The Impact of Ubiquitous Computing in the Internet Age: How Middle School Teachers Integrated Wireless Laptops in the Initial Stages of Implementation

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This study investigated teacher experiences that emerged as a result of the introduction of wireless technology that placed personal laptops in the hands of every student in their classrooms. Five themes emerged as major factors during the transition to the effective use of ubiquitous technology in the classroom and its positive effects on teachers, including administrative expectations, knowledge acquisition, methods of teaching, teacher/student relationships, and teacher/teacher relationships.

The process of integrating computers and the Internet in education has been both difficult and time consuming. The existing literature on technology integration shows that teachers need assistance in learning to use computers as tools for teaching (Schwab & Foa, 2001), and that sustained group professional development can improve chances for meaningful and lasting integration (Blumenfeld et al., 1991), but the ideal level of training for different purposes and contexts remains elusive. Previous studies have shown consistently that teachers need time to become comfortable with the machines (Sandholtz, Ringstaff, & Dwyer, 1997; Sheingold & Hadley, 1990).
The research also shows that teachers’ beliefs about teaching and learning both affect initial levels of adoption and evolve when they begin to use computers (Collins, 1991; Cuban, 1986, 2001; Dwyer, Ringstaff, & Sandholtz, 1991), but the findings are not conclusive on how these processes take place and how teachers feel during times of transition. Recent large-scale survey research on factors relating to computer and Internet use (Becker, 2000) have shed light on important trends, but studies utilizing interpretive methods are needed to understand the process of change.

Windschitl and Sahl (2002) stated that “in conjunction with the use of technology over time, teachers often change their classroom practices…Our understanding of how and under what specific conditions these transformations take place is less clear and may require more highly contextualized investigations of teachers who learn to use technology with colleagues and students” (p. 169). In addition to this articulated need, the pace of change in both technological tools and their place in our society makes the landscape of changing practice highly volatile; conclusions reached during the dominance of standalone desktop computers during the 1980s, and the dominance of networked desktops in the 1990s, may not hold in the early 21st century when the Internet is a growing part of everyday North American life. In addition, an increasing number of private and public schools are putting wireless laptop computers into the hands of all students and teachers (Hill & Reeves, 2004; Rockman, 2003). This study, with an indepth look at three teachers and their first semester’s use of wireless laptop computers, contributes to our growing body of knowledge related to teachers’ developing use of computers, and gives us a clearer understanding of how teachers work through the process of integrating the first generation of ubiquitous networked computer technology into classroom instruction.

BACKGROUND: UNDERSTANDING TECHNOLOGY’S IMPACT ON EDUCATION

From the standpoint of access, educators have achieved great success at integrating computers with Internet connections into education. In 1994, only 3% of schools in the US provided access to Internet-connected computers in classrooms or instructional labs; by 2001, that number was 87%. From 1998 to 2001, the ratio of instructional computers to students in public schools went from 12.1:1 to 5.4:1 (U.S. Department of Education, 2002). Programs in which all students and teachers have their own wireless laptops are growing in popularity. The largest program is in the state of Maine,
where all 7th graders in public schools received their own laptops beginning in Fall 2002; students and teachers in the state reported a positive impact of the program on student engagement and learning (Polster, 2003).

Despite increased access, recent national surveys still show that only computer teachers and business education teachers have their students use computers frequently, defined as more than 20 times over a 30-week period (Becker, 2000). Regardless of the fact that many educators recommend high-order integrative experiences with computers (Bransford, Brown, & Cocking, 2000), the majority of computer use across subject areas where computer skills are not the direct goal remains “skill and practice” software, or traditional computer-aided instruction (Becker).

What will happen as teachers and students gain increasing access to networked computers at the classroom level? Results from contexts in which such access was provided in the 1980s and 1990s (Collins, 1991, and the studies from Apple Classrooms of Tomorrow, or ACOT, Dwyer et al., 1991; Sandholtz et al., 1997) suggested that major shifts tend to occur such as whole-class to small group instruction and lecture and recitation to coaching. It is the combination of these shifts that leads to a different perspective on teaching and learning and a transformation of the classic classroom context. Many would argue that this transformation is positive and leads to increased student learning (Brogan, 2000; Mehlinger, 1996; Polman, 2000; Sandholtz et al., 1997) although other studies have not found this increase statistically significant in regard to standardized tests (Hill & Reeves, 2004; Rockman, 2003). Many of the studies have identified a stepwise pattern of technology adoption (Dwyer et al., 1991; Lloyd & Welliver, 1989; Wang, 2000). At first, teachers familiarize themselves with the technology. Then, they might begin adapting it to their own use by creating documents, checking e-mail and searching the Web for lesson plans, as well as keeping grades and creating files that organize their classroom. They may also begin to allow students to use basic software for drill and practice instruction or to use the computers as word processors. This phase appears to be where many teachers who report using computers seem to be stuck; less than 30% of teachers who use computers at all utilize them for instruction (Pianfetti, 2001). After this stage, teachers begin to more fully integrate computers in instruction, by incorporating the computer into existing classroom practice, and perhaps even transforming classroom practice through reorientation or entirely new innovations the technology makes possible. Previous studies have indicated the time it generally takes teachers to progress to such integration is substantial: up to five or six years (Sheingold & Hadley, 1990). While describing these processes linearly helps to reveal general patterns,
people seldom behave in a linear fashion. As teachers begin to use computers in their classrooms as teaching tools, they continue to fluctuate between teaching strategies and levels of integration while choosing the strategies they deem most appropriate for their objectives, which may or may not include technology.

