Toward Technology Integration in the Schools: Why It Isn’t Happening

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Research in the past decade has shown that computer technology is an effective means for widening educational opportunities, but most teachers neither use technology as an instructional delivery system nor integrate technology into their curriculum. This qualitative study examined the classroom practice of 30 “tech-savvy” teachers who used computer technology in their instruction, how much they used it, the obstacles they had to overcome to succeed in its use, and their general issues and concerns regarding technology. Participants were volunteers from two elementary schools, one middle school, and one high school. All identified by their schools as being proficient with technology.

The study found that the teachers were highly educated and skilled with technology, were innovative and adept at overcoming obstacles, but that they did not integrate technology on a consistent basis as both a teaching and learning tool. Two key issues were that their students did not have enough time at computers, and that teachers needed extra planning time for technology lessons. Other concerns were outdated hardware, lack of appropriate software, technical difficulties, and student skill levels. Results suggest that schools have not yet achieved true technology integration. There are implications for teachers, administrators, and teacher educators.
As a classroom tool, the computer has captured the attention of the education community. This versatile instrument can store, manipulate, and retrieve information, and it has the capability not only of engaging students in instructional activities to increase their learning, but of helping them solve complex problems to enhance their cognitive skills (Jonassen & Reeves, 1996; Newby, Stepich, Lehman, & Russell, 2000). However, the same computer technology that permeates other sectors of American society and helps to drive our industrial sector has not been fully incorporated in the nation's schools (ISTE, 1999; Morrison & Lowther, 2002). Teachers in the United States are generally under-prepared to integrate technology into their instruction in meaningful ways (Strudler & Wetzel, 1999; Schrum, 1999; Willis & Mehlinger, 1996). Only one-third of teachers reported that they were well prepared to use technology in their classroom instruction (NCES, 2000). Fortunately, there is some indication that K-12 schools and teacher education programs are in the process of addressing the issues of computer technology being used in classroom contexts (Karchmer, 2001; Roblyer, 2003). Moreover, schools and teacher education programs are looking for effective models from teachers who have successfully integrated computer technology into their instruction (Becker, 1998; NCES, 1999). This study sought to identify some reasons that computer technology integration in U.S. schools has not occurred at the rate both educators and the public have come to expect.

TOWARD THE USE OF TECHNOLOGY: THE CHANGING ROLE OF THE TEACHER

Despite successful efforts to acquire computer hardware and to raise the student to computer ratio to 5:1 (World Almanac, 2002), there has been less success identifying, which computer skills should be taught in school and how computers can be used for teaching and learning (Dooling, 2000). Thus, current attention has turned to what is actually happening in the classroom with computer technology. A survey of schools conducted by the National Center for Educational Statistics reports that fewer than 20% of teachers felt that they were prepared to integrate computer technology into their classroom instruction (NCES, 1999). Despite all the time and money invested into putting the hardware and software in place, as Becker (1998) has suggested, "...students still spend most the their school day as if these tools and information resources had never been invented" (p. 24).

Why has adoption of technology in the classroom been slower than acquiring the resources? Wright and Shade (1994) suggested that early
emergence of classroom computers in the late 1980s and early 1990s put teachers in a quandary, that the integration of computer technology into the curriculum was poorly planned, and that teachers were generally poorly trained. A further difficulty with the introduction of the computer into the classroom was that teachers did not fully understand the role computers should play and often felt threatened with the possibility of being replaced by them (Fuller, 2000; Loveless, 1996). Others feared that the computer would interfere with teacher-student relationships (Laffey & Musser, 1998). Nonetheless, survey research has reported that most teachers have positive attitudes toward the use of technology in the classroom despite lacking confidence in their abilities with computer technology (Hardy, 1998; Schrum, 1999; Willis, Thompson, & Sadera, 1999). Much of this positive attitude results from educators understanding the instructional implications of tapping the Internet and the vast resources of the World Wide Web (WWW or Web) (Crossman, 1997; Harmon & Jones, 1999; Kahn, 1997). Many teachers have come to appreciate the limitless possibilities that web sites and creative software can add to their traditional classroom teaching methods. It is much easier to search for fresh ideas by surfing the Web than by poring over text-based resources (Anderson & Speck, 2001).

The purpose of this study was to examine the teaching practices of 30 teachers who used computer technology in their instruction, both as a teaching and learning tool, and to identify the obstacles they overcame in the process. Participant teachers were profiled, major issues and concerns that they encountered were reported, and the overall level of technology integration in their teaching practice was reported.

Participant teachers were considered by their respective school administrators to be proficient in their instructional use of technology. Examining how participant teachers overcame obstacles in their use of computers in the classroom has the potential to add information to practical development for the successful integration of such technology into teaching practice. Qualitative studies of classroom life can provide the basis on which effective change strategies can be initiated and can provide a contextual focus for efforts aimed at pedagogical issues (Eisner, 1999). Constructivist learning theory (Lincoln & Guba, 1985) frames this work; it assists the understanding of phenomena developed from the interpretation of data.

