibility of the themes that were found emerging from the analysis. Once emergent themes were identified, the data were searched for negative cases. Where negative cases were identified, they are described in the data analysis section of this paper.

Data Collection

Sites and Participants

Between September 2001 and June 2002, data were collected during 9 sets of workshops, classes, and conference presentations. On-campus workshops and classes took place in the music education classroom, a music theory classroom, and in the music technology laboratory, all of which were located in close proximity to one another. The music education classroom is equipped with equipment usually found in such classrooms, e.g., acoustic classroom instruments, several MIDI keyboards, stereo system, whiteboards. The theory classroom was equipped with a stereo system and a staved whiteboard (musical staves). The technology lab had 12 MIDI stations, each with a computer (5 Mac and 7 PC) and a MIDI keyboard.

One workshop was conducted off campus, in an elementary music classroom in a public school. The SMART Board was also used as a platform for conference presentations for music education professionals: two at state-level music technology conferences and one series of 9 sessions at the national music education conference.

In all, more than 230 preservice and practicing teachers engaged in workshops or class sessions where the SMART Board was used as a tool for teaching: 39 practicing teachers and 20 undergraduate students attended workshops on campus, 26 practicing teachers were members of graduate classes in which the SMART Board was used as a tool, 12 practicing teachers attended an on-site workshop held in a music education classroom in their own district, at least 40 practicing teachers participated in two sessions at state music technology workshops, and at least 100 participated in the 9 sessions presented at the national conference.

Settings

1. In September, a 3-hour technology workshop for local music teachers was held on campus, in the music education classroom. 16 teachers participated (TMU Workshop, described in Footnote 2). The SMART Board was used in projected mode: to introduce "Making Music," a composition program for young children, to help teachers see ways that the SMART Board can make it possible to teach music in a one-computer classroom (which is the situation for most music teachers who have a computer in their classroom). The teachers participated in a follow-up discussion designed to elicit their reactions to the SMART Board and its potential in their own teaching. For this session, data were collected through videotape of the session and follow-up discussion, observer field notes, and instructor reflection.

2. During October, 12 students in an undergraduate class in jazz improvisation worked in the technology lab for 2 class periods to learn to use the software “Band in a Box” as a basis for improvisation. The SMART Board was used in projected mode as a medium for teaching the basics of using this software. Data were collected through videotape, instructor reflection, and conversations with the jazz improvisation instructor.
3. In October, in a graduate class in Research in Music Education, 11 practicing teachers used the SMART Notebook application as a tool for organizing emergent themes as they learned processes of research analysis. Data were collected through instructor reflection, observer field notes, and follow-up discussion with class members.
4. In November, 13 practicing teachers from one school district attended an on-campus technology workshop in which they learned to use the music notation software “Sibelius.” The SMART Board was used in projected mode. Data were collected through videotape, follow-up discussion, and instructor reflection.
5. Also in November, in the department’s technology lab, 8 undergraduate students learned to use “Finale,” another music notation program, through the SMART Board in projected mode. Data were collected through instructor reflection.
6. In December, an inservice workshop was held on location in a public school music classroom. 12 teachers attended this workshop, in which the SMART Board was used as the mode of presentation for an overview of music education software. Data were collected through videotape, follow-up discussion, and instructor reflection.
7. In January, the SMART Board was used as part of a session presented at the state music education technology conference in Ann Arbor, Michigan. The same session was repeated for teachers in the Upper Peninsula of Michigan several weeks later. About 30 teachers attended the Ann Arbor session and about 10, the Upper Peninsula session. In Ann Arbor, data were collected through videotape and presenter reflection. In the Upper Peninsula, only a reflective journal was possible.
8. In April, at the national inservice conference of MENC–The National Association for Music Education in Nashville, TN, the SMART Board was used as part of 9 sessions that introduced a new music education technology product. Over 100 music teachers, music teacher educators, music education students, and music technology industry professionals attended these 9 75-minute sessions held over 3 days. Data were collected in the form of presenter reflections and unsolicited participant responses.
9. In June, 14 practicing teachers in a graduate class in Psychological Foundations of Music Education used SMART Notebook on two different occasions as a tool for organizing their thoughts into a heuristic in an effort to scaffold their understanding of the interrelationships among some complex ideas. Data were collected through videotape, instructor reflection, and observer field notes.