We know that some teachers have moved through all these phases to transform their practices, but most have not. Access, even at the most ideal classroom level, may not be enough. As Mehan (1989) suggested “it would be inappropriate to conclude that the computer, in and of itself, is the agent of change” (p. 19). The computer is part of the larger social system, including students, teachers, and the past histories of relationships, methods of instruction, and the organization of schools in general. Classrooms that adopt computer technology as a learning tool experience a change in the construction of the classroom context and the practices of those participating in that context. The computer is not an agent, but because it has symbolic value in our society as an indicator of progress, power, and prestige, it is much more than a neutral thing (Csikszentmihalyi & Rochberg-Halton, 1981). Teachers’ beliefs, skills, self-efficacy, experience, and social context mediate how they interpret the message of the computer (Christiansen, 2002; Cuban, 2001; Pacey, 1999). Some educators may feel threatened by the notion that the machine is taking their place as the holder of knowledge, while others feel more powerful if they have the ability to facilitate the use of these high-status machines (Turkle, 1984). In the past, many teachers have feared the computer would destroy the personal relationships in teaching (Cuban, 1986), but some educators now stress collaborative and communicative uses for these machines that were previously seen as isolating individuals. Numerous studies have shown that continued teacher training is essential to progress (Schwab & Foa, 2001; Wang, 2000), and that teachers who have more constructivist ideas about teaching are more likely to integrate technology (Becker, 2000; Windschitl & Sahl, 2002). Given this state of affairs, the continued dominance of “transmission-oriented” pedagogy (Becker) may make merely symbolic change (Fullan & Miles, 1992)—where the purchase of networked computers is part of an effort at the appearance of innovation—just as likely as true progress at innovation, regardless of increasing access to technology and training on the mechanics of how to use the technology.

Computers and the Internet are increasingly a tool integrated into daily life. Wireless networked laptops create an infrastructure with ubiquitous access to information on the Web, computing, and persistent access to one’s own personal data. This study aims to clarify how personal beliefs, experiences, and
attitudes interact with social and institutional realities in the early stages of teachers’ wireless laptop implementation in the early 21st century.

METHODS: RESEARCH SETTING, GOALS, AND PARTICIPANTS

To determine the structure and essence of the phenomenon of teachers experiencing ubiquitous computer technology (wireless laptops) in their classrooms, we conducted research at a suburban private all boys’ middle school, which we shall call “St. Hezekiah’s.” The school was selected because it was one of the first in our major Midwestern metropolitan area to implement a wireless laptop program for all students and teachers.

Because the study was conducted in a ubiquitous wireless technology setting, access to computers was not an issue; therefore, we were able to focus attention on issues such as the effect of computers on the lives of teachers and their beliefs about education, how the transition to technology took place in this context, and how teachers developed new practices. We were able to see how methods of instruction, teacher/student interactions and teachers’ feelings of competence and success changed as they began using the technology in their classrooms. We focused on teacher experiences, with the goal of understanding how these teachers were personally affected by computer technology as well as how the presence of ubiquitous computers may have affected their teaching. Burns, the first author, made all the initial contacts with the participants, and collected all data on site; both authors were involved in research design, analysis, and writing. The data collection included semi-structured interviews of the principal and three teachers at the beginning and end of their first semester of implementation, weekly observations in one or more of each teachers’ classes, and weekly e-mail journals of technology integration activities provided by the teachers.

The three teachers selected for this study were volunteers who taught at the 7th grade level and provided a range of content area focuses and technology experience. The participants were each given pseudonyms: Tom Mathews—Middle School Principal, Barbara Vogel—7th grade English teacher, Paul Duisen—7th grade Science teacher, and Bruce Leary—7th grade Religious Studies teacher.

Tom, the middle school principal, had spent more than two decades at St. Hezekiah’s and reported in his initial interview that he really enjoyed his job. He was excited and proud to be leading his faculty in such an endeavor even though he felt that his own computer skills were not very advanced. He very much wanted the program to be successful, and mentioned a variety of
inservice programs that the school had already held as well as the school’s willingness to pay for any technology related seminars that teachers wanted to attend.