The definition of integration of technology into teaching practice. As teachers have struggled to realign their conceptions about the nature of teaching and learning with technology, they have had to tackle formidable barriers to real change from the traditional class. It was not enough that
teachers simply made the effort to become familiar with computer technology. Hooper and Rieber (1999) described five phases of teachers' use of technology: (a) familiarization, (b) utilization, (c) integration, (d) reorientation, and (e) evolution. It was asserted that teachers often do not progress past a utilization stage. In the utilization stage, teachers become prematurely satisfied with their limited use of technology, but lack a positive commitment to it and readily discard the technology at the first sign of trouble. Real change occurs in the integration, or "breakthrough phase," according to Hooper and Rieber (1999, p. 254). In the integration phase, teachers consciously decide to designate certain tasks and responsibilities to technology, so much so that the lesson fails if the technology fails. As an example, they liken the computer to the chalkboard—most teachers would have a difficult time teaching without it. For purposes of this study, then, integration means a reliance on computer technology for regular lesson delivery.

This study examines the difficulties that select tech-savvy teachers have had to overcome in order to use computer technology (CT) in the classroom by both teachers and students. In doing so, this study brings into question the status of actual integration of technology into their schools. The initials CT are used in this study rather than simply technology, which has other connotations, or IT, which can stand for either instructional or information technology.

**METHODOLOGY**

The present study employed both qualitative methods and quantitative methods. A mixed-method approach served to converge findings and extend the breadth of the inquiry (Cresswell, 1994). Qualitative methodology was used as a tool because of its broad approach toward understanding and explaining the meaning of social phenomenon in a naturalistic setting (Marshall & Rossman, 1999; Merriam, 1998). Quantitative methods were employed to analyze Likert-scale data found on survey-questionnaires.

**Context**

Data was collected for the study in the classrooms and computer laboratories of four local schools in a populous, urban county in a southern state. This county has a school population of 161,000 students served by 208 schools. There are two school districts in the county, a city school district
and a county school district. There are 165 schools in the city school district and 43 schools in the county school district. The target schools included Elementary School A and Middle School B from the city school district, and Elementary School C and High School D from the county school district. These schools were chosen because they were identified by sources as having good reputations for encouraging an atmosphere for computer-based learning.

Participant schools were identified through personal referrals. Professors in the local university's Instructional Design and Technology Department program were asked to provide the names of schools where technology was widespread. The director for student teacher placement also provided important referrals. From these conversations, several names of candidate schools were identified and contacted for identification. With respect to the two county schools, the county's research director confirmed the efficacy of the two school selections within her district. The participant schools were also chosen because they represented a broad, K-12 observational mix: two elementary schools (Schools A and C), one middle school (School B), and one high school (School D).

**Elementary School A.** Elementary School A was situated in a large, urban school district located adjacent to a university. It was located in a low-to-middle-income residential area. The university's College of Education operated the school in cooperation with the city. Students and faculty often used School A for research, observation, and field experiences. School A had a population of approximately 350 students and 21 teachers. Most of the classrooms had four computers, and teachers were provided with what was called a "21st Century" cart holding a large computer monitor that could be easily seen by the entire class. The school had no designated computer lab, but the library had four or five modern computers. The library acted as the lab since it allowed individual classes to schedule visits. Five observations and interviews were conducted at School A.

**Middle School B.** Middle School B was situated in a middle-income residential area in the same large urban school district as School A. Serving grades 6-8, it had a student population of 1,200 and a faculty of 62. Most classrooms at School B were equipped with five new Macintosh computers, four for student use, and one for use by the teacher. As in School A, "21st Century Carts," were in all of the target classrooms. In addition, the school featured two computers labs, both with 30 new Macintosh computers. The computer labs were available to all content-area teachers who wished to
schedule them in advance. All classrooms and computer labs had Internet access. Seven observations and interviews were conducted at School B.

**Elementary School C.** Elementary School C was operated by the county school district in a suburban, upper-income residential setting. School C served grades K-8 and had a population of 482 students and 22 teachers. Most of the classrooms were equipped with 4-5 new computers, and there was one computer lab with 26 new Macintosh computers. The lab was accessible to all teachers, but due to a rotational cycle, teachers could only expect an opportunity to use the lab once every two weeks. All classrooms and the lab had access to the Internet. A mobile cart containing 30 wireless laptop computers was also available for classroom use. Nine observations and interviews were conducted at School C.

**High School D.** High School D was also in the county school district in an upper-middle class suburban setting. It had a school population of 1700 students and 87 teachers and featured many technology innovations. For instance, the Theater class had access to an expensive digital tape recorder, and the lab software enabled the class to edit tapes into polished products. Further, School D had its own server and sometimes aired student products over their network into all the classrooms. There were two modern lab facilities, each equipped with 30 new Macintosh, Internet-wired computers. The labs were available for scheduling by all teachers. The classrooms generally had 4-5 computers, also Internet wired. Like School C, teachers had access to a mobile cart containing 30 laptop computers for classroom use. Nine observations and interviews were conducted at School D.

**PARTICIPANTS**

As has been established, a majority of teachers throughout the country are not using computer technology as a part of their instruction. For this study, then, it was desirable to seek not only teachers who were fully prepared to use technology in their instruction, but also those who were identified by other educators as being skillful ("tech-savvy" in the vernacular) in their practice.

The participant teachers in this study were thus identified by purposeful sampling, based on the assumption that the qualitative researcher wants to discover, understand, and gain insight, and therefore must select a sample from which the most can be learned (Merriam, 1998). Using a technique
known as snowball sampling (Marshall & Rossman, 1999; Merriam; Patton, 1990), participant technology teachers were identified by asking for referrals "...from people who know what cases are information-rich; that is, good examples for study, good interview subjects" (Patton, p. 182).