Data Analysis

Before collecting and analyzing the data, we anticipated that the data would provide information about the impact of a SMART Board on the nature of student interaction and peer support in the learning processes of participants. Our initial experiences with the SMART Board led us to believe that its presence in an instructional setting would provide greater opportunity for shared experience and student interaction. We did not anticipate the extent to which themes would emerge that were reflective of inherent qualities of the technology and of its applications in the various contexts. Levels of interaction among participants were indeed higher than might be found in technology workshop or class settings where students were each working at a separate computer or where the teacher is working from a laptop and data projector. But as we studied the data, it seemed that while the amount of interaction that took place was indeed important, what emerged as much more important were the strengths of the learning environment established by this technology.

From analysis of the data captured by the videotape, field notes, journals, and follow-up discussions, the most important themes that emerged helped us characterize and better understand the strength of this technology when used as an integrated part of a quality learning environment. Emergent themes elucidated some of the inherent qualities of the SMART Board itself that enabled it to support learning, specifically (a) its capacity to support collaborative creative thinking, (b) its capacity to serve as a focal point in the classroom, (c) the transparency of the technology, and (d) its capacity to make instruction more efficient. Equally important were themes related to the ways the presence of the SMART Board enabled better use of technology, including its capacity to (a) extend software functionality in a one-computer classroom, (b) enable peer interaction, and (c) enable the teacher to mediate and scaffold learning. To a great extent, these themes are interactive, overlapping in a variety of ways, which will be evident in the presence of cross-references in the discussion that follows.

Inherent Qualities of the Technology that Support Learning

Capacity to Support Collaborative Creative Thinking

In many of the settings, the SMART Board was used as a platform for enabling collaborative creative work. In most of the workshops and presentations, the technology was used as a platform for software that enables musical creative process (composition software for young children such as Morton Subotnick's "Making Music" and "Making More Music," and notation and sequencing software designed for older students and professional musicians). In graduate music education classes, on two occasions captured in the data collection, students used the technology as a platform for expressing and organizing complex ideas into a manageable heuristic. In all cases, data show that the technology enabled the students to get to the concepts sooner and more efficiently. Participants' work captured by the videotapes clearly indicates that the presence of the technology immediately fades into the background as they become engrossed in their interaction with the software and the product they are trying to produce. Further, that both instructor and participants can manipulate the elements of the various programs with a finger instead of a mouse makes collaborative work clear and obvious to all participants (further discussed in later sections of this analysis).

Music software designed to support creative process tends to be open-ended in nature. This software was originally designed to be used by one person at a time, situated in a one-on-one relationship with a computer. As well, music software of this category has no inherent content; it serves as a framework within which the creative processes take place. The SMART Board enables the software to be used as it was intended, to foster creative thought and products through problem solving. However, the SMART Board extends the functionality by allowing the entire class to engage in the same interactive processes as opposed to the original design where one person at a time interacts with the software (further discussed later). When used in a whole class setting, the teacher (and not the software company) is able to design the activities and then enable the whole class to engage in those activities. These experiences in a teacher-scaffolded environment enabled students to build their understanding of the nature and capabilities of the software and of the processes it supports. Learning the mechanics of the process and software holistically applied within a musical context seemed to enable participants to know how to function independently when they engaged in the same processes on their own at computers or workstations (Ruthmann, reflective journal). This was evident in the videotapes through the absence of participants' questions to the instructor and in that they seemed to have a clear vision of what they wanted to do with the software once they had opportunity to work on their own. The environment seemed to support their ability to problem solve on their own.

In the graduate classes, SMART Notebook was used by the whole class working together as a group to organize their understanding of some complex concepts through the formation of a heuristic (on separate occasions in two different classes). In each case, as the group generated ideas, the instructor recorded them on the board using electronic ink. Key words were converted to typed text, grouped, regrouped, colored, highlighted, and connected through the SMART Notebook software. The agreed-upon representation was then printed and distributed for use in subsequent analytical work. Having engaged in this kind of activity previously, using a standard whiteboard or blackboard, the instructor was keenly aware of the advantages of being able to move text and graphics to new locations on the board, making the process much more effective and efficient (Wiggins, reflective journal).