Barbara Vogel, the English teacher, did not come to teaching until after she had raised her own family. She had been teaching for eight years and described herself as a pragmatic teacher in the sense of attempting to apply concepts learned to everyday life. She had not been successful with any type of group learning in her classroom. Barb said that she was not comfortable with computers at all, yet she frequently used e-mail, PowerPoint™, and Microsoft Word™ for her own purposes. She appeared to be positive about technology in general but very leery of trying to implement its use in the classroom.

Paul Duisen, the science teacher, felt that teaching was his calling in life and he had been teaching for 19 years. Paul stated very frankly that he had no clue what his philosophy of teaching was—he just did whatever worked. If it didn’t work he changed to something else. Paul was very comfortable with technology, believed it would be great for the students, and couldn’t wait to get started using it. He mentioned that he did not use group work a lot—he felt that at this age level they were not ready for it. His favorite method of teaching was talking—“I like to talk and I am more of a presenter type and a challenger—throw something out there and see what they do with it.”

Bruce Leary, religious studies teacher, described himself as an introvert, yet he was an extraordinary communicator—willing to share his ideas and feelings in many different formats. He said that he was not called to teaching, but found it to be a comfortable fit. He did not have a particular philosophy of teaching, but mentioned several that he drew from, including Dewey and aspects of a Waldorf education, which he said emphasizes spiritual development as well as intellectual development. His two favorite methods of teaching were discussion and journaling. He did not feel that he was good at getting students to work in groups. Bruce was very comfortable with using computers for his own use but was rather nervous about using them with his students. He believed that the laptop technology would contribute to student learning.

THE PROCESS OF TECHNOLOGY INTEGRATION

Before describing our findings in detail, we will briefly summarize each teacher’s progress throughout the semester. Paul—the most comfortable of the three with technology—began using the laptops as soon as the students
got them in September. He had the students take notes on the computers, set up folders, get information from the World Wide Web (WWW or Web), and e-mail him. However, his comfort with the technology did not immediately lead to creative innovation in the classroom. He integrated the technology, but essentially only as a tool to continue teaching the same way as he had for years. For example, he had the students take notes on their computers during lectures instead of using paper and pen.

Barb was nervous about using the technology initially, but after just a few successful experiences she proceeded to enthusiastically seek out more ways to incorporate the technology into her classroom instruction. Although she used the technology frequently, and incorporated more writing time within the classroom, she also did not significantly change her methods of teaching. But she did begin to be more creative within the bounds of her old methods. For instance, when doing brainstorming for essays she began using the educational software Inspiration™. The concept map representation was qualitatively different, as well as more flexible, than the notes she would have otherwise made on the blackboard.

Bruce, while not afraid of the technology on a personal level, was somewhat nervous about using the technology in his classroom, so his high level of technology integration was surprising. Rather than choosing to have his students take notes with a word processor, or doing simple research on the Internet, he chose a more complicated desktop publishing program, Microsoft Publisher™ to begin with. Despite some anxiety, he had his students begin creating electronic journals using this program at the same time he taught himself how to use it. Nonetheless, it took him nearly the entire semester before he was willing to experiment with e-mail, even though he was already very familiar with that program. As with the other two teachers, his style of teaching did not really change with the increased use of technology; rather, he used the computers to make his old lessons new and more interesting. This he did quite successfully.

Previous research has shown that integration of technology into the classroom is a complex process and involves not only teachers’ knowledge of computers but also administrative expectations, teachers’ beliefs about education, and a myriad of other informal ways that teachers may learn to use technology (Windschitl & Sahl, 2002). Six aspects of the process of the integration of ubiquitous laptop technology in these teachers’ classrooms were studied in the Fall of 2002: (a) the impact of flexible administrative expectations, (b) the development of technology knowledge, (c) interactions with teaching methods, (d) changes in teacher/student relationships, (e) changes in the relationship among teachers, and (f) the impact of ubiquitous
technology access. Together, these describe the landscape for changes brought about by the wireless laptop program.

**Impact of Administrative and Parental Expectations**

The principal at St. Hezekiah’s did not expect his teachers to immediately begin to use the new technology in their classrooms every day, or to dramatically change their methods of teaching. Tom said,

> My expectations for the teachers are that they utilize the laptops in their classrooms on a regular basis. That doesn’t mean every day; but that they should have the kids turn them on and use them two or three times a week for taking notes, for writing papers, for doing homework, for doing Internet research, for e-mailing.

Thus, it was not surprising that even though the teachers knew that the administration was in favor of using the technology, these teachers did not believe they were being overly pressured by the administration to use it by conforming to any preset expectations.

Maintaining flexible expectations may have been the best way to allow teachers to work out ways to deal with this new phenomenon of ubiquitous technology. Having precise expectations may have limited the way that the teachers approached the challenge of integrating the technology. According to March and Olsen (1979), “a strict insistence on purpose, consistency, and rationality limits our ability to find new purposes” (p. 77). Their principal created a relatively relaxed atmosphere with minimum expectations so these teachers were allowed to experiment with the technology to find appropriate and successful ways to use it in their classrooms.