After receiving nominators’ reasons for citing certain teachers in schools, there was no definitive set of characteristics that would serve to guarantee the proficiency of the participant teachers, and clearly some would prove to be far more skillful with CT than others. However, this study was less concerned with definitions of words than it was in having teachers who could reliably use CT in their lessons; hence, it proceeded on the assumption that, when the search went on for “the best in the school with technology,” (a phrase used in the participant search) the participant teachers were among them.

Corroborating what had been said in prior discussions about the target schools, the administrators were very cooperative in providing the names of technology teachers they thought would participate in the project. At Schools C and D, the administrators provided a tour of their school and introduced teachers they likewise thought would be interested in the project. In all cases but one, the teachers enthusiastically agreed to be participate and completed the survey-questionnaire (Appendix A).

**PROCEDURE**

Data collection proceeded by using established qualitative methods that follow a complex, multiple-methods design (Marshall & Rossman, 1999). Dates, times, and locations for a classroom observation were made, and participant teachers were then observed during a class in which they used computer technology. Last, an informal postobservation interview was conducted as soon as possible after the lesson. The participant group consisted of 30 teachers.

Three sources of data were collected. Table 1 provides an overview of data collection for these methods. The first was a survey-questionnaire each teacher completed after agreeing to participate. These were collected in person by the researcher either before or after the classroom observation. The second was the classroom observation. Each teacher was observed once. The duration of each observation was 30-45 minutes. This amount of time was consistent with a normal class period and would be ample to observe in detail the teacher’s actual use of the computer in the lesson. Together with the results of the survey-questionnaire and interviews, this observation time
was sufficient to triangulate findings and to adequately answer the research questions (Patton, 1990). The third data source was a postobservation informal interview.

**Table 1**
Overview of Data Collection Instruments

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What:</strong> Survey questionnaire</td>
<td>Observation Measure</td>
<td>Informal Interview</td>
</tr>
<tr>
<td><strong>When:</strong> Pre-observation</td>
<td>During class time</td>
<td>Post-observation</td>
</tr>
<tr>
<td><strong>Where:</strong> Teacher discretion environs</td>
<td>Classroom or CT lab</td>
<td>Classroom</td>
</tr>
<tr>
<td><strong>How:</strong> Hardcopy</td>
<td>By researcher</td>
<td>Direct questioning</td>
</tr>
<tr>
<td><strong>Why:</strong> 1) Background information 2) Experience 3) Perceptions of CT use 4) Open-ended questions</td>
<td>1) Classroom environment 2) Student tasks 3) Teaching practice 4) Student responses</td>
<td>Teacher lesson responses</td>
</tr>
</tbody>
</table>

**Survey-Questionnaire (Appendix)**

Participant teachers filled out a survey questionnaire, the primary resource for teacher-reported information. Its five sections, consisting of 48 questions, included: (a) background information, (b) experience with CT, (c) perceptions of CT use, (d) computer tasks used in classrooms, and (e) open-ended responses.

The background information in Section 1 helped to understand an early relationship of the participant to computer technology (CT) and teaching. Section 2 was instrumental in exploring the practical CT experience of the participant. Section 3 provided data on how the participant teachers viewed their own skill and confidence levels with computers, as well as those of their students. Section 4 asked them about specific instructional computer tasks. Additionally, the open-ended questions in Section 4 were paired with similar questions during the informal post-observation interview, and helped to cross-reference findings from the *issues and concerns* question.
Classroom Observation Measure

The purpose of the classroom observation was to accurately record such detail as the ratio of computers to students in use during the lesson, teacher actions during the classroom instruction, which computer applications the teacher chose for the lesson, the level of integration of the computer into the lesson. Also noted were student responses to the lesson and computer-related difficulties that occurred during the course of instruction.

Postobservation Informal Interview

Three questions were asked during a face-to-face informal interview shortly after the formal observation of the teacher's lesson was over or shortly before the close of the lesson. The questions were designed for the teacher to discuss the lesson directly and at the same time help the researcher answer the broader research questions.

The informal interview questions:
1. What were some of the things you were trying to accomplish in today's lesson?
2. What is your assessment on how things went?
3. What are some of the issues and concerns you dealt with today that have been fairly common for you in technology lessons?
4. What are other bumps in the road as you have sought to use computers in class?

DATA ANALYSIS

Data analysis began immediately upon the collection of complete data sets from as few as five participants. Using a constant-comparative method (Bogdan & Biklen, 1998), it was possible to create themes and categories after just several observations. Statistical Package for the Social Sciences (SPSS) was used to analyze and chart numerical data.
RESULTS

Teacher Participant Profile

In Table 2, participant teachers were identified by the order in which they were observed during data collection, 1-30, along with their school and their subject matter.