Capacity to Serve as a Focal Point in the Classroom
Data collected during workshops where the SMART Board was used as a platform for teaching teachers how to use software in their classrooms revealed the strength of the tool as a focal point for large group instruction. This was reflected in the physical motions of participants as captured in videotapes of these workshops. Whenever the instructor touched the board, participants' heads turned and their eyes and attention became fixed on the SMART Board. If participants were working on their own computers and the instructor moved to and touched the SMART Board, they would stop working almost immediately and focus on what the instructor was doing or saying. The response was so immediate that it seemed almost like a "switch" that could turn their focus on and off. Having taught the same seminars in the past without a SMART Board, the instructor was aware that in similar situations (but using a laptop and projector), many participants would continue to work at their own screens and listen more casually, glancing up when what he was saying seemed important to them. As the instructor watched the videos, he noted that there was something about his direct physical interaction with the screen content and the SMART Board that seemed to engage the learners and cause them to pay greater attention. Reflecting on earlier experiences, he realized that it was harder for participants to engage with the speaker if he was sitting at the same level as the students manipulating his own computer. He speculated that under these circumstances, to the participants, he probably seemed detached from what was going on the screen (Ruthmann, reflective journal).

In one of the follow-up discussions, a teacher commented that the SMART Board enables the instructor to "maintain eye contact with the students the whole time." This probably contributes to what creates the focal point. Other teachers commented about the size and clarity of the screen, the general "presence in the classroom," that everyone could see so easily, and that their "eyes were not fatigued as they might be with a TV screen," all of which contribute to the ability of this technology to function as a focal point in an instructional setting.

Transparency of the Technology
The data enabled us to characterize this technology as transparent from two perspectives. First, the technology seems to fade into the background and support learning without interfering in the process. In all settings, students' attention was clearly focused on the topic or task at hand and not on the SMART Board (except for initial "oohs and ahs" that tended to occur when participants first became aware of some of the capabilities of the technology). In these data, the learning experiences in the global environment of whole group instruction settings were seamless – virtually uninterrupted by the technology. For example, the transcripts of the jazz improvisation class learning to use "Band in a Box" as a basis for improvisation were uninterrupted by the presence of the technology. The processes through which the students learned to use the software flowed steadily throughout the session devoid of interruptions where students sought clarification of how to use the software. The only times that technology interrupted the students' musical process occurred when students were working on their own computers. These interruptions were linked to problems related to the students' computer workstations and not the SMART Board (Ruthmann, reflective journal). In the global environment, there were no questions about use. The questions that did occur at the local level were not related to the learning that had been mediated by the teacher at the SMART Board; they concerned other issues.

Second, we characterize the technology as transparent because of its capability of clarifying process for students. Music notation software is extremely complex; it has many boxes, toggles, and tools on the screen that must be manipulated in order to accomplish a task. Added to this complexity are multiple menus with numerous menu options. Often, it is difficult for people who have never worked with a particular software program before to be able to find their way around the screen with ease. It was evident in the data that one of the qualities of the SMART Board technology that enabled the instructor to teach students to use complicated software easily was the clarity with which ideas and techniques could be demonstrated.

One instance in the data where this was particularly evident was captured by videotape during a workshop in which practicing teachers were learning to find the “Navigator” in the music notation program “Sibelius.” It was located in the "View" menu and buried in the middle of the list of options. Studying the video, the instructor realized that in earlier workshops, when teaching “Sibelius” through a laptop/projector mode, participants would have to locate his mouse on the screen and try to follow what he was doing in order to learn the process. They would then try to apply it to their own computers. With the SMART Board, he was able to show them how to find the “Navigator” using his finger on the board, with the participants already engaged by his presence in the front of the room (focal point). In past experiences teaching through the laptop/projector mode, he always had to clarify the process several times verbally and then personally assist those who were unable to follow what he was doing. When he used the SMART Board to show them how to access this feature, “OKs” were heard from around the room immediately after he showed them how to find the “Navigator.” Participants were then able to apply what they had seen and began work immediately without any need for repetition or further clarification.