Through conversations with Barb, Bruce, and Paul, it was evident that social purpose and the school’s context, as described by Pacey (1999), had been important motivating factors in their desire to begin integrating technology into their instruction. They were aware that studies of technology have shown that computers in the classroom can be of great benefit to teaching and learning; therefore, they were willing to try to adapt the technology to their own classrooms.

These teachers were also cognizant that the technology program was implemented in part to maintain the academic status of their school, at great expense, among other private and public institutions in the area. Each teacher expressed this as a belief in their responsibility as employees to do their best to try and use the technology in their classrooms. For example, Bruce
said that “one of the motivating factors in terms of using it in class nearly everyday [is that] I’ve got $50,000 worth of computer equipment sitting on the kids’ desks…how could you not use that?”

Bruce’s statement points to another set of expectations relevant to teachers: that of the parents. The parents at St. Hezekiah’s were paying an additional $850 per year for these wireless laptop computers, and teachers were aware that parents expected the equipment to be used frequently within the context of the classroom as more than just a typewriter or encyclopedia.

Despite the administrative flexibility on implementation of technology by teachers, the merit method by which salaries were determined for all faculty members at St. Hezekiah’s encouraged some form of integration. For the last few years, 20% of teacher evaluation consisted of items related to technology. Such a percentage could easily impact teachers’ salaries for the following year as well as all subsequent years, and added incentive for teachers to make the effort to appropriately use technology.

**Development of Technology Knowledge**

Each of the teachers in this study had a solid foundation of computer skills as described by Wang (2000) prior to the start of the study. They were familiar enough with computers that they frequently used computers for their personal use, creating documents, using a grading program, and e-mailing as well as occasionally using the computer lab with their students for tasks such as researching information through the Internet.

St. Hezekiah’s had provided some training on technology integration for the faculty, but these three teachers did not all agree about the quality of that training. They were more concerned about what training was available to them during this implementation period than what had occurred previous to that semester. They spoke of what they thought would have been helpful in relation to training on integrating computers into their classroom instruction as teaching tools as well as learning more complicated applications such as MS Publisher™ to further that process. As the semester progressed, Burns observed each of the teachers finding what suited them best in accordance with their own preferences for learning about technology and developing the skills that were necessary for them to integrate the technology into their individual classrooms.

Paul’s initial level of confidence and self-efficacy in relation to computer use was very high. He had a good working knowledge of computers and a few of their applications. He felt that over the years the administration had
provided him with adequate computer training. Paul said that over the past 10 years he may have gone to three or four workshops on applications and that he had “taught a couple of classes on web stuff and things for the teacher training here.” Paul said that he does not go to texts or manuals to find answers. When he wants to learn about something, he asks people he believes will have the answer and when appropriate he likes to have hands on practice.

Bruce believed that the training and support that the faculty had received from the school’s administration was very good. Overall he appeared to be less confident about his computer abilities than Paul, and while he still wasn’t quite sure what to do with the technology, he felt that he had been trained as well as could be expected and that the rest was going to be up to him. While he wasn’t quite sure of what was about to happen, he faced the challenge of the new technology willingly and believed that it was going to be beneficial to his teaching as well as for student learning. On his own, Bruce bought magazines that dealt with technology and spent countless hours exploring the Internet. He taught himself how to use the applications that were available on his machine as well as ones he downloaded from the Internet to enhance what he was doing in the classroom. Bruce would have liked to have had manuals made available to him so that he could have taught himself more about different applications. By the end of the semester, Bruce’s skill using some computer applications had increased so dramatically that he had become an expert with them.

Barb, unlike Bruce or Paul, was less than enthusiastic about the training that she received from the school previous to the introduction of the ubiquitous technology, believing that it had been inadequate for her needs. She found the all day seminars provided by the school on how to use technology in the classroom boring and generally not applicable to her subject area. The short peer-to-peer sessions during faculty meetings she felt were seldom about how to integrate the technology and more about practical applications such as how to use the grading program or connecting your TV to your computer. Barb had not taken any classes or seminars outside of what the school had provided, and admitted that the laptop she had received from the school two years before looked brand new because she had used it so seldom. She appeared to be the least proficient with the technology at the beginning of the semester, and was also the one who appeared to be the most apprehensive at the prospect of having the technology in her classroom.

Nonetheless, one of the reasons Barb volunteered to participate in the study was that she felt Burns’ presence would be an impetus to her learning more about how to use the computers. Even before the semester began, Barb began asking for specific ideas on how to integrate the technology into her
classroom. Once she found direct connections to her established teaching practices, it was easy for her to make the transformation into using the technology. This is a common theme among many research studies conducted in relation to computer use by teachers. Once teachers like Barb begin to see the benefits of computers in their own classroom they develop an intrinsic desire to learn more about them (Bailey & Brownell, 1998; Conyers, Kappel & Rooney, 1999; Faseyitan, Libii, & Hirschbuhl, 1996; Milone, 1999, Wang, 2000).