Table 2
Order of Teacher Observations

<table>
<thead>
<tr>
<th>Teacher</th>
<th>School</th>
<th>Subject Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Elem. School C</td>
<td>Math</td>
</tr>
<tr>
<td>2</td>
<td>Elem. School A</td>
<td>Lang. Arts</td>
</tr>
<tr>
<td>3</td>
<td>Middle School B</td>
<td>Lang. Arts</td>
</tr>
<tr>
<td>4</td>
<td>Elem. School C</td>
<td>Lang. Arts</td>
</tr>
<tr>
<td>5</td>
<td>Middle School B</td>
<td>Lang. Arts</td>
</tr>
<tr>
<td>6</td>
<td>Elem. School A</td>
<td>Science</td>
</tr>
<tr>
<td>7</td>
<td>Elem. School A</td>
<td>Lang. Arts</td>
</tr>
<tr>
<td>8</td>
<td>Elem. School A</td>
<td>Lang. Arts</td>
</tr>
<tr>
<td>9</td>
<td>Elem. School C</td>
<td>Science</td>
</tr>
<tr>
<td>10</td>
<td>Elem. School A</td>
<td>Lang. Arts</td>
</tr>
<tr>
<td>11</td>
<td>Elem. School A</td>
<td>Math</td>
</tr>
<tr>
<td>12</td>
<td>Middle School B</td>
<td>Science</td>
</tr>
<tr>
<td>13</td>
<td>Middle School B</td>
<td>Comp. Sci.</td>
</tr>
<tr>
<td>14</td>
<td>Middle School B</td>
<td>Lang. Arts</td>
</tr>
<tr>
<td>15</td>
<td>High School D</td>
<td>Fine Arts</td>
</tr>
<tr>
<td>16</td>
<td>High School D</td>
<td>Lang. Arts</td>
</tr>
<tr>
<td>17</td>
<td>High School D</td>
<td>Lang. Arts</td>
</tr>
<tr>
<td>18</td>
<td>Elem. School C</td>
<td>Lang. Arts</td>
</tr>
<tr>
<td>19</td>
<td>Middle School B</td>
<td>Science</td>
</tr>
<tr>
<td>20</td>
<td>High School D</td>
<td>Lang. Arts</td>
</tr>
<tr>
<td>21</td>
<td>High School D</td>
<td>Lang. Arts</td>
</tr>
<tr>
<td>22</td>
<td>High School D</td>
<td>Soc.St./History</td>
</tr>
<tr>
<td>24</td>
<td>Elem. School C</td>
<td>Lang. Arts</td>
</tr>
<tr>
<td>25</td>
<td>Elem. School C</td>
<td>Soc.St./History</td>
</tr>
<tr>
<td>26</td>
<td>Elem. School C</td>
<td>Soc.St./History</td>
</tr>
<tr>
<td>27</td>
<td>High School D</td>
<td>Lang. Arts</td>
</tr>
<tr>
<td>28</td>
<td>Elem. School C</td>
<td>Soc.St./History</td>
</tr>
<tr>
<td>29</td>
<td>Middle School B</td>
<td>Comp. Sci.</td>
</tr>
<tr>
<td>30</td>
<td>Elem. School C</td>
<td>Soc.St./History</td>
</tr>
</tbody>
</table>
Of the 30 teachers who volunteered for the study, 12 were at the K-5 elementary level, 10 were at the 6-8 middle school level, and 8 were at the 9-12 high school level. Figure 1 shows at a glance that the distribution of teachers across grade levels was fairly consistent. There were 11 observations in the elementary and high school grades, and 8 in the middle school. The subject area chart shows that there were 14 observations of language arts lessons, seven in social studies/history, four in science, two in computer science, and one each in fine arts, business education, and math.

Next, the two charts in Figure 2 highlight the background of the participant teachers. Chart I reveals a broad range of teaching experience, with 53% of the teachers having from 1-7 years of experience, while the remaining 47% reported more than eight years. The educational level shown in Chart II shows that 26 (87%) of the teachers held master’s degrees, and of the 26, twelve had eighteen hours or more beyond a master’s degree.

Next, the three charts in Figure 3 show the extent of the teachers’ experience with CT in terms of workshops attended, classes taken, and class time using CT. A workshop is a session or clinic provided by a school district as a professional development opportunity for teachers. Fourteen (47%) teachers reported that they had attended seven or more workshops, while eight (27%) of the teachers said they had attended fewer than three workshops. The only teacher who did not attend a workshop reported taking one to two computer courses, so all of the CT teachers had formal training of some kind. Next, the second chart indicates the number of formal courses taken by
**Figure 2.** Background information on 30 CT teachers

The participants. Highlights from this chart are that 16 teachers (53%) either took no CT courses, or just one or two. The third chart shows the class time level of experience. Here, 12 (40%) teachers said they did CT instruction less that 25% of the time, and another 12 (40%) used it between 25% and 50% of the time. In sum, 24 (80%) of the teachers used CT in their instruction less than half of the time. Six teachers used CT more than 50% of the time. Of these, two teachers said they used CT more than 75% of the time.

**Figure 3.** CT experience of 30 participant teachers
Teacher Perceptions of CT Confidence and Skill Levels

The purpose of reporting these results is to establish that the subject teachers saw themselves as tech-savvy and more likely than other faculty to integrate CT in their instruction. With regard to computer use, self-efficacy is influenced by a synergy of confidence and skill (Joo, Bong, & Choi, 2000); that is, it is difficult to be confident in using CT without a given skill level, and it is difficult to acquire a high CT skill level without some degree of confidence. Using a Likert-like scale (1=low, 5=high) teachers were asked to rate both their perceived confidence level using CT and their perceived skill level with CT. Figure 4 depicts the charts of perceived confidence and skill levels of the teachers. They show clearly that the both skill and confidence levels are at the high end of the scale.