In one of the follow-up discussions after a workshop, a teacher commented that she had taken computer classes in the past and found that in this experience, “it was much easier to follow the steps.” She added that she felt confident that she could easily replicate what she had watched the instructor do.

The instructor also noted, as he watched the videotapes, that one important advantage to using the SMART Board in teaching teachers how to use notation software was the availability of the SMART Keyboard. Because many music notation software programs are complex, they often utilize many keyboard shortcuts and keystrokes in combination with mouse clicks. When teaching notation software with a laptop and projector, it was difficult to make the key presses and shortcuts clear to participants. He recalls their asking for clarification again and again. The virtual keyboard displayed on the screen enables participants to see not only the mouse clicks, but any and all key presses needed to accomplish a task. The videotapes of these sessions reveal that participants were able to synthesize and apply keyboard shortcuts much faster and more correctly through the use of the SMART Keyboard. This feature was invaluable for quickly and easily illustrating mouse/keyboard shortcuts.

Efficiency of Instruction

It is clear from the ideas presented to this point that there are many aspects of the SMART Board technology that enable it to support a more efficient teaching/learning environment. The use of the SMART Board in teaching unfamiliar software seemed to eliminate many of the questions, requests for clarification, and repetitions that the workshop instructor recalled occurring in workshops presented with a laptop and projector. Using SMART Notebook to help students organize complex ideas into a heuristic was a far more efficient venue than writing words on a traditional board and then constantly erasing them to relocate and reorganize them as students worked with the ideas. That the SMART Board served as a focal point in classroom instruction saved the time that is sometimes spent waiting for student attention or repeating material for students who have not been attentive. That the SMART Board enabled a kind of seamless instruction, uninterrupted by the technology itself, and the clarity with which it supported instruction also contributed to efficiency of instruction.

In conducting workshops, the instructor was aware that features of the SMART Board enabled him to move participants beyond the technical operational skills of the programs they were learning to the application and synthesis of concepts much faster and more effectively than he had been able to do through a laptop/projector model (Ruthmann, reflective journal). He was able to respond more quickly and efficiently to questions. Because he was standing next to the SMART Board and demonstrating the software, he was able to engage with the participants and the software at the same time. Before, when he had been a “slave” to his laptop in order to control the screen, he needed to bend over or sit while he tried to engage the class and operate the software. With the SMART Board, he was able to point directly to what he was talking about enabling a direct physical connection between his words and the actions on the screen.

Participants seemed to have no problems understanding where he was pointing on the screen. With the SMART Board, there was one less level of complication (interference) in students' construction of understanding of the software program. When working with a projector and laptop on earlier occasions, he had encountered many questions from students, asking him to repeat processes again and again. Consistently throughout these data, with the SMART Board, he received few to no requests to repeat and review processes.

Some of the comments made by participants in workshops and conference presentations reflected characteristics of the technology that contribute to efficiency. Learning about the capability of converting handwritten text to printed text, one university professor exclaimed, "Ahh, that would be so good, because I could write my notes in my lousy handwriting and then everyone could read them." A teacher commented that she was able to see the SMART Board's capacity to "enhance learning because of the clarity of the image." She stated that when she uses a television screen in her classroom, "the image is fuzzy – not clear enough for the students to see well." (We know that this issue is related to the quality of the projector used in the presentation, but it is also attributable to the size of the screen that the SMART Board provides.)

In terms of efficiency, some negative cases emerged as well. The first is that when the instructors were less familiar with the processes of using the SMART Board, the flow of instruction was occasionally interrupted when the instructors made operational mistakes with the technology. Over time, these mistakes would diminish and eventually be eliminated with further experience with the equipment. In these settings with adults, while these incidents may have interrupted the flow of the lesson, they did not detract from the learning situation because the participants were also interested in learning how the SMART Board functioned. As such, these instances became opportunities for demonstrating correct SMART Board technique, and were not perceived as interferences. Also, students using the technology for the first time generally commented in some way about its capabilities (e.g., "oohs and ahs" occurring the first time students saw that words or drawings could be dragged to another part of the board), but these instances were brief and did not detract from students' focus on the task at hand in any of the settings.