Barb’s mention of researcher presence in the classroom points out one means these teachers had at their disposal for developing ideas and skills: just-in-time feedback and suggestions from educational technology experts. In addition to the “push” researcher presence gave her, Barb also credited her increased knowledge of technology and her ability to integrate it into the classroom to the help Burns was able to give her as a product of observing in her classroom. During the initial phase of this study, Bruce and Paul seldom asked Burns questions about technology or how to integrate it into the classroom, but we cannot rule out the possibility that researcher presence in their classroom on a weekly basis influenced their implementing technology into their instruction. By the end of the semester, both had also begun to frequently ask Burns questions about technology integration. This should be taken into account when interpreting the findings of this study, but it also has implications for professional development: a technology integration specialist occasionally present in teacher classrooms could provide valuable, personalized, just-in-time assistance.

People learn in diverse ways, for diverse reasons, and at varying rates, and these three teachers were no exception. Paul, Bruce and Barb all integrated technology at some level, but they found the method for learning that suited them best.

Interaction with Methods of Teaching

At a minimum, all three teachers reached the stage of the integration process where they began to incorporate or adapt the computer to fit their existing teaching practices, and two teachers even began transitioning to the transformation of practices during this first semester. This contrasts strongly to studies of technology integration reporting in the late 1980s, when it was found that such changes commonly took up to five years (Sheingold & Hadley, 1990). Paul had already established his use of computers during previous years. He had used PowerPoint presentations, constructed a web site,
and had occasionally taken his students to the computer lab to create web pages. During this semester Paul used mostly lecture and discussion in his class, and occasionally he had the students complete lab projects. On one occasion, he had the students create PowerPoint presentations, which was more student-centered than his norm, but because of his lack of experience in this area it did not go well. As he put it, “They did all kinds of far-out things, then they turned their backs and read what they wrote which resulted in totally boring presentations. I finally said enough, turn it off.” Because of the availability of the technology, he tried to use it in a different fashion, but instead it reinforced his preference for teacher-directed methods.

The introduction of the technology did not effectively change Paul’s methods of teaching; he simply had the students use a different tool—computer as opposed to notebook—to take notes in class. As Mehan (1989) stated, it is not the computers that change a classroom, but what people do with them. By the end of the semester, it did appear that Paul was searching for more ways for his students to be able to use the computers effectively in his class—for instance using spreadsheets to collect and analyze data.

Although Paul was the most proficient with computers at the beginning of this study, he was the one who changed his style of teaching the least during the course of the semester. In a two-year project conducted through the Southwest Educational Development Laboratory (Burns, 2002), a similar inverse relationship was found between teachers who started in their project as proficient users of technology and changes in styles of teaching. In their study, this inverse relationship applied to the computer science and business application teachers. The researchers believed the lack of change was due in part to the nature of the courses they taught, as well as their already established knowledge of computer applications. In Paul’s case, his belief about what science consists of at this 7th grade level—facts and “repetitive directions”—and his belief that students at this age need to have a lot of consistency or structure could account for the lack of change in his teaching methods. Paul’s past use of computer technology was considered cutting edge for so many years in the context of his school it may also have contributed to his not integrating the laptop technology in a more creative fashion during this semester. He had already established patterns that had been considered good and effective ways to use technology and was considered an “expert” by many of his peers.

Bruce, on the other hand, did begin to use different methods of teaching as a direct result of his appropriation of technology in the classroom. At the beginning of the semester, the students in his classes were seated in traditional rows, and much of their class time was spent in a lecture/discussion
format similar to Paul’s classroom. As the semester progressed—and Bruce introduced the electronic journals—more class time was turned over to a strictly lecture format as he instructed the students on how to use the Microsoft Publisher™ program. But as the multimedia “e-journals” became the centerpiece of the class, and students became more proficient in their use of computers, much more class time was spent with the students actively working on the computers.

Bruce began to ease up on his earlier control of all students doing the same thing at the same time as the semester progressed. In addition, the frequency of students working together and sharing ideas increased as the semester progressed. During the first few weeks, students spent the entire class either participating in all class discussion or working individually at their desks. During the last few weeks, students spoke quietly to each other throughout class—helping each other with questions related to the computer as well as subject matter.

Barb began to effectively incorporate technology as a learning tool in her classroom, and while her overall style of teaching did not change, she was able to give her students much more individualized attention. Because of the computer in the room, Barb believed she was able to move through some curricular objectives such as grammar more quickly. One day her computer was down and she said, “It made me realize how much longer ‘the lesson’ took.” In addition, instead of the students creating their own sentences with particular parts of speech, she had them find sentences on web sites to practice grammar skills. These changes left more time for writing within the bounds of the classroom, which in turn enabled Barb to spend more one-on-one time assisting students in the process of writing on their computers.