![Figure 4](image)

**Figure 4.** Perceived confidence and skill levels of 30 CT teachers

**Key Findings**

- **Confidence Level.** Mean = 4.1. **Skill Level.** Mean=3.9. On a scale where 5=high, these means, statistically close together, show strong levels of confidence and skill among the respondents. One teacher rating herself as low in confidence and another just a step higher at Level 2 were two of three teachers reporting a skill Level 2. This confirms that confidence and skill tend to intertwine. Moreover, at the high end of the scale (4 or
the difference between confidence and skill was just one teacher (22 vs. 21). The number at the middle of the scale (3) remained an unchanged 20%. Thus, the confidence level and the skill level of the teachers was much the same. A Pearson correlation (.856) between teacher skill and confidence showed a significance at the .01 level (two tailed).

It may be noteworthy upon further analysis that Teacher 7, who rated herself with the least confidence and was among the three teachers at the 2nd level in skill, had a strong desire to improve her CT situation: “I would like to write a grant that would allow me to buy new computers that I could hook to the television for instruction. And I would like a scanner.” Similarly, Teacher 10 (Confidence=2, Skill=2) expressed a strong interest in improving her own CT lot: “I’m involved in a new program where I’ll be taking some courses at the board of education and the Teaching and Learning Academy.” The only other teacher to respond with a Skill=2 (but had a Confidence=4) was Teacher 23, a high school Business Education teacher who would like to learn “PowerPoint for entrepreneurship presentation and an interactive website for mock trial in Business Law.” Thus, even as teachers rated themselves lower than others on the CT confidence and skill scales, they showed an eagerness to improve their CT education.

There was an interesting statistic at the highest end of the scale (5 on the Likert scale). This was a notable difference in those who rated themselves highly confident (14) versus those who rated themselves highly skilled (9). This suggests that some teachers considered themselves more confident than skilled with technology and that confidence is a key factor in learning to teach with computer technology.

Overcoming Obstacles

There was no Likert-scale mean to report in this category. Respondents were asked an open-ended question: “What obstacles have you overcome in order to use CT in your instruction?” To be successful, many teachers must overcome certain obstacles they encounter. From how to get chalk, crayons, a supply of paper, to how to get a new desk or fix a broken one, it is part of the job. CT has added a new dimension to these kinds of barriers. Of the 30 participant teachers, 100% reported the following obstacles they had to overcome in order to use CT in their instruction. Table 3 lists these obstacles. Percentages shown total more than 100% since teachers often
Toward Technology Integration in the Schools

mentioned more than one obstacle to overcome, and numbers totaled more than 30 for the same reason.

Table 3
Major Obstacles Overcome by 30 CT Teachers

<table>
<thead>
<tr>
<th>Obstacle</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment</td>
<td>14</td>
<td>46.7</td>
</tr>
<tr>
<td>Time</td>
<td>9</td>
<td>30.0</td>
</tr>
<tr>
<td>Student Skill Level</td>
<td>7</td>
<td>23.3</td>
</tr>
<tr>
<td>Teacher Skill Level</td>
<td>5</td>
<td>16.7</td>
</tr>
<tr>
<td>Scheduling</td>
<td>5</td>
<td>16.7</td>
</tr>
<tr>
<td>Software</td>
<td>4</td>
<td>13.3</td>
</tr>
<tr>
<td>Internet</td>
<td>2</td>
<td>6.7</td>
</tr>
<tr>
<td>Class Size</td>
<td>2</td>
<td>6.7</td>
</tr>
</tbody>
</table>

Key Findings

- **Equipment.** \(N = 14\). Forty-seven percent (47%) of the teachers had to overcome various difficulties with equipment (hardware), making it their biggest obstacle. Of the 14 teachers reporting equipment difficulties to overcome, four had initial problems just getting enough computers. Teacher 28 solved the problem by being "motivated to go during the summer to computer technology classes in order to be a 21st Century Teacher," which entitled her to six new desktop computers and two laptops. Another four teachers dealt with antiquated computers that couldn’t perform well enough. Teacher 6 put her problem this way: “Scavenging to find computers that are even marginally capable of running rudimentary software,” while Teacher 13 solved her problem by coming to a new school with up-to-date computers. Other teachers reported a variety of equipment problems to overcome. Several mentioned software incompatibility or the inability to run programs, while others had mechanical difficulties and breakdowns. Teacher 25 had to overcome a “fear of using computers and problems arising—not printing, Internet down.”

- **Time.** Nine teachers (30%), mentioned time as a difficulty to conquer. While some teachers simply mentioned time as a factor in their responses,
others were more specific. According to Teacher 1, “It can be difficult to find a time to squeeze technology into the curriculum when there is so much, skill wise, to teach.” Teacher 12 said concisely, “35 kids, 5 computers, 50 min. period,” a lament echoed by Teacher 19: “Time for all the students to get on the computers and get finished.” And for Teacher 25, it was a case of the timing of her lab period being out of sync with her current unit of study.

- **Student Skill Level.** Seven of the 30 teachers (23%) thought that the varying degrees of student skill levels in their CT classes were an obstacle to overcome. Two comments in particular summarize this finding. Teacher 23 noted that “The makeup of students in 30-plus classes varies, thus computer skills will vary,” while Teacher 21 said, “Students who are unfamiliar with computers need tutorials on how to use them.” During the informal interview, she also expressed concern that a special education student was gaining very little from the class because of a failure to learn the rudimentary skills necessary to keep up with the class. “He sort of sits and looks at the screen and gets frustrated,” she said of the student.