Several other negative cases emerged in follow-up discussions. Some participants (and sometimes the instructors) were bothered by the shadow cast on the board as hands passed between the projector and the board in the process of using the board. Upon hearing a description of the stand-alone rear projection SMART Board, participants who had noted the shadows stated that the rear-projection board would have been a much better tool for supporting these experiences. One teacher who has a SMART Board in her classroom (without rear-projection) shared that she has had occasional problems with students making shadow puppets and the like on the screen when she is trying to use the tool to teach. Participants also speculated that the SMART Board featuring a built-in projector might be simpler to use and take less time to set up.

Contextual Qualities that Enable Better Use of Technology

Extends Software Functionality in the One-Computer Classroom

Music class periods tend to be short (generally ranging from 20 minutes to 45 minutes, depending on district policy). As a result, it is usually difficult for music teachers to make time to take students to a technology lab during a class session that involves other activities. The SMART Board makes it possible to use a single computer in the setting of the music classroom enabling the integration of technology experiences with other music class experiences.

The SMART Board enables a whole class to experience software that was designed for one or two students. This is particularly important to music teachers (as participants expressed repeatedly in follow-up discussions and at conference sessions) because in many cases, if music teachers have access to a computer at all, there is only one in their classroom. In all data, it was clear that teachers were keenly aware of and excited about the capacity of this technology to enable them to create opportunities for their students that would not have been possible in the past. They anticipated using it to support students' listening, composing, and performing activities. Suggestions included using the SMART Board as a platform for creating and archiving:

- call charts (graphic representations) to guide music listening experiences
- students' brainstormed reactions to music listening experiences
- students' analyses of music listening experiences
- iconic and symbolic representations that support music performance
- student musical compositions, arrangements, and plans for improvisation

Music teachers who are fortunate enough to have two or three computers in their classrooms often utilize a rotation system as a means of organizing classroom instruction. This means that throughout the flow of a class session, different students move away from other group activities to take their turns working independently at the workstations. Teachers indicated that the movement of students to and from the workstations tends to be disruptive to the flow of the lesson and that it is often difficult to organize instruction in ways that link the independent work to the whole group activity. Comments in follow-up discussions and throughout workshops that included software overviews show that the practicing teachers were most excited about the potential of the SMART Board for enabling whole-class interaction with music software. Teachers said that SMART Board technology would enable them to integrate music software in a way that would fit with their usual ways of operating in their classrooms.

Teachers also commented that the SMART Board easily supports a variety of modes of representation of ideas: text, graphic, iconic, symbolic. In combination with software and on its own, they saw it as an extremely useful vehicle for supporting and sharing students' understanding of musical ideas, particularly through iconic or graphic representation. Music teaching involves a great deal of graphic and iconic representation of sound to scaffold student understanding of musical ideas (which are, of course, nonverbal in nature). Teachers who value using these tools as doorways in to musical understanding (Wiggins, 2001) saw the potential of this technology to enhance the learning experiences of their students. In particular, they valued the flexibility of representation it supports and the ability of the technology to save and archive student work.

It is also important to note that the SMART Board enables teacher mediation and scaffolding for students working with software. This is discussed more fully later, but it is connected to the technology's capacity to extend software functionality.

Enables Peer Interaction

The capacity of the technology to support open sharing in a large group setting fosters peer interaction and peer support, two essential ingredients of a supportive learning environment. Teachers commented on the potential of the SMART Board to support interactive learning. In a follow-up discussion, one teacher commented that she saw value in the SMART Board enabling "one student to walk up to the screen and do something that everyone can see – with space to move around." She could see that it would "encourage more class participation and interaction – especially with younger students who do not have fine motor skills."

The video camera captured some particularly rich data during one of the workshops where teachers were learning to use the notation software "Sibelius." Because there was a particularly large group participating in this workshop, the teachers were asked to work as dyads, two to each computer. The video camera happened to be located very close to one dyad and therefore recorded all of their verbal interactions. The less experienced member of dyad continually asked for support from the more experienced member, which he readily provided. This interaction, along with the instruction mediated by the instructor and SMART Board, clearly scaffolded her work throughout the workshop.

The conference presentation sessions seemed to motivate peer interaction among the community of teachers in attendance as they shared ideas through informal comments about how they might use (or in the case of two teachers, already use) the SMART Board in their music teaching. In these exchanges, it was clear that teachers' differing levels of experience with teaching music and teaching through technology enriched the discussions and enabled some to go away with much food for thought. The opportunity for teachers to share and discuss technology use with their peers is an important step in teachers' integration of technology within their classrooms (Windschitl & Sahl, 2002).