After just one semester, some effects that computers can have on the teaching and learning process as described in earlier studies could already be seen in these classrooms with ubiquitous technology (Collins, 1991; Cuban, 1993; Dwyer, et al, 1991; Mehlinger, 1996; Rockman, 2003; Zehr, 2000). The teachers in this study, conducted in 2002, were already familiar enough with computers that as they began to move toward integrating computers more fully into their classes they also began to adjust and refine their previously established methods of teaching.

**Changing Teacher/Student Relationships**

Numerous studies on computer technology in the classroom have found that an area of teaching that is significantly impacted by the introduction of
computers is student/teacher relationships (Collins, 1991; Mehlinger, 1996; Zehr, 2000). Students are frequently more knowledgeable than their teachers about computers. This creates classroom situations where teachers rely on the expertise of their students and/or are learning together with their students, creating a community of learners (Rogoff, 1994). These role reversals create an atmosphere that produces more personal communication between the teachers and students. After one semester, two of the teachers in this study characterized their classrooms similarly, and believed that the computers had aided them in developing closer relationships with their students.

Barb was the most impressed with how computers altered her relationship with the students. She believed that in previous years students thought that she was pretty uptight and were sometimes afraid of her: “It always bothered me that I didn’t have a better rapport with the kids.” She made a conscious effort in 2002 to change her teaching persona and become more “of a mother type teacher” in order to improve her relationships with her students. She believed that her efforts had paid off and that the computers had assisted her in this endeavor. For example, during the first few weeks of class when students were assigned seatwork or a writing assignment, she expected quiet; but after just a few sessions of using the computers to write, she began recommending that they have other students review and talk about their work before they handed it in. She believed that because she worked with them so much more frequently in one-on-one sessions, it had made her students believe she was “more approachable and so they [were] willing to come for help.” She also felt that having to sometimes admit her lack of knowledge and ask the students for help on how to use the computer had made her appear more human in their eyes.

Bruce had also witnessed quite a change in his relationships with his students. He said he had never been what he’d consider strict with his students, so there had always been a certain amount of freedom in his classes. This year, however, he had noticed some important differences. In the past, by the end of the semester, he frequently developed a sense that his students were intentionally trying to rile him; but that did not happen in Fall 2002. He sensed what he called “respect” for his willingness to use the computers in his class. He also said,

the conversations are different. With some kids in particular, you’re talking on a personal level…[We have] a common bond of conversation because we have to use the same tools and techniques…It gives us something to talk about that’s not just academic.

When discussing teacher to student interaction, Paul began by saying in some ways the computer had led to less face-to-face interaction before and
after school because, “now they just e-mail me instead of coming in to ask questions.” This may be related to the fact that Paul was already fairly proficient with computers, and therefore there were not as many occasions when he would have required help from students. And although he did use the technology in his classroom, he still used lecture and discussion as his main method of teaching and did not have one-on-one experiences as Bruce and Barb did in their classrooms.

### Changing Teacher/Teacher Relationships

Researchers have also found dramatic increases in the amount of collegial interaction that takes place as teachers begin to share their successes and failures with the technology (Christiansen, 2002; Rockman, 2003). This phenomenon also occurred at St. Hezekiah’s. Whenever Barb learned something new, she shared that information with others on staff hoping that they would benefit from the knowledge as well. For instance, when she learned the software application Inspiration™ she told the computer teacher all about it and when shown how to select different printers she passed that knowledge on to another English teacher. Bruce mentioned how going to educational technology conferences with a few other teachers had changed the way he communicated with those teachers. They had a shared experience that continued to grow as they tried to implement some of what they learned into their classes. He felt that he was also communicating more with the other religious studies teachers: “we are now sharing information about websites we find and how we are using them.” Paul, as was typical for him, was not as effusive as the other teachers, but he did agree that teacher-to-teacher communication had changed, “there is a lot more e-mail and we are helping each other a lot with applications.” The increased sharing of ideas among teachers was not limited to their own school. They were also very welcoming to teachers who came from other schools to learn about laptop technology. Two of the teachers offered to go to the visiting schools and give presentations on their experiences with the laptops.

### The Impact of Ubiquitous Computer Access

This study also documented transitions that occurred when teachers and their students had constant, immediate access to computers. Teachers are much more likely to use technology once they feel comfortable with it, and
they will only become comfortable when they are able to use the computers on a consistent basis. Access gave the teachers in this study the ability to have experiences that resulted in the increased use of technology in their classroom instruction. As the teachers used the computers, they built up caches of direct experiences that assisted them in feeling comfortable in using the machines with their students. In turn, as all three teachers experienced using the computers in their instruction, they felt even more at ease.

Feelings of fear at losing control of the classroom diminished as these teachers became more confident about their ability to solve minor problems related to the computer’s hardware and software. These teachers began to experience self-actualization when using computers and developed feelings of self-efficacy about their abilities to use computers in the classroom for instruction as a result of more access. As they became “experts” at using the technology and began to develop their own lesson plans using technology, they became very confident in their abilities to effect change, as indicated by their growing willingness to share with their peers.