- **Teacher Skill Level.** Five teachers (17%) felt that their own lack of expertise needed to be overcome before they could succeed as a CT instructor. Four of the five had similar comments in crediting their schooling. As Teacher 22 put it, “I had to take a few classes to learn how to use some of the technology programs.” Teacher 24: “I was once very afraid of using the computers. Now, I am much more confident and comfortable. I give credit to the numerous informative computer training workshops which the county has provided.” Teacher 10 mentioned that the lack of workshops available when she first got into CT use held her back: “At the time, the workshops and instructions were minimal,” but she has since gone to over six workshops or courses.

- **Scheduling.** Scheduling difficulties emerged with five teachers (17%). This category is related to time, but has been created to account for those teachers who specifically do most of their instruction in school computer labs. As noted earlier in this article, all teachers (except at the high school) had at least four serviceable computers in their classrooms, but most preferred to do their class CT work in school computer labs. Whereas school labs provided around 30 high-tech computers (except at Elementary School A, where there was none), the number of teachers wanting to use them caused scheduling problem in many cases. At Elementary School C, for example, teachers were on a two-week rotation basis, meaning that if teachers did not use their in-class computers, then they had to wait two weeks to get into the one available lab.
Software. Problems with software fell into two categories, compatibility and availability. This occurred with four teachers (13%). As Teacher 21 explained her obstacle, “incompatible software and hardware—Apple Works versus Claris Works in same lab,” while Teacher 6 said that her dilemma was “finding reasonably-priced software ($10 per station), appropriate and complex enough for the middle school students.”

Internet and class size. Two teachers (7%) in each category. Two teachers mentioned connectivity problems to the Internet, and two said that large class size interfered with the ability to get all students onto and off of computers during class time. With regard to the former, Teacher 7 had only one computer with Internet access, while Teacher 26 complained of “Internet crashes.” As for class size, Teachers 12 and 26 had classes in excess of 30, so that not all students could get onto computers at the same time, even in labs, which generally were equipped with 30 computers.

DISCUSSION

Is Technology Really Being Integrated into these Schools?

It appears from this research that true integration of CT into the target schools has not happened. The difference between CT integration and CT use is that integration connotes full-time, daily operation within lessons (Hooper & Rieber, 1999). As skilled and enthusiastic as they were, the teachers in this study were only occasional practitioners of CT. Survey item 7 (Appendix) asked participants to approximate the instructional time spent using CT on a weekly basis. A full 80% of them reported that they used CT less than 50% of the time, clearly suggesting that real integration had not taken place. Table 4 breaks down the percentages of class time the participants used CT in their instruction.

Table 4
Percentage of Class Time 30 Teachers Used CT in Their Instruction

<table>
<thead>
<tr>
<th>Scale</th>
<th>Descriptive</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>below 25%</td>
<td>12</td>
<td>40.0</td>
</tr>
<tr>
<td>2</td>
<td>25-50%</td>
<td>12</td>
<td>40.0</td>
</tr>
<tr>
<td>3</td>
<td>51-75%</td>
<td>4</td>
<td>13.3</td>
</tr>
<tr>
<td>4</td>
<td>above 75%</td>
<td>2</td>
<td>6.7</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>30</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Taken into consideration that these 30 participant teachers are the most prolific users of CT at their schools, these findings make it apparent that there was overall a low level of instructional time devoted to instructional uses of CT. The clear inference is that in all content areas, students at these schools were engaged in little or no technology instruction at a constant standard.

Why CT has not Happened: The Major Obstacles

If we accept the premise that most teachers show concern about a variety of issues and obstacles that affect their ability to succeed in the business of teaching, then the CT teachers are no exception. Their areas of concerns are often within the context of technology. Whereas neither up-to-date textbooks nor class size were particular issues with these teachers, current computer hardware and software were. Such barriers to successful CT instruction can be added to a historical continuum of teacher complaints that include students, parents, and administrators.

Hardware. Teachers were grateful for the computers they had, but many of the devices were old, slow, incompatible with new educational software, and lacked proper networking. There was little consistency in the array of hardware the schools provided: some PCs, lots of Macs. Printers, rarely seen in a classroom, were small and overloaded in the labs when all the students would try to print results at the end of a lesson. If a computer froze or had wiring problems, oncall technicians were nonexistent. Trouble-shooting came from that person on the staff with the most technical knowledge. Of course, mention hardware, and discussion of money is not far behind. "Oh, if only I could get my hands on new simulation software. But there is no money for that," lamented one of the teachers as if for all of them.

Time. As enthusiastic as the participant teachers were about CT, they expressed an overarching concern about the amount of time to prepare CT lessons. Since they had all delivered lessons in the traditional manner without CT, they reported a dramatic increase in the amount of time it took to prepare a class to use some form of CT. At the very least, back up lesson plans had to be devised in case of technology failure. Students had to be more carefully directed to be productive in groups where just one member used the computer. Rotation plans had to be in place to share sparse computer time equally.
The time it took to get students engaged in a computer lesson from start to finish in a class less than an hour was stressful to the participants. Take the computer labs, for instance. For openers, many students came late since it was not their regular class. They had to find seats at computers that were operating, switching on, load disks and/or log into the school's server, listen to directions, and read handouts. Then they would negotiate keyboards and menu bars to get to desired location. This would often take up to 10 minutes of class time. Subtract also from class time it took to close up the station, and a good CT class might get 25-30 minutes of quality instruction. These teachers were a brave lot, but some of them wondered if it was all worth the extra time.