Enables Teacher to Mediate and Scaffold Learning
When a student is working alone at a computer, all interaction is based on what the creator/manufacturer designed the software to do. The experience is completely controlled by the creator/manufacturer of the software and is not mediated by the teacher's professional expertise or judgment. The SMART Board enables the teacher to mediate and support student learning with the entire class. When used as a platform for interacting with creative music software, the benefits lie in the interaction of the features of the SMART Board and music software, and the instructional design, as mediated by the teacher. For example, a teaching environment with a SMART Board allows the teacher, if he or she chooses, to use software that has a behaviorist design and use it in a constructivist manner. Software that only allows for simple "right" and "wrong" answers can be constructively integrated into a large group problem-solving activity when mediated by a SMART Board (Ruthmann, reflective journal).

This brings us to an important point that is supported by the recent work of Windschitl & Sahl (2002). These researchers share evidence that shows that it is an erroneous assumption that the introduction of a new technology tool will alter a teacher's beliefs about teaching and learning or change what happens in a classroom. Teachers teach from their own belief systems – their beliefs about how teachers should teach and about how students learn. What emerged from the data in the present study is that teachers who believe in constructivist teaching and learning saw great potential in the SMART Board as a tool to support what they already consider to be good teaching and learning. They saw it as a tool that would enable them to carry out the processes that they already believe to be important – and to carry them out in more effective and more efficient ways. Teachers who already use software that is rooted in an atomistic/behaviorist vision of music teaching and learning (and there are many examples of this on the market) saw the SMART Board as an excellent platform for continuing to use this software as they always have, but in a more accessible format.

Teachers who already use software that supports more holistic/constructivist learning saw the SMART Board as an excellent vehicle for continuing to use this software as they always have, but in a more accessible format. However, because the SMART Board enables the teacher to mediate whole-group interaction with the software, teachers who understand the limitations of more atomistic/behaviorist software have the opportunity to mediate the children's experience, enabling them to use the software in more creative, open-ended ways.

A related example is the use of the SMART Board as a platform for brainstorming and arranging ideas in the graduate classes. It is because the instructor of these classes valued this approach that the students engaged in this process. It was not that the SMART Board was the impetus for teaching in this way; it was that this teacher used this technique because she believed it to be valuable – and the SMART Board happened to be a good tool for facilitating the technique.

Findings

Analysis of these data enabled us to characterize and better understand the strength of SMART Board technology when used as an integrated part of a quality learning environment. Themes emerged reflective of (a) inherent qualities of the technology that support learning and (b) contextual qualities of the learning environment that enable better use of technology.

One inherent quality that supported learning was the SMART Board's capacity to support collaborative creative thinking. Data provided evidence that, although the SMART Board is not an inherently creative tool, its capabilities supported creativity in effective, efficient, and transparent ways. The technology seemed to enable learners to get past technology related operational skills and to the concepts sooner and more efficiently. The presence of the technology seemed to fade into the background, enabling learners to become engrossed in their creative work. The facilitated environment easily permitted teacher mediation and scaffolding which enabled learners to build the understandings required to work effectively and produce a product. The ease and clarity of presentation and demonstration seemed to foster in learners a clear vision of what they wanted to do and an understanding of how to proceed. The environment supported learners' abilities to solve problems on their own.

A second inherent quality that supported learning was the SMART Board's capacity to serve as a focal point in the classroom. The tool seemed to command immediate attention from all learners because of the size and clarity of the screen and because it enabled the teacher to work from a location that was easily visible to the learners. The teacher's direct physical interaction with the tool and ability to maintain eye contact with learners engaged them and resulted in greater participant attention. A third inherent quality was the transparency of the technology in that it seemed to fade into the background and support learning without interfering in the process and in its capability of clarifying operational process for learners. A fourth inherent quality was its capacity to make instruction more efficient in that it focused learner attention, diminished the need for questions, clarifications, and repetitions, and helped learners organize complex ideas and understand complex processes in less time and with less effort.