Taken in combination, these factors contributed to the three teachers increasing their use of technology in their classroom instruction as the semester progressed. By the end of just one semester, all three of the teacher participants in this study were using the computer virtually every day in their classrooms. Although we cannot rule out all the other factors involved in integrating technology, it is obvious that constant and immediate access played a major role in teachers integrating technology into their classroom instruction.

THE PERSONAL IMPACT OF TECHNOLOGY ON TEACHERS

One reason for conducting this research was to observe how the introduction of ubiquitous technology in the classroom impacted the lives of teachers. Areas that were noticeably affected by the introduction of technology included teachers’ feelings of competence and success, how teachers felt about themselves in relation to technology, and how they felt about technology in general. Another area where small changes were beginning to occur was teachers’ beliefs about the teaching and learning process.

The reasons teachers felt more competent and successful may not have been the same, but, as previously reported, all three were convinced that the computers enhanced their ability to reach the students and become more effective teachers. Paul felt he was more effective because computers helped him become more organized; Bruce believed he became more effective as a
teacher because his students were reading more often; Barb felt that she had become more successful because of working one-on-one.

Noticeable differences also developed in how some of the teachers felt about themselves in relation to technology as the semester progressed. While not strongly opposed to the idea of laptop computers in her classroom, Barb had not looked forward to having to incorporate them into her classroom instruction. By the end of the semester, she was effusive about the benefits that computer technology provided for her and her students. Bruce was surprised at how the proficiency he achieved in using computers had such a dramatic impact on his feelings of adequacy as a teacher. He came to see that the computers had given him a vehicle to express himself in ways that he, as an introvert, was previously unable. He saw his competence with and use of technology also improving the behavior of his students towards him in the classroom. Paul came into the semester with a sense of competence at using technology, and he maintained that sense throughout. Perhaps as a result of his peers’ progress in catching up with him, he began to look for more creative ways to use the technology toward the end of the semester.

The effect computers had on teachers’ beliefs about the teaching and learning process was also of interest. During this semester these three teachers did not express any changes in their ideas about what needs to occur in the classroom for learning to take place, but one would not expect such changes in such a short period of time. In other studies (Dwyer et al., 1991; Lloyd & Welliver, 1989; Windschitl & Sahl, 2002), it took several years before teacher participants began to alter their beliefs about the teaching and learning process. However, small changes had begun to occur within the structure of the classroom that suggested changes might develop. For instance, as a result of the more personal relationships that had begun to form and the frequent sharing of expertise, at least two of the classrooms had started to show signs of becoming more of a community of learners (Rogoff, 1994).

MEETING TEACHERS’ NEEDS

Research dealing with computer technology in K-12 education began in the 1980s when floppy disks were still floppy and the Internet was not yet accessible to the general public. Today, the speeds at which computers operate and the myriad uses of the Internet provide us with an unparalleled information resource. This technological resource tool has become prevalent in our homes, offices and increasingly our schools. Cuban (2001) stated that technology integration will occur in schools, but that it is going to take a
long time and require much teacher training. However, the results of this study and the ever increasing prevalence of computers in every aspect of our lives suggest that the transition to technology integration may occur much more quickly, and may require less teacher training than previously anticipated.

One of the reasons for conducting this research was to determine what sort of assistance teachers might need to begin integrating today’s technology into the classroom. We were optimistic about teachers meeting the challenge of ubiquitous technology, but we were quite surprised at the ease with which these teachers made the transition to integrating the computers into their instruction with a relatively limited amount of outside training. These teachers appeared to actually skip the first two steps of the integration process as established by other research studies (i.e., adoption and adaptation as described by Dwyer et al., 1991; familiarization and integration as described by Lloyd & Welliver, 1989).

There are several reasons why this apparent skipping of developmental stages occurred. Probably the most significant reason was that these teachers had access to their own personal computer laptops for two years prior to the study, and although they did not get more than a modicum of training from the school on how to use the machines or the applications, they did have the opportunity to begin experimenting with them at their leisure. They were also required to use a computerized grading system during these two years, which assisted them with becoming more familiar and comfortable with the machines. Another contributing factor for these teachers’ quick development as integrators of technology, relates to computers being much more prevalent in homes, schools, and businesses. Unlike the teachers studied in the late 1980s and the early 1990s, these teachers already knew how to search websites, use e-mail, shop online, and so forth, before they ever had to use the computers for classroom instruction. This is not to say training today’s teachers is not necessary or that more and continuous training could not prove beneficial, but these teachers, in this study, managed to acquire the necessary skills to integrate the technology with only a small amount of specific training from outside sources. The fact that computers and software applications are much more user-friendly than just 10 years ago was probably another contributing factor. Because of the increased simplicity, the teachers were able to actually drive the learning process themselves by acquiring knowledge and skills through texts and embedded application help menus. There were technology “experts” on staff at St. Hezekiah’s, but these teachers generally first sought help from their peers or their students if they needed additional instruction.

When discussing the preparation for this transition to technology with these teachers, it was interesting that for three teachers in the same school
they each had different thoughts on how effective their previous training had been—one thought it was great, one thought it was adequate, and the third thought it was lacking. Yet they all managed to integrate the technology into their classrooms. Any initial apprehension about technology use in the classroom had been replaced by profuse enthusiasm from each of them by the end of the semester.

The implication for administrators or those in charge of preparing a faculty for this transition is to ensure that teachers have a good understanding of the basics of computer technology before they are expected to use the technology in the classroom. Making sure teachers have a year or two of using computers for school use and on their own time previous to the students receiving their laptops is also likely to be quite beneficial. Having a technology integration specialist occasionally present in teacher classrooms to offer just-in-time support and advice could also prove to be very beneficial for teacher success in integrating technology into their classroom instruction.

Teachers are bound to be anxious about using computer technology with their students even when they are familiar with the computer itself. Few teachers have experienced being taught with computers integrated into the educational experience; therefore they are not going to have many models of teaching with computers from which to draw. Burns (2002) suggested, and we concur, that creating situations where teachers are given time during the day to participate in communities of learning with other teachers will help them become more comfortable with using the technology, and they will begin to model for each other effective ways to implement computers into instruction.

Windschitl and Sahl (2002) found in their study of three teachers in a school with laptop technology that the process of technology integration is complex and that teachers who did begin to integrate technology held particular beliefs about the teaching and learning process. The three teachers in this study held varying beliefs about education, and none met the pedagogical criterion Windschitl and Sahl posited necessary to foster integration, yet the teachers all began to use the technology. The teachers did not change their more traditional teacher-centered approaches to teaching by moving toward more student-centered methods, but they did all use the technology as a tool in their classrooms and the students appeared to be benefiting from that use.

Once the transition to ubiquitous technology begins, as many resources as possible should be made available to all teachers so that they are able to find what they need in order to successfully integrate technology into their classrooms. This could be as simple as keeping a library for some teachers
or, as Christiansen (2002) suggested, continued education that keeps the teachers at a technological skill level comparable to their students. There were only three teachers in this study and each of them had a different idea as to what sort of training would have benefited them. Teachers, like most adults, will probably learn best when they are allowed to choose their mode of learning.

**FUTURE DIRECTIONS**

Although this study has provided reasons to be hopeful that integration will take place with less effort than previously thought, it is important to note that through conversations with these teachers it was clear that not all faculty members at this school were making such progress; some teachers did not integrate technology despite their high level of access. Nonetheless, all three of the teachers at St. Hezekiah’s Middle School in the study—who started out at varying levels of technology competence and confidence—began to effectively integrate wireless technology into their instruction. Integration did not mean that these teachers changed their methods of teaching nor their beliefs about teaching, nor did the technology necessarily become the centerpiece of the classroom. The computers were being used as an educational tool that provided another dimension to their repertoire of teaching methods.

Further studies in the area of teachers and ubiquitous technology are clearly needed. Given the contradictory findings of this study and others (Becker, 2000; Hill & Reeves, 2004; Winschitl & Sahl, 2002), further research on interactions of beliefs and practices with these technologies is warranted. Relatedly, longer-term studies of school contexts with wireless laptops are obviously in order, since we do not know what will happen to practices once the novelty factor wears off. Further studies that focus on what sort of assistance works best at reducing anxiety in teachers as they begin implementation could provide valuable support to educators involved with preparing teachers to begin using computers in the classroom. It could also prove to be beneficial to continue to focus on how teachers’ thoughts and feelings about computers begin to change as they become more comfortable with the machines and their use in the classroom and how teacher perceptions of themselves may change as a product of ubiquitous technology. Finally, studies that focus more closely on contextual factors such as level of school (elementary, middle, or high), and administrative expectations would also provide valuable information to those responsible for technological integration programs.
Because computers in combination with Internet access are such a flexible resource for all types of information, more schools may soon be trading in textbooks for wireless laptop computer technology. As computer technology continues to penetrate all aspects of our lives, the transition to using technology in our classrooms may not be as dramatic or difficult as was once predicted. The increased ubiquity of networked computer technology makes the context of this study much different from studies conducted more than five years ago. The teachers in this study did not even have to change the physical structure of their classrooms to accommodate the technology. As teachers’ levels of basic computer literacy increase in our society, we may see that more teachers, when given access, will integrate technology rather than allowing it to gather dust. In the 1980s, integrating computer technology required teachers to revolutionize their teaching. In the 1990s, the Internet revolution took place outside our schools, throughout North American society. In the 21st century Internet age, ubiquitous wireless laptops may be the tool that finally makes networked computing an everyday part of schooling, precisely because teachers may understand the tool well enough to integrate it into meeting their existing teaching goals. It remains to be seen what the long-term changes in the practices and culture of schooling may be.

References