**Student computer skill level.** One concern to emerge from the participant teachers, and perhaps little addressed in the literature, is the issue of student CT skill level; that is, such items as keyboarding and negotiating the menu systems. The teachers reported that their teaching was affected by the degree to which they contended with students whose skill level was deficient. Historically, of course, not all students keep up with instruction at the same pace, and teachers have had to adjust. But by adding the keyboarding dynamic to the mix, difficulties have the potential of rising geometrically. What happens to teacher time when the slow student also becomes a slow technology student? This issue might become even more important if we consider a further context: that the teachers were reporting this concern based on little actual CT instruction. Had the teachers integrated CT on a daily basis, they might have reported the issue as even more daunting.

There is significance to the findings on student skill levels that are not as apparent as other issues such as time and money. Yet they could have broader ramifications. In a regular classroom, the technical skill playing field is level for all students, but in a CT lesson, it becomes a possibility that lack of skill might interfere with content learning. By way of explanation, all classes everywhere, of course, are composed of students who come to class with an assortment of mental and physical skill levels. The CT lesson often compounds differences among students because there is technical skill involved, and all students must have rudimentary skill levels to succeed in CT lessons. In a class of 30, can a teacher possibly keep all students up to the same speed?

In some respects the skills level concern can be viewed as an extension of the so-called "digital divide," in the sense that students with computers at home can be expected to perform better in CT lessons than those without it, and that the situation is somehow unfair. But if used as an excuse, this complaint is thin, and is not the school's dilemma any more than it is to suggest
that some students are going to read better because there are more books available to them in the home. Parents, of course, should add a computer to the household as well as a television. For the schools' part, however, what they can do is to require CT training as early as Kindergarten and maintain a CT requirement as an integral part of instruction through all the grades, much in the same fashion as reading programs are managed.

The Internet. The participant teachers were unanimous in their praise of the Internet, and recognized it as the great landmark in education it has been called (Leu, 2000; Reinking, 1998). There were just few concerns about Internet use by the teachers, but they echoed what has been heard in the education community and beyond—the Internet is a mixed blessing, replete with copious amounts of both useful and worthless information. This paradox is important, since it appears to have spooked some teachers, who voiced concern that, as blocks or other censoring devices became enabled in their schools, their Internet use as a teaching tool became constricted. For others, it was another obstacle to overcome, and they did it by preparing carefully selected advanced web sites, sifting through information, and by careful monitoring of student work. The Internet censorship issue outlined in this study suggests a greater question; namely, whether the Internet will suffer the same fate as some school libraries, where excessive constraints inhibit the freedom of students to access valuable information.

CONCLUSION

Implications for Present and Future Teachers

Teachers might be well served by learning effective CT instruction. The sampling phase of this study gave rise to conversations with school administrators regarding which teachers they felt would be best for this study. They were quick to identify teachers they felt were strongest users of CT because they knew right away who they were. Perhaps because they were supportive of CT use in their schools, they spoke with pride about these teachers. It was as if they were talking about a different breed of teacher altogether. It was clear that these administrators considered the CT teacher among the vanguard of educators.

Not all school administrators are going to be as supportive of CT as these were, but as the inexorable trend toward CT in the classroom continues, it would seem a certainty that teachers be as CT competent as possible, not just for their students' sake, but because there may come a time when
Toward Technology Integration in the Schools

CT skills will become a basis for employment. The principal at one of the target schools, widely respected for her CT expertise, thought that that time might be the present. As the CT teachers confirmed during interviews, she knew that all her teachers had computers, and she expected them to be used. Classrooms across the country are quickly becoming outfitted with 3-4 computers, and the proliferation of wireless laptop carts means not a wider availability of CT but that teachers can use their classrooms instead of labs. It is logical, therefore, to assume that teachers at some point will no longer have the option of not using CT to some extent.

Implications for School Administrators

Schools can expect evermore state and local pressure to get a full measure CT integration into the curriculum. Random, occasional use of CT, as was the situation for this study, may be a good start. But unless administrators take the lead and make a difference, schools will continue to lag behind other sectors in society. The concerns and issues raised by the 30 CT teachers as they forged ahead despite many obstacles raises the question as to whether schools can successfully meet the CT challenge. The major areas of concerns that the CT teachers raised involved time (planning and instructional) to do their CT work, adequate funding for hardware and software, the varied skill levels of students, and computer-related technical problems.

Often the issue for a school is not the number of computers it has, but what teachers are able to do with them. Are schools providing the kinds of software applications and CDs needed to enable CT to be relevant for instructional purposes? According to this report, maybe not. There appears to be too much scrambling and scrounging by individual teachers to get the right software and the right connections, to printers and to the Internet, and they don’t have the time for it. Administrators should do the scrounging for the teachers. They should collectively lobby higher levels in the district for more resources: always for more hardware, but especially software. Sufficient bandwidth, reliable servers, sufficient storage capacity for student files, and a complete, school wiring network are all within their purview.