Addressing the other major theme, one contextual quality that enabled better use of technology was the SMART Board's capacity to extend software functionality in a one-computer classroom. It was evident in the data that teachers were intrigued by the possibility of using software in a whole class setting and could envision many possibilities for its integration into their teaching to support performing, creating, and listening experiences. Teachers were further intrigued by the tool's capacity to support multiple modes of representation of ideas and to archive student work. Perhaps most important, the SMART Board allows teachers to mediate and scaffold instruction, as opposed to permitting the software itself to mediate instruction as when students are working alone at a computer.
A second contextual quality that enabled better use of technology was the SMART Board's capacity to foster peer interaction. In their comments, teachers indicated that they could see the tool's potential for this kind of support. It was also evident in their own mutual interactions as they participated in workshops, classes, and presentations sessions.

A third contextual quality that enabled better use of technology was the SMART Board's capacity to enable the teacher to mediate and scaffold learning. Where software is involved, this enables the teacher and not the software creator/manufacturer to design and support student work. Where the teacher may have a different vision of teaching than the software design establishes, the SMART Board enables the teacher to use the software in a way that is more conducive to the ways he or she would teach in other environments. Where the board is used to support teaching and learning in a non-software environment, its features also make it an extremely effective and efficient tool for scaffolding and mediating learning.

Taken together, the inherent qualities of the SMART Board technology and the contextual qualities that enable better use of technology for teaching and learning make this an invaluable ingredient in a quality learning environment. It should be noted, however, that the effectiveness of the relationship between the inherent and contextual qualities will be mediated by the teacher's ability to envision its use. For example, the nature of the SMART Board design supports a constructivist teaching/learning environment – and teachers who choose to teach from a constructivist stance will find many ways to use the SMART Board to support their work. However, the technology itself does not have the power to transform teaching. As Windschitl and Sahl (2002) have found, teachers' willingness and ability to utilize new technologies in ways that support effective teaching/learning are deeply rooted in their beliefs about learners and learning.

In our work in this study, we used the SMART Board as part of constructivist teaching in classes and workshops and as part of sharing of constructivist ideas in conference presentation sessions. The context in which we presented the SMART Board surely influenced the teachers' responses to the technology. In many cases, newcomers to the ideas were as intrigued by the ideas of constructivist music teaching as they were by the use of the SMART Board to share the ideas.

Notes

1. Researchers have only just begun to investigate why this phenomenon occurs. See, for example Windschitl & Sahl (2002) and Kerr, S. (1996). Visions of sugarplums: The future of technology, education, and the schools. In S. T. Kerr (Ed.), *Technology and the future of schooling* (pp. 1-27). National Society for the Study of Education.
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2. A group of these teachers has formed a professional organization for sharing ideas about constructivist music teaching and learning. The organization, which is called Teaching for Musical Understanding (TMU), holds Saturday workshops open to all music teachers. One of these workshops was a data collection site for this study.

3. Prior experience providing inservice education in music education technology has made us aware that this is one of the primary reasons that music teachers shy away from or avoid bringing technology into their classrooms. They do not see it fitting into the ways they generally organize instruction in their classrooms. They see it as an "extra" or as an interference or intrusion.

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Appendix A

As to teachers' willingness and ability to envision themselves using this technology, the follow-up discussions made it clear that the participants quickly embraced the technology and were able to immediately envision its integration into their teaching. They were impressed by its capacity to save a student's work while it was in progress, making it possible for them to return to it for subsequent editing and revision. They saw its capacity to archive student work and teacher planning materials as a particular strength. They saw the technology as a tool that would enable and easily support a multi-mode approach to music teaching (enactive, iconic, symbolic).

Teachers also commented on the portability of the equipment and its potential functionality across disciplines. Music teachers expressed their thoughts that it would be an attractive and useful purchase from the perspective of administrators – a view that was corroborated by personal conversations with a principal who attended one of the workshops and with a principal in a school that had already purchased two SMART Boards (one of which is used regularly by the music teacher). In a third case, a teacher who attended the TMU workshop was able to convince her principal to purchase a board for the music room with very little effort.

Upon seeing the SMART Board at a conference session, a music technology professor from another university remarked, "Look! They've already invented what I've dreamt about for years!"