Moreover, schools need to upgrade the CT in teachers’ classrooms, get teachers to use them (or find out why they don’t), and de-emphasize ritual lab sessions. The best development to date to counter the lab phenomenon is the advent of the wireless laptop computers that can be carted from room to room. Aiding this phenomenon is that some schools have adopted a 90-minute class, fewer times per week (e.g., the A/B schedule) that have enabled teachers to keep students on computer tasks longer.
Perhaps what schools need, and some have, is a tech-savvy member of the administrative team who has the time to devote to CT issues. Some schools have called such a person a tech-coordinator. This person should handle software ordering through catalogs in the same way books are ordered. Likewise, just as books are placed in a bookstore or library, the tech-coordinator sees that the software gets downloaded into the school server and that teachers are properly connected to it. In an interesting development, school librarians have been easing into this position as a result of becoming Internet research facilities and repositories for laptop carts. School districts, of course, have had technology people on staff for years, but with the proliferation of CT has come a proliferation of glitches, and individual schools need immediate assistance, not work-orders. Going back to the data, as Teacher 1 stressed, “It would be great if all schools had a tech teacher to coordinate lessons with the classroom teacher. I believe then technology would be best integrated into the curriculum.”

Implications for Teacher Educators

Teacher education programs have arguably the greatest influence on the methods that teachers use to impart their lessons (Goodlad, 1994). What teachers do in classrooms is a reflection on their training. In finding that some of the most skillful CT teachers in the school community are doing much less with technology than they could, this study raises serious questions about how there were trained. Teacher education programs are understandably in a transitional phase with regard to CT, which is a relatively new kid on the university’s curricular block. While there appears to be wide acceptance that teachers should be better prepared to use CT in their classroom instruction (Schrum, 1999; Strudler & Wetzel, 1999; Willis & Mehlinger, 1996), there may be some concern as to how best to effect the proper training. As this report shows, technology workshops and other special offerings continue to be an important resource for teachers.

Where possible, a College of Education could survey recently placed graduates. To what extent are they using CT? What software? What are strengths and weaknesses in their training and recommendations for improvements? Also possible is a self-assessment survey of faculty: How much CT time they model for their preservice teachers? What is the faculty level of CT expertise? Would they like more CT training? What is the state of hardware in the classrooms? Should CT methods be taught in Methods classes or be part of the Instructional Design and Technology Department? Or both? Should minimal CT requirements for graduation be reassessed?
While self-assessments are prone to issues regarding reliability, perhaps departments can set up a system of observations to check levels of computer integration. Investigators might find that the barriers to effective technology integration in higher education are the same as those articulated by the participant teachers in this study: planning time, availability of computer hardware and software, student skill levels, and technical issues.

Recommendations for Future Studies

Future studies, of course, should include a sampling from a much broader spectrum of tech-savvy teachers in the field. Further, school administrators should be surveyed on their perceptions of the CT instruction as it is practiced in their own schools. What should be determined is to what extent computers are a priority within the curriculum structure, and how important it should be to train teachers to use them in the classroom. The educational community as a whole, as well as the general public, might be surprised to find that the computer is far less utilized as an educational tool as has been supposed, this despite perceptions to the contrary.

References


Toward Technology Integration in the Schools 543


APPENDIX

Confidential Survey Questionnaire for Teachers Using Computer Technology (CT)

Name ________________________________ No. ____
School ________________________________
Date ____________

Please respond to the following questions by circling the appropriate letter or number.

I. Background Information

1. What was your approximate age when you first used a computer?
   a. 7 or younger   b. 8-12   c. 13-17   d. 18 or older

2. How many years have you been teaching?
   a. 1-3   b. 4-7   c. 8-12   d. 13 or more

3. In what year of teaching were you when you began using computer technology (CT) for instruction?
   a. 1st/2nd   b. 3rd/4th   c. 5th/6th   d. 7th/8th   e. 9th or more

4. What is your highest degree?
   a. BA   b. BA+18   c. Masters   d. Masters+18   e. doctorate

II. Experience

5. How many college or university CT courses have you taken?
   a. 0   b. 1-2   c. 3-4   d. 5-6   e. 7 or more

6. How many CT workshops have you attended?
   a. 0   b. 1-2   c. 3-4   d. 5-6   e. 7 or more

7. What is the approximate amount of instructional time you spend using CT in your classroom on a weekly basis?
Toward Technology Integration in the Schools

III. Perceptions of CT Use

8. How would you rate your confidence using CT?

1 2 3 4 5
(low) (high)

9. How would you rate your skill level using CT?

1 2 3 4 5
(weak) (very strong)

10. How would you rate your students’ overall confidence using CT?

1 2 3 4 5
(low) (high)

11. How would you rate your students’ overall skill level with CT?

1 2 3 4 5
(weak) (very strong)

IV. Common Computer Tasks used in Classroom Lessons.

12. Which of the following common CT applications have you used in your instruction?

[0=Never, 1=Rarely, 2=Occasionally, 3=Frequently, 4=Extensively]

Production Tools Used by Students

<table>
<thead>
<tr>
<th>Application</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<td>Database</td>
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<tr>
<td>Spreadsheet</td>
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<tr>
<td>Draw/Paint/Graphics</td>
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<tr>
<td>Presentation (e.g., MS PowerPoint)</td>
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<tr>
<td>Authoring (e.g., HyperStudio)</td>
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<tr>
<td>Concept Mapping (e.g., Inspiration)</td>
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<tr>
<td>Planning (e.g., MS Project)</td>
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</tbody>
</table>
V. Please use the space provided to respond briefly to these open-ended questions.

13. What obstacles have you overcome in order to use CT in your instruction?  
A:

14. Do you see yourself as being innovative with the computer? If so, how?  
A:

15. How do your students respond to your CT instruction?  
A:

16. What are factors that influenced your decision to use CT in your instruction?  
A:

17. What are some issues and concerns regarding your use of classroom CT?  
A:

18. Where are you going next with your CT instruction or your CT education?  
A: