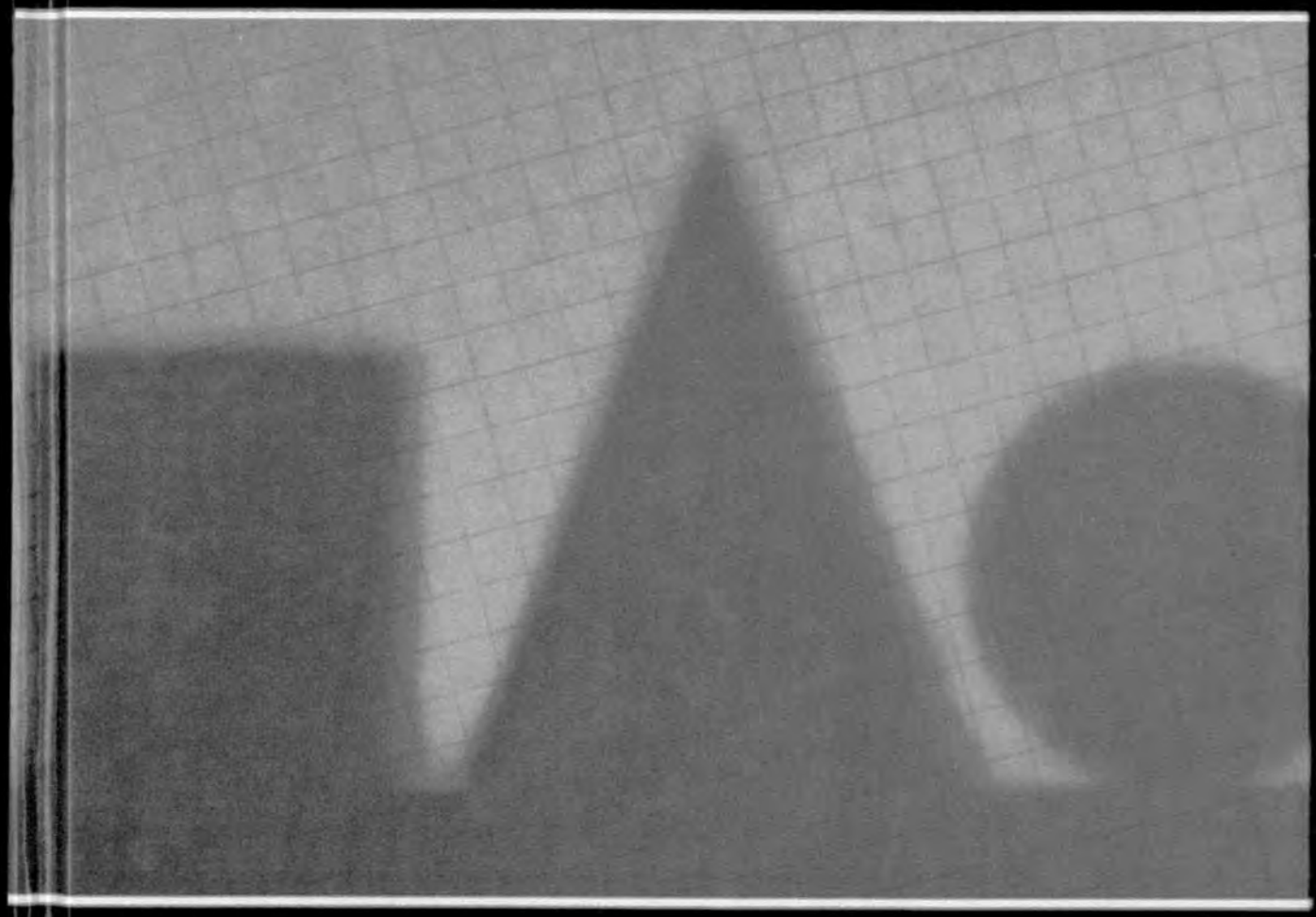
Handbook of Classroom Management

Research, Practice, and Contemporary Issues



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Classroom Management and Technology

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INTRODUCTION

Computer technologies are a set of dynamic tools that continue to evolve and transform classroom teaching and learning. As new technologies emerge and develop over time, they are often at the forefront of educational innovation and play an increasingly significant role in society. The majority of students have access to an Internet-connected computer in their classroom today and almost all students have access to one in their schools. The ratio of students per Internet-connected computer increased from nearly 20 students per computer in 1998, to 4.1 students per computer in 2004. The number of teachers using technology for planning or instruction increased from 73% in 2002 to 83% in 2003 (Ansell & Park, 2003). These numbers provide evidence that the role of technology has substantially multiplied over the past decade. Technology has progressed from being a novelty in the classroom to a "major tool of the trade" (Becker, Ravitz, & Wong; 1999).

Although widely promoted, and now generally accepted, integration of technology into the classroom is by no means an effortless process. There is a clear disconnect between the optimism of those advocating technology in the classroom and the realities of teaching and learning in 21st-century classrooms (Cuban, 2001). Teaching and learning with computers presents a series of new challenges and demands related to education professionals. These challenges include, but are not limited to, teacher training, funding, maintenance, and classroom management. Cuban stresses the importance of teachers and students studying these challenges, "educators have to come to terms with [technology] as an educational tool. Understanding technology and the social practices that accompany it as a potent force in society is incumbent on both students and adults" (p. 194).

While adding technology to a classroom equips teachers with a new range of classroom management tools such as spreadsheets and databases to manage school and classroom records and information, technology also presents a series of new classroom management issues such as moving students from the classroom to the computer lab or managing a classroom in which

students are using a variety of different technologies such as wireless laptops or handheld computing devices.

As an example, the following fictitious scenario describes one teacher's attempt to integrate technology into the classroom while maintaining an effective learning environment. The students in Mr. Williams' seventh-grade social studies class are studying the different branches of government. The students are clustered into small groups of five to six students scattered throughout the room while there is a buzz of talking and typing emanating throughout the room. One cluster of students is gathered around a single computer, communicating in real time with their local congressman. Prior to sitting down at the computer, these students generated a list of questions to ask their representative and now are engaging in an interactive text-based discussion with her. As one student types, the other students take notes either in a traditional notebook or on a personal digital assistant (PDA).

Another group of students is gathered in the back corner, sitting at individual computer stations. The students are completing a web-based research assignment that Mr. Williams developed. The research assignment requires students to access specific Web sites to answer a carefully sequenced set of questions. The predetermined Web sites have been bookmarked, to help the students follow the activity with relative ease. A red cup sits next to each computer monitor. If the students do have a question, they know to place the cup on top of their monitor as a symbol to Mr. Williams that they need his assistance.

The third group of students is sitting on the floor in the front of the room. Each student has a PDA and folding keyboard in his or her lap. They are working together to write a collective essay about the roles and responsibilities of the different branches of government. The students, who outlined the essay as a group, each wrote individual sections of the essay to share with the group. Now, they are beaming their sections to one another. The assignment list that Mr. Williams prepared for them requires them to review each other's paragraphs and to work on developing a group conclusion.

The fourth group of students has pulled a group of desks together and is working on the laptops that Mr. Williams checked out from the school library. These students are working to edit a series of digital video clips they recorded. The students interviewed members of the community about the branches of government and are now editing the videos to create a documentary video to share with the class. All of the students in the group have an assigned role, such as script writer, editor, or interviewer that helps to ensure equal participation.

Whereas the scenario depicted above may be the dream of those high-tech teachers, it may be a nightmare for many teachers who are uncomfortable with managing the technology-infused classroom. This chapter addresses the managerial issues that teachers encounter as they attempt to use technology in teaching.

RESEARCH ON TECHNOLOGY AND CLASSROOM MANAGEMENT

Because computer technology use in classrooms is relatively new, little research exists to document how the introduction of technology affects classroom management. There certainly is no scientifically based research using random assignments to treatment and control groups to investigate how technology impacts classroom management issues and practices. Instead, there are a number of small investigations, typically using qualitative methods such as surveys, interviews, and observation techniques to examine the interactions between technology use and classroom management. Many of these small research studies are doctoral dissertations.

A number of these reports and studies describe how technology can be used to manage school and classroom records and information (McNally & Etchison, 2000; Kahn, 1998). Tools that can facilitate this type of classroom management include word processing, spreadsheet, database,

and draw-and-paint programs. These tools can be used to compute grades, track attendance, store lesson plans, provide classroom seating charts, and communicate with parents. Used in this way, classroom management refers to the use of technology to improve record keeping, to reduce paperwork, and to free up teachers' time to focus more on instructional activities and planning. The use of these tools will be addressed later in the chapter.

However, a less studied and written about aspect of classroom management and technology concerns how the introduction of technology into classrooms changes and affects the dynamics of the classroom. Only a few studies (Sandholtz, Ringstaff, & Dwyer, 1990; Dwyer, 1994; Xu, 2002; Gross, 2002) examine such issues as designing and maintaining the physical classroom environment, establishing and maintaining classroom rules and routines, interactions among students, interactions between teacher and students, academic engaged time, managing transitions among activities, and many other aspects of classroom management that are affected by the presence and use of instructional technologies. Dwyer (1994) reported that children interacted with one another more frequently while working at computers, and the interactions were different—the students spontaneously helped each other. They were curious about what others were doing and they were both excited about their own activities and intently engaged. The fear that students would become social isolates while working on computers was unfounded.

Gross (2002) identified the problem of managing technology in the classroom as one of the greatest challenges mentioned by the teachers in her study. Teachers were concerned about behavior problems developing when the teacher worked with one group of students at the computer, while another group of students was working on a different task. The teachers were also concerned about how to make use of one or two computers in the classroom. Gross discovered that as teachers became more comfortable with software and student grouping, classroom management became less of an issue.

Xu (2002) studied the implementation of an accelerated mathematics learning information system in a middle school special education program. Although the special education students engaged in considerable talking and off-task behavior while working in the more independent computer environment, the teachers suggested that the discipline problems were no more than those in a regular classroom. These teachers did develop behavioral contracts with students regarding the completion of their assignments, and they developed new rules regarding the use of the computers.

There are also reports of teacher concerns about classroom management when using technology, including fears that unruly students may damage expensive equipment, and concerns about moving children from classrooms to computer laboratories (Irving, 2003).

Reports of effective technology use in classrooms often describe how students actively engage with the technology in inquiry-based, knowledge-construction strategies. Because many traditional classrooms are teacher-centered and favor direct instruction methods, using technology effectively may require a paradigm shift to promote constructivist behavior—student problem solving, exploring the learning environment, conducting learning activities, and students' monitoring their own learning. This shift may threaten some teachers who fear a loss of control. Using technology effectively for instructional use requires considerable planning on the part of the teacher, with the ever-present potential malfunction of the technology looming in the background. Teachers need to perform the activity and test the equipment for possible problems before students become involved (Saurino, Bouma, & Gunnoe, 1999). Planning and managing the technology adds additional tasks to a teacher's already full plate. Teachers with poor or average classroom management skills may shy away from using instructional technology for fear of losing control of the classroom (Margerum-Leys & Marx, 2000). It is difficult for teachers to integrate technology into their instruction if they have poor classroom management skills because computers add another layer of complexity to classroom management

and to monitoring student work. "Teachers need multitasking skills when students are working with computer technology and the Internet" (Dertler, 2002, p. 78).

Apple Classrooms of Tomorrow

The largest and most comprehensive study on the introduction of computer technology into classrooms was the Apple Classrooms of Tomorrow project (ACOT), which involved 32 teachers and 650 students over a period of four years (Dwyer, 1994; Dwyer, Ringstaff, & Sandholtz, 1991). This project, begun in 1986 by Apple Computers, investigated how routine use of technology by teachers and students would affect teaching and learning. ACOT began work in seven classrooms representing a cross-section of America's K–12 schools. Each participating student and teacher was given two computers, one for home and one for the classroom, since at that time computers were big and heavy and the two-computer formula was the only way to ensure that students and teachers would have constant access to technology.

The overall outcomes of the ACOT project were quite positive. Cooperative and task-related interactions among students in ACOT classrooms were more extensive than in traditional classrooms. Children tended to use computers more, rather than less, as their competence with technology increased. Teachers acted more as guides and mentors and less like lecturers. Students became more active as they became peer tutors, led classes, and organized work groups. Students interacted often with one another while working at computers, spontaneously helping each other while displaying great curiosity about what others were doing. Teachers reported working harder and longer hours, but enjoying their work more and feeling more successful with their students.

Teachers altered the physical setup of their classrooms and modified daily schedules to allow students more time to work on projects. In elementary and middle grade settings, traditional recitation and seatwork were balanced with interdisciplinary, project-based instruction.

Absenteeism at one high school was cut in half, and 90% of ACOT graduates went on to college. These students routinely employed inquiry, collaborative, technological, and problem-solving skills uncommon to graduates of traditional high school programs (Dwyer, 1994).

Particularly germane to the topic of classroom management, Sandholtz et al. (1990) examined classroom management changes that occurred during the course of the ACOT project. Based on weekly reports sent via e-mail, correspondence between sites, and bimonthly audiotapes from teachers, data from 32 elementary and secondary ACOT teachers in five schools were collected over four years. Using qualitative analyses, the authors describe how teachers went through three management stages, described as "survival," "mastery," and "impact." In the "survival" stage, teachers were overwhelmed by their need to control student behavior, organize the physical environment, and redefine their role in the classroom. Teachers expressed anxiety about being unprepared to deal with such issues as students copying or stealing each others' disks. The addition of technology also meant that teachers had to cope with lack of space, inadequate lighting, and even weather that affected the computers. Broken equipment, noisy or bottlenecked printers, and software bugs added to the teachers' frustration.

During the second year of the ACOT program, teachers started to move into the "mastery" stage by beginning to anticipate problems in student behavior, classroom environment, and technology, and to develop strategies for solving them. Since the computers were the main source of both student attraction and misbehavior, many teachers started to restrict the use of computers. Teachers also addressed the variety of cheating schemes by implementing such strategies as confronting individual students, holding class discussions on ethics, and imposing grading penalties. Teachers also began using the technology to catch cheaters and prevent recurrences.

To deal with the physical space problems created by the addition of computers, printers, and cables, teachers rearranged classrooms to allow the greatest amount of free space, and developed systems for organizing and storing disks, printer papers, software, and other computer-related items. Teachers also began enlisting student assistance in setting up computers and furniture to save time. Teachers also developed rules for the use of printers to avoid the jamming of printers and reducing noise level. As teachers developed greater familiarity and expertise in the use of technology, increased levels of student engagement and motivation were reported, further decreasing management problems.

In the third and fourth years, the teachers began to enter the "impact" stage by successfully using the technology to manage the classroom rather than just troubleshooting. Teachers developed techniques for monitoring student work, keeping records, grading tests, developing new materials, and individualizing instruction. Technology began to save teachers time rather than requiring extra time. One school developed a format for preparing the students' Individualized Education Programs (IEPs) that simplified the process of creating these plans. The authors concluded that at the "impact" stage teachers had learned to use the technology to enhance student motivation, interest, and learning, and incorporated technology in their teaching so as to make the technology indispensable (Sandholtz et al., 1990, p. 35).

Other Research Studies

In a more recent study (Russell, Bebell, Cowan, & Corbelli, 2003), each student in three fourth-grade classrooms was provided with an AlphaSmart, a text-editing word processor. One surprising finding concerned classroom management. The researchers concluded that "when every student had the same resources, technology management was generally easier and less time consuming for teachers. To this end, the teachers who made the most extensive use of technology in their lessons found the greatest degree of improvement in general classroom management" (Russell et al., 2003). The ability to have all students use an AlphaSmart at the same time decreased the need for teachers to manage whose turn it was to use the AlphaSmarts and computers. This logistical improvement in the management of classroom technology was deemed one of the most important changes that resulted from students having full access to the AlphaSmarts. Further, students developed a greater sense of ownership, responsibility, independence, and empowerment. Full, rather than limited, access to technology greatly increases its use in classrooms.

Some of the classroom management problems cited by teachers may occur because students have limited access to the technology, and teachers have to control that access. Students may vie for this access, thus creating classroom management problems. As the Russell et al. (2003) study suggests, when students have unlimited access to the technology, some kinds of classroom management problems may diminish.

While some studies note that technology improves student time on task, other studies describe classroom management problems when using technology. One study on preservice science teachers' use of educational technology during student teaching (Irving, 2003) discovered that student teachers with lower achieving students expressed reluctance to use technology for fear of how their students would behave, especially in a computer laboratory. As one student teacher commented:

> It's stressful to get them to be quiet in the hallway, to get them to the computer lab is hard; when they are in the computer lab . . . they kept making the computers talk. They just don't behave. And when you're in the computer lab, you can't tell who's doing it. So I have no real control over them . . . I can't see whose computer is making the noise. (p. 212)

Another student teacher from the same study felt that immature, unruly students in her classes made it difficult for her to incorporate expensive and breakable equipment in her lesson plans. As she stated:

> We all have a lot of really immature, emotionally, behaviorally disturbed kids who just pick up, touch everything, throw it, break it, hit each other, run around, you know, jumping over desks . . . So the issue is equipment safety and meddlesome kids who just sit in the back and while . . . you're teaching your class they might be breaking something. (Irving, 2003, p. 213)

Three of the student teachers in this study expressed concern about low-achieving students' ability to stay on task, to engage with electronic technologies, and to treat equipment safely and with respect. On the other hand, three other student teachers from the same study, who also worked with low-achieving students, did not report difficulties with behavioral issues when using technology. One of them extolled the virtues of laptop carts as a way to differentiate instruction and tailor lesson plans for individual students (Irving, 2003).

Summary of Research Findings

Research concerning classroom management and the use of technology is scant, but that which does exist provides some insight into the intersection of these two topics. As the classroom context changes, so do the classroom management issues. When technology is first introduced into classrooms, management issues are likely to arise. When classrooms have only one or two computers, students are likely to vie for access to this equipment, and teachers have to develop rules regarding their use. In technology-rich classrooms, teachers must deal with issues related to the physical arrangement of the classroom to accommodate computers, printers, and other paraphernalia. As teachers become comfortable with the technology and develop more skill in its use, technology seems to save teachers time, rather than requiring additional time. Getting to this point, however, may take a couple of years.

Creative use of technology for instructional purposes also seems to lead to a different teaching style, one that is less teacher-centered and more student-centered. Many teachers are uncomfortable with this new role as guide or facilitator and resist integrating technology into instruction in a meaningful way. Teachers who struggle with classroom management issues are unlikely to embrace technology since it introduces more variables into an already complicated situation. Even those teachers who are skilled in classroom management will have to deal with issues such as managing access to the equipment, monitoring student time on task, and being alert to new forms of possible cheating.

TEACHER USE OF TECHNOLOGY FOR NONINSTRUCTIONAL ACTIVITIES

It has been documented that classroom teachers' most frequent use of technology is completing noninstructional activities (Becker, et al., 1999). Noninstructional activities include communicating with parents, providing student feedback on assignments, and engaging in professional development activities. Noninstructional activities are essential for creating an effective classroom learning environment; however, they detract from the amount of time teachers are able to spend directly interacting with students. Given that teachers spend more than 11 hours a week on noninstructional activities, technology that enables teachers to be more efficient is a welcome professional tool (Dockterman, 2002). When teachers spend time outside of the classroom for professional activities, they use a computer to assist them 97% of the time (Dockterman, 2002). Teachers find spreadsheets and databases and network

systems are effective technology tools that aid in streamlining noninstructional activities and facilitate communication and access to resources (Dockterman, 2002).

Software such as spreadsheet and database programs may be used to manage school and classroom records and information. A spreadsheet is a piece of software that allows users to arrange text or numbers in rows and columns. It allows users to enter data, much like data would be entered onto a ledger form. The data entered can be analyzed using formulas, charts, and graphs. Teachers report that they find spreadsheets to be a helpful classroom management tool by using it specifically to track student progress. For example, by entering student grades into a spreadsheet program, teachers can sort the grades to track one student's progress throughout a grading cycle or to compare all student grades on one particular assignment. Teachers can chose to track the scores either by listing the raw number or by creating different charts or graphs. Recording and organizing data in this manner not only enables teachers to streamline their paperwork, but it also is a helpful way to share student progress with parents and students. Spreadsheets also may be used to streamline teachers' noninstructional tasks, such as creating and maintaining a class budget, creating class lists, scheduling student projects, and keeping student attendance.

Much like spreadsheets, databases also can be used by teachers to record and organize essential classroom information. Teachers cite that the most frequent use of databases is recording student demographic data (Dockterman, 2002). For example, at the beginning of the school year, teachers will create a database that holds basic information such as student name, parents' names, contact information, birthday, and medical information. Once these data are entered into a database, teachers can use it for easy access to their students' home contact information or to create documents such as nametags or student lists.

Word processing software is another technology tool used by teachers to streamline their noninstructional activities. Word processing software enables users to edit, store, and print documents. It is an efficient way to make revisions and to save and file documents. Teachers' most frequent use of this software is to create lesson plans and instructional materials (Berson, Berson, & Ferron, 2002). Examples of instructional materials that teachers can create include worksheets, tests, lab reports, outlines, book report forms, and unit guides. In addition to creating instructional materials, word processing software can be used to prepare documents such as letters home to parents or class newsletters.

School networks, intranet or Internet, are another essential classroom management tool for teachers. School networks enable teachers to engage in professional communication with colleagues, parents, and students. An intranet system permits teachers to exchange information within the school building. For example, teachers may upload lesson plans or student information to the intranet to share with other teachers in the building. This not only is an effective way to share professional information, but it is an efficient way to track student achievement and behavior. By storing student grades and behavior on a school intranet, teachers can trace student grades or behavior issues over time and across classes. For example, a high school teacher having classroom behavior issues with a student can easily pull up the student's behavior chart to see if the behavior issues occur across all subject areas or just one class.

Access to the Internet assists teachers with classroom management much like a school intranet system, but because it is not limited to the school building, teachers have access to many more resources and people. The Internet has proven to be an effective tool for communicating with students, parents, and members of the community. It also is an effective research tool for teachers and provides professional development opportunities for teachers. Teachers report that e-mail access through the Internet provides them a flexible and efficient way to share classroom news with parents. The increased parental involvement and awareness with the school that results from frequent e-mail communication between teacher and parent has been shown to have a positive impact on student classroom behavior (Sumner, 2000).

TEACHER AND STUDENT USE OF TECHNOLOGY FOR INSTRUCTIONAL ACTIVITIES

Managing the learning environment when using technology also varies according to the configuration of the technologies. A teacher-centered lesson using a single computer with a display station calls for different classroom management than a student-centered classroom in which all students are equipped with wireless handheld computers and pursuing individual assignments. Issues that emerge from integrating a variety of technologies and their impact on classroom management are explored here, along with the implications of how instructional technologies are organized for managing the learning environment.

Of a different nature, as more courses and programs are offered online, instructors must manage multiuser virtual learning environments to provide for individual expression while also building a safe community. Among the issues arising from these virtual contexts are ways of establishing appropriate norms for student computer responses, monitoring appropriate language and potentially offensive language in online discussions, and responding to bullying or teasing of other online students.

Burns' (2002) two-year research study of technology integration into the classroom revealed that the primary reason teachers don't use computers in instruction is fear. Teachers reported a fear that using technology for instruction would disrupt the traditional classroom mores. This fear stems from the notion that computers hold the power to shift control from the teacher to the student. The research of Becker et al. (1999) substantiates this finding. The following section discusses classroom management issues and strategies related to specific technology classroom learning environments.

One-Computer Classroom

The function of a computer in a one-computer classroom may simply be teacher use for noninstructional activities such as those discussed in the previous section. However, there are varied and powerful opportunities to use the one computer for effective instructional purposes. Student use of the one-computer classroom has been likened to students lining up to drink water from a hallway drinking fountain (Anderson, 2004). The bottleneck created by this line of eager students is ripe for classroom behavior problems.

Ashmus (2004) outlines seven categories of usage for the one computer classroom. These categories and a brief description of how the one computer may be used in the classroom are listed in Table 20.1.

Classroom management strategies are essential for creating a successful learning environment in the one-computer classroom. Issues that must be considered are as basic as ensuring that the location of the one computer is appropriate for its intended use. Ashmus (2004) reminds teachers to check to be certain that the placement of the hardware ensures convenient access. Convenient access may be defined as a central location for classroom display for all students or as a center that is to the side of the classroom. Because students often will be working on the one computer on their own or in small groups, it is vital for teachers to be appropriately prepared. Being prepared requires teachers to pre-check the computer for all required software and to ensure that students have detailed directions to lead them through the assignment.

Beyond being prepared, teachers should consider specific instructional strategies that have proven effective for teaching in the one-computer classroom (Ashmus, 2004). Among these strategies are creating "trained experts" from the students in the class, asking the volunteers or parents to assist, implementing cooperative learning methods, rotating student computer time, creating standardized methods for saving student work, providing students with a template or checklist to guide them through the assignment.

TABLE 20.1
Uses of One Computer in the Classroom

Category	*Sample Usage*
Administrative Tool	Teacher uses for noninstructional activities
Presentation Tool	Teacher demonstrates key concepts or ideas or presents outline for student note taking
Communication Station	Teacher or students e-mail or videoconference with students/classrooms in other locations
Information Station	Teacher or students use the Internet or CD-ROM to conduct outside research
Publishing Tool	Teacher or students create class newsletter or brochure; students create project-based materials
Learning Center	Students use content-specific software for remediation, such as drill and practice
Simulation Center	Students use software to work through simulations or use guided directions to move through different resources

Multicomputer Classroom

Teachers who have access to multiple computers in the classroom typically design classroom instruction so that students either cluster around the computers in groups to complete the same assignment or set up a station model in which students rotate to different computers, completing a different task at each station. Burns' (2002) research of technology-enhanced instruction revealed a variety of classroom management patterns being practiced in the multicomputer classroom. She named and defined the four more prominent models as:

Learning stations model (13 students to 2 computers). Teams of four to five students are rotated through three different "learning stations" to gather data and information for their project. In one particular application of this structure, one station used a digital camera to gather images, another station used a simple electronic spreadsheet to analyze data, and a third station used printed materials about the community. Each of the stations had roles for every team member as well as instructions for completing the tasks at that station.

Navigator model (4 students to 1 computer). Using a road trip analogy, teams of four to five were assembled and given role cards. The "driver" controlled the mouse and keyboard, while the "navigator" helped the driver operate the computer. "Back-seat driver 1" managed the group's progress and "back-seat driver 2" served as the timekeeper. The navigator attended a 10- to 20-minute training session in which the facilitator provided an overview of the basics of particular software. Once trained, the navigators returned to their teams and instructed team members in the use of the software. The navigator could only give instructions, but could not touch the mouse or keyboard. The rest of the team rotated through "driving" the computer so that everyone had a chance to use the software.

Facilitator Model (6 students to 1 computer). This model was useful for carrying out more complex projects that required different skill sets and levels of expertise. The designated facilitator had some experience with the software in use and showed the most novice users (students) how to use the software application to create a layout for a final product. Like the navigator in the model just mentioned, the facilitator worked with the layout group, and the content group worked without a computer to create content for the newsletter or report. All group members, with the exception of the facilitator, rotated through the layout and content groups to ensure each member gained experience with the software and the content.

Collaborative groups model (7 students to 1 computer). In the collaborative groups model, each small group was responsible for creating some component of the whole group's final product. For example, one part of the group wrote a report, another created a map, and a third used the computer to gather census data and display it in graphs. (p. 36)

Classroom Lab

In the classroom computer lab, the ratio of student to computer is one to one. Given the influx of money that has been dedicated to student use of computers, one would expect teachers to be using lab-based computers more often for instruction. However, only 67% of teachers reported that they used the computer during class time (Technology counts, 2003). Teachers report that the number is not higher because they find it difficult to schedule time to take their classes to the school computer lab, they are fearful of losing control of their students in the lab, and they cite the inordinate amount of preparation time required for taking students to the lab (Burns, 2002). While these obstacles may be valid concerns for teacher avoidance of the computer lab, there are a number of guides and reports for teachers that list suggested strategies for effective classroom management in the computer lab. These guides often provide helpful classroom management tips for the classroom teacher.

Starr (2004) surveyed a team of education technology specialists to arrive at a laundry list of classroom lab management tips. The following is a sample of the innovative and helpful strategies.

- Always run through a technology lesson *before* presenting it to the class—and always have a back-up lesson prepared in case the technology fails.
- Type directions for frequently used computer operations—opening programs, inserting clip art, printing documents, and so on—on index cards, laminate them, and connect them with a circle ring. Keep a set next to each computer.
- Have students turn *off* their monitors when you're giving directions.
- Appoint classroom technology managers. Consider an Attendance Manager, who takes attendance and serves as a substitute teacher helper when necessary; a Materials Manager, who passes out materials and runs errands; a Technical Manager, who helps resolve printer and computer issues; and an End-of-Class Manager, who makes sure work areas are neat—keyboards pushed in, mice straight, and programs closed—before students are dismissed.
- If you have classes filtering in and out of a computer lab each day and have little or no time to set up between classes, arrange for older students to help. Even second graders can put in CDs and start programs for the kindergarteners who follow them. Simply end your lesson five minutes early and walk the older students through the process of setting up for the next class.
- When working on lengthy technology projects, print out step-by-step instructions. Include some that say "Save your work; do not go any further until you help your neighbors reach this point." This helps less-proficient students solve problems more quickly, keeps the class at roughly the same point in the project, and fosters collaborative learning.
- Make it a class rule that students can help one another but cannot ever touch another student's computer. That way, you can be sure that learning occurs even when students help one another.
- Keep a red plastic cup at each computer. When students need help, have them place the highly visible cups on top of their monitors.
- Before students leave class, have them turn their mice upside down so the trackballs are showing. You'll lose fewer trackballs that way.
- Place different colored sticker dots on the left and the right bottom corners of each monitor. Use these to indicate which side of the screen you are talking about—very

helpful when using certain programs, such as the new Kid Pix—and to determine whose turn it is if students share a computer.

- Plug all speakers into a main power bar. Turn the bar off when you're teaching and turn it on when students are working. If the room becomes too noisy, turn off the power bar to get students' attention.
- Use a Video Out card to project a monitor display onto a television screen.
- Type PLEASE WAIT FOR INSTRUCTIONS on 8½ by 11 papers, laminate them, and tape one sheet to the top of every monitor. Students flip the signs to the back of the monitor *after* you've given directions.
- Create a folder in the Start menu and place any programs you use with students in that folder. Students never have to click Programs—everything they use is in one folder.
- When working in a computer lab, assign each student a computer. Students can line up in "computer lab order" in their classrooms. Seating goes very quickly when they get to the lab.
- If you're working on a network, ask your technology coordinator to set up a shared folder for Internet resources. Then, when you're planning an Internet lesson, simply save a shortcut to the Web site in that folder. During lab time, students can go to the shared folder, double click the link, and go right to the site without typing the URL. This saves time and stress for both students and teachers.

Mobile Computing

Emerging technology trends suggest that schools are moving towards providing mobile computer access to all students (Dede & Ketelhut, 2003). Mobile computer options include either laptops, personal digital assistants (PDAs), or mobile phones for teachers and students. Laptops, PDAs, and mobile phones are becoming more and more popular among teachers and students because of their portability; however, other features make them invaluable tools. They often have wireless network capabilities, allowing users to access the Internet without being physically connected to the network. They also allow for easy file sharing. PDAs connect with a desktop computer, allowing the user to synchronize data.

The mobile computing configuration allows teachers to use computers in their own classroom setting and it provides one computer for each student. Terms such as "ubiquitous computing" or "pervasive computing" have been used to describe the phenomenon of the one-to-one computing model. This new trend of ubiquitous computing is considered the most recent stage in the evolution of technology, emerging form the eras of mainframe computers and desktop computers (Weiser, 1995). In other words, handheld computers will be everywhere, with every child using one in school and at home. Bull, Bull, Garofalo, and Harris (2002) compare the transition to "ubiquitous computing" with Moore's Law. Moore's Law originated with Gordon Moore, cofounder of Intel, who stated that computing power doubles every 18 to 24 months and, at the same time, the cost of computing is essentially halved. Price drops such as these will open the door to widespread one-to-one computing with mobile computing devices.

Mobile computing allows teachers a freedom of movement to better monitor and record classroom activities (Carter, 2004; Curtis, 2003). One teacher commented, "This freedom of movement allows me to be a better record keeper, better assessor; and hopefully, a better teacher" (Pride, 2003). Teachers also report that using mobile computers to document classroom behavior enables them to see a more "comprehensive picture of learning, yielding formative data that was [sic] useful in guiding the development of lessons and activities" (Pride, 2003).

Providing one laptop or one PDA for each student has been shown to be an effective way to provide access for all students, improve communication with parents, increase student motivation, and encourage student collaboration. In addition to these benefits, mobile computing initiatives have encouraged teachers to engage their students in inquiry-based learning activities

and to differentiate instruction for individual students. The Toshiba Laptop Learning Challenge by the National Science Teachers Association (1999) lists several advantages for using laptop computers in educational settings. Among these advantages area that laptop computers:

- Provide portability within the school, outside the classroom
- Provide portability for field trips and investigations
- Provide immediate data processing and graphic feedback
- Provide immediate feedback and analysis for decision making in the field
- Allow file sharing
- Facilitate group work and collaboration
- Generate reports and presentations
- Permit flexible and innovative uses
- Provide access to expert resources on the Internet or through e-mail

The use of mobile computers in the classroom can contribute to improved student classroom behavior. In a pilot laptop initiative, the student attendance rate increased and student discipline problems decreased. At one elementary school, detentions dropped from 28 to 3 among students who had laptops, suspensions decreased from 5 to 0, and 91% of the students with laptops improved their grades in at least one academic area (Profiles in success, 2004).

One laptop or one PDA for each student holds the potential of transforming classroom teaching and learning as we know it today. However, the possibility for classroom management challenges multiplies with mobile computing. Inappropriately surfing the Internet or damaging the computers are two examples of potential management problems. When teachers take measures such as designating "Think Time" or "Lids Down" time when students must direct their attention to the teacher, planning ahead for recharging batteries, bookmarking web addresses, and setting up shortcuts for software programs, classroom management issues in the mobile computing classroom can be relieved.

Teachers have found that they become more efficient in the mobile computing classroom. This newfound efficiency may be attributed to the ease of access that comes with using a laptop or PDA. Pride (2003) outlines four categories of ways teachers are taking advantage of ubiquitous computing in their classroom: calendar, address book, to-do list, and memo pad. Pride's account gives examples of how these applications affect classroom management. For example, the teacher who uses the calendar function on the mobile computer can set the alarm to indicate when students need to leave the classroom for individualized instruction or the teacher can keep a list of class activities and homework assignments so that when a student who is absent returns, she can simply beam the information to the student's PDA. The memo function on a PDA can assist teachers in a variety of ways. For instance, teachers can keep a memo list for each student, recording daily observations about student learning and behavior (Pride, 2003).

Mobile phones are another form of mobile computing. As mobile phones become more and more prevalent in today's society, students begin to bring them to school. For many teachers they may seem a hindrance; however, they are being used effectively in some classrooms. As with the other forms of mobile computers, mobile phones can lead to classroom management issues. These issues include issues related to Internet safety, student cheating, and student time off task. At the present time, many school systems and schools recognize these risks and have banned mobile phones from school settings.

There are, however, a number of educational uses for mobile phones. For example, teachers may prepare interactive quizzes, puzzles, or math problems that can be sent from the teacher to the students. The students can complete the assignment and then send the responses back to the teacher or to another classmate. Mobile phones also can be used to access the Internet. Thus, they become a rather inexpensive tool for voice, image, and video messaging for class

assignments, such as student study groups. Within this category of Internet uses is simple text e-mail messaging or instant text messaging. Teachers can create collaborative lessons that call upon students to share data such as photographs or text with students either within the same class or in another location. Additionally, individualized learning activities for students with special needs can be used to differentiate instruction. For example, audio and video supplements could be prepared (National Centre for Technology in Education, 2004).

It is essential that teachers follow school Acceptable Use Policies (AUPs) and have clear expectations for students before mobile phones are introduced into classroom instruction. Teachers should be familiar with the phones so that if there is an instance where students are not following classroom guidelines, they are able to track the student use of the mobile phone through phone options such as the list of recent calls or a transcript of the text messaging.

Assistive Technologies

Assistive technologies refers to the array of devices and services that help people with disabilities perform better in their daily lives. The Individuals with Disabilities Education Act of 1997 requires that assistive technology be considered when developing the Individual Education Program (IEP). A recent study concluded that many more Americans, besides those who have been categorized as having disabilities, can benefit from the use of assistive technology. The study estimates that 60% of working-age adults (101.4 million) are likely or very likely to benefit from the use of assistive technology (Forrester Research, 2003, p. 8).

Devices such as motorized chairs, remote control units to turn on appliances, voice recognition systems, and computers all can assist people with severe disabilities. Computers are particularly important in allowing many students with a range of disabilities to participate in normal classroom activities that would otherwise be impossible. The following are some examples of how computer technology can assist students with disabilities:

- User-friendly keyboard enhancements can simplify typing.
- A combination of lasers and computers can aid students to move a mouse and make selections on a computer display with eye movement alone.
- Voice recognition software can translate a student's spoken words into text on the computer screen, and text-to-speech allows a student to hear his words spoken.
- Computer-assisted instruction (CAI) is self-paced and individualized for each student's needs.
- Braille translation software and Braille printers enable blind students to read.
- Alternative keyboards with touch windows and switches are available for students with limited motor control.
- Screen-enlarging software can assist students who may have sight impairments.

Many such assistive devices exist for a variety of disabilities and more and more are being created.

Having pupils who need such technologies presents challenges for schools, teachers, and other students. The cost for purchasing appropriate assistive technology is always a challenge for school systems. Knowing what assistive technologies can help students, and learning how to install and use these technologies can challenge teachers. Students may consider the assistive technologies to be unfair advantages for some students, particularly those whose disabilities are less physically recognizable.

What is clear is that teachers must begin to understand and use assistive technologies to help students with disabilities, and even those who are not diagnosed as being disabled, to maximize their learning opportunities. Technology can open doors to learning for students whose opportunities to learn would otherwise be severely curtailed.

Virtual Learning Environments

Virtual learning environments, often referred to as distance learning, online learning, telecollaboration activities, or multiuser virtual learning environments, are learning experiences that allow students to interact with other via the Internet. Virtual learning environments present innovative learning opportunities for students, yet also present a new series of classroom management challenges for teachers. Online learning can take many forms in the classroom. The most prevalent model of online learning is based on the Virtual High School model. That is, individual or small groups of students from a traditional school enroll in a course sponsored by an organization outside of the student's school building. The course activities are primarily asynchronous, meaning that students and teachers do not engage in online discussion at the same time.

The typical student enrolled in a virtual class chooses to enroll to have access to course content unavailable in the local community. Beyond access to locally unavailable courses, students seek out online learning opportunities because of the flexibility to take classes anytime, anywhere, and to have the opportunity to engage in learning experiences with learners from around the globe. It becomes the responsibility of the student and the student's school to identify an appropriate time and place for online learning. Some schools have designated specific labs or individual computers in computer labs for use by students enrolled in online courses. It is important for teachers and students in the school to mutually agree on when and where online students should work on their online course assignments. Agreeing on the time and location will minimize classroom management issues.

Telecollaborative activities are another category of virtual learning environments that allow students to learn in ways not possible before the advent of the Internet. Harris (1999) defines telecollaboration as "an educational endeavor that involves people in different locations using Internet tools and resources to work together." (p. 55) Students engaged in telecollaborative activities may use e-mail to correspond with an expert, such as an archaeologist on an international expedition or with other students across the globe about the effects of global warming on their local community. Web-based discussion boards provide students the opportunity to engage in asynchronous chats with an author of the novel that they just completed reading. Synchronous chats through programs such as Instant Messenger allow students to collect and share local weather data with classrooms in other locations. Students can participate in real-time communication that allows audio and video through videoconferencing. An example is the Model United Nations project, in which students throughout the globe videoconference with one another to discuss and debate global issues. Multi-User Virtual Environment Experiential Simulators (MUVEES) are another category of technology that empowers students to communicate with others in geographically disparate locations. MUVEES engage students in virtual spaces that have been created for learning, such as virtual museums or historical situations (Dede & Ketelhut, 2003).

Because Instant Messenger and MUVEES link students with others in geographically disparate locations, they are two powerful technologies that allow students to learn in a way that was not possible when students were limited to resources and learning experiences within their schools and local communities. Yes, these two technologies can cause classroom management problems in the classroom. For instance, it is very easy for students to get off-task and engage in online conversation that does not relate to the assignment. This happens when students strike up conversations with the students or experts that do not relate to the assigned task or topic. Students may also use the tools to engage in conversation with friends who are not a part of the assignment. For example, a ninth-grade student who is assigned to have an Instant Messenger conversation about a collection of poetry with a ninth-grade student in another state, may choose to contact his friend who is home sick from school for the day rather than the student in another state. Teachers should address classroom management issues such as these before

students ever turn the computers on. There should be a clear set of classroom expectations and consequences related to online communication. Students should understand that off-task communication is not permitted, why it is not permitted, and what the consequences will be. Teachers should monitor students' online communication by ensuring that student computers are positioned so that a teacher can easily circulate around the room and view what is on each computer screen. Teachers may also require students to print out a transcription of the online discussion. Printed transcripts allow teachers to ensure that students stay on task and also help teachers stay in touch with what students are learning from the activity.

Internet Safety

Telecollaborative activities provide students with powerful learning opportunities. Yet, they present teachers with a new set of classroom management issues. These issues reveal the dark side of technology, such as hacking, false information, cyber bullying, child pornography, child molestation, and kidnapping (Berson et al., 2002).

The majority of Internet safety issues that occur are a result of student interaction with people they do not know over the Internet. Rather than prohibiting student communication over the Internet, teachers, parents, and students should be aware of and discuss Internet safety issues before engaging in telecollaborative activities. One of the most significant features of communicating online for all Internet users is the ability to communicate anonymously. Internet users often use different screen names and give false information about themselves online. Internet users, specifically teenagers, create false personas and engage in an online fantasy world. For many teenagers, this is a way for them to escape from the difficulties of adolescence and try out different personalities. However, this practice is extremely dangerous and most teens do not understand the consequences (Berson et al., 2002). Teachers should talk with students about what information is acceptable to share over the Internet and with whom the students should be communicating. Teachers should actively monitor the students' computer screens when students are online and read excerpts of all online discussions.

Accessing inappropriate materials is another peril of using the Internet. Students may inadvertently come across Web pages that contain sexual, violent, or simply inaccurate information. Many school systems use filter software that prohibit access to inappropriate Web sites. However, none of this software is 100% effective. Again, teachers should consistently monitor student computers and should talk with students about what they should do when the access inappropriate Web sites.

Most schools have Acceptable Use Policies (AUPs) that oversee student use of the Internet. AUPs serve three primary functions: to educate students, parents, and teachers about Internet; to define boundaries of online behavior; and to specify the consequences of online misconduct (CoVis, 2004). Presenting an AUP to students and parents is the first step in developing an awareness of Internet safety. This awareness begins with the acknowledgment that there is inappropriate information on the Internet and there are dangerous people lurking in the shadows of online communication. From this awareness, there should be an educated discussion about the consequences of dangerous Internet activities and the steps one should take to avoid them.

CONCLUSION AND RECOMMENDATIONS

The literature reviewed in this chapter may be organized into two categories: descriptive and research-based. The majority of the literature that has been published about classroom management and technology is descriptive and exploratory. There are a large number of publications and Web sites dedicated to this topic. We attribute this to the fact that classroom teachers

are grappling with how to create effective learning environments with the emergence of new technologies in their classrooms. The second category of literature is research related to the topic. There are relatively few published studies related to the nexus of classroom management and technology. Those that do exist are often small studies or doctoral dissertations. The lack of research studies is most likely attributed to the fact that computer technology use in schools is a relatively new phenomenon and scholars in the field are just beginning to recognize the need for such studies.

Because so little research exists on classroom management issues related to the use of technology, there are many areas where research can inform our understanding of effective practice. The following are but a few potential research topics and questions.

Relationship of Effective Classroom Management Skills and Use of Technology

A few studies suggest that teachers who are already effective managers may be more inclined to use technology in their classrooms than teachers whose classroom management skills are weak. Similarly, Irving's dissertation study (2003) found reluctance among intern teachers to use technology with certain classes because the teachers were fearful that rowdy students might damage expensive equipment. Further exploration of the relationship between teachers' classroom management skills and disposition to use technology would be worthwhile.

Relationship of Student Time-On-Task Using Technology and Classroom Organization and Teacher Monitoring

This field would benefit from numerous observational studies of teachers who are effective in keeping students academically engaged when using technology to see how their classrooms are organized, how they prepare students for the task at hand, and how they monitor student behavior. For instance, are the well-known constructs of Jacob Kounin (*withitness, smoothness, momentum*) major predictors of student on-task behavior when using technology, or are there other explanations for a teacher's effectiveness? Are there physical arrangements of computers in a classroom that are more effective in keeping students on task than other arrangements?

Transitions To and From Technology Use

Transitions from one activity to another often result in wasted time and potential disruptions. It would be fruitful to study these transitions to learn how to best structure transitions to and from technology use. Questions to be investigated include: Are transitions to computer technology use similar to or different from other kinds of activity transitions? What procedures do effective teachers use to keep transitions brief and nonintrusive? What can teachers do to ensure smooth transitions?

Given the unique nature of researching classroom management and technology, efforts should be made to conduct collaborative research, that is, research in which scholars and practitioners partner to better understand the relationships between classroom management and technology. Collaborative research would help to bridge the gap between theory and practice. It would provide researchers with an entrée into understanding how classroom teachers are adapting and inventing classroom management techniques as new technologies emerge. Collaborative research would also provide practitioners with the opportunity to engage in self-study opportunities and would help them to refine and improve their own classroom management strategies.

Based on this review, it is our recommendation that traditional textbooks on classroom management should begin to address the issue of technology and how its introduction affects

classroom management dynamics. Additionally, teacher education programs should incorporate technology and classroom management issues into preservice teacher education experiences. It is also our recommendation that as school systems develop technology-based professional development activities for inservice teachers, they should incorporate classroom management strategies for teachers into the staff development. By this we mean that when teachers are introduced to a new piece of hardware or software they should not only learn how to use it, but also should learn classroom management strategies connected with its use.

The research also indicates that teachers need time to go through "stages" of using technology before they become comfortable with it and can actually start saving time through its use. Also, students have certain needs, according to Glasser (1999) (survival, love and belonging, power, freedom, and fun), and teachers should recognize and take advantage of these needs vis a vis computer use. Glasser maintains that inappropriate behaviors by students are often misguided efforts to achieve power, which he uses synonymously with "self-esteem" and "self-importance." Teachers need to address this need for power by combining the needs of students with classroom assignments or activities. By understanding and incorporating basic human needs into the classroom structure, the more students will be convinced that their schoolwork satisfies their needs, the harder they will try and the better work they will produce. Organizing computer technology assignments to allow and encourage learning teams and to give students opportunities to fulfill needs for power or self-importance will help to establish an effective classroom management system and reduce undesirable attention-getting behaviors. Dwyer's findings (1994) support Glasser's choice theory, particularly in relation to feelings of power, belonging, freedom, and fun. Dwyer discovered that students spontaneously organized collaborative work groups around their computer assignments. They often had to be chased out of classrooms at recess, and frequently worked with their peers after the formal end of the school year. Working with the computer technology seemed to fulfill a number of these students' basic needs.

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REFERENCES

1999 Toshiba/NSTA laptop learning challenge. (1999, 2004). Retrieved March 23, 2004, from http://www.nsta.org/programs/laptop/

Anderson, W. (2004). That's not a drinking fountain or how to survive in a one computer classroom. Retrieved March 23, 2004, from http://www.ncrtec.org/tl/digi/onecomp/

Ansell, S. E., & Park, J. (2003). Tracking tech tends. *Education Week*, *22*(35), 43–44, 48.

Ashmus, D. (2004). But I don't have a computer lab! Using one computer in the classroom. Retrieved March 22, 2004, from http://www.serve.org/seir-tec/present/onecomptr.html

Becker, H. J., Ravitz, J. L., & Wong, Y. (1999). Teacher and teacher-directed student use of computers and software. Retrieved March 23, 2004, from http://www.crito.uci.edu/tlc/findings/computeruse/html/startpage.htm

Berson, I. R., Berson, M. J., & Ferron, J. M. (2002). Emerging risks of violence in the digital age: lessons for educators from an on-line study of adolescent girls in the US. Retrieved March 23, 2004, from http://www.ncsu.edu/meridian/sum2002/cyberviolence/index.html

Bull, G., Bull, G., Garofalo, J., & Harris, J. (2002). Grand challenges: Preparing for the technological tipping point. *Learning and Leading with Technology*, *29*(8), 6–12.

Burns, M. (2002). From black and white to color: Technology, professional development and changing practice. *THE Journal*, *29*(11), 36.

Carter. (2001). Laptop lessons: Exploring the promise of one-to-one computing. Retrieved March 23, 2004, from http://www.techlearning.com/db_area/archives/TL/200105/laptops.html

CoVis. (2003). What you need to know about acceptable use policies. Retrieved March 23, 2004 from http://www.covis.nwu.edu/info/network-use-policy.html

Cuban, L. (2001). *Oversold and underused: Computers in the classroom.* Cambridge, MA: Harvard University Press.

Curtis, D. (2003). A computer for every lap. Retrieved March 23, 2004, from http://glef.org/php/article.php?id=Art_1032

Dede, C., & Ketelhut, D. (2003). Designing for motivation and usability in a museum-based multi-user virtual environment. Retrieved March 23, 2004, from http://muve.gse.harvard.edu/muvees2003/documents/DedeKetelMUVEaera03final.pdf

Dertler, K. E. (2002). Factors which affect middle school teachers' willingness to utilize technology as an instructional tool. (Doctoral dissertation, LaSierra University, Riverside, CA). Retrieved from the Digital Dissertations database. Publication No. AAT 3055178 unpublished.

Dwyer, D. (1994). Apple classrooms of tomorrow: What we've learned. *Educational Leadership, 51,* 7.

Dwyer, D. C., Ringstaff, C., & Sandholtz, J. H. (1991). Changes in teachers' beliefs and practices in technology-rich classrooms. *Educational Leadership, 48*(8), 45–52.

Forrester Research, Inc. (2003). *The wide range of abilities and its impact on computer technology.* Research study commissioned by Microsoft Corporation. Cambridge, MA.

Glasser, W. (1999). *Choice theory.* New York: HarperCollins.

Gross, D. (2002). An analysis of perceptions of factors that influence microcomputer use in three urban public schools. (Doctoral dissertation, Wayne State University, Detroit, MI). Retrieved from the Digital Dissertations database. Publication No. AAT 3071785 unpublished.

Harris, J. (1999). First steps in telecollaboration. *Learning and Leading with Technology, 27*(3), 54–57.

Irving, K. E. (2003). Preservice science teachers' use of educational technology during student teaching. (Doctoral dissertation, University of Virginia, Charlottesville, VA). Retrieved from the Digital Dissertations database. Publication No. AAT 3097272 unpublished.

Kahn, J. (1998). *Ideas and strategies for the one-computer classroom.* (Report No. BBB27495). Eugene, OR: International Society for Technology in Education. (ERIC Document Reproduction Service No. ED421981)

Margerum-Leys, J., & Marx, R. W. (2000, April). *Teacher knowledge of educational technology: A study of student teacher/mentor teacher pairs.* Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA. (ERIC Document Reproduction Service No. ED442763)

McNally, L., & Etchison, C. (2000). Strategies of successful technology integration. Part 1. *Learning and Leading with Technology, 28*(2), 6–12.

National Centre for Technology in Education. (2004). Mobile phones. Retrieved March 23, 2004 from http://www.ncte.ie/ICTAdviceSupport/AdviceSheets/MobilePhones/

Pride, C. (2003). *Handhelds in the classroom—tools for teachers.* Retrieved March 23, 2004, from http://www.techlearning.com/story/showArticle.jhtml?articleID=12803444

Profiles in success: *Maine learning technology initiative.* (2004). Retrieved March 23, 2004, from http://www.apple.com/education/profiles/maine/

Russell, M., Bebell, D., Cowan, J., & Corbelli, M. (2003). An AlphaSmart for each student: Do teaching and learning change with full access to word processors? *Computers and Composition, 20,* 51–76.

Sandholtz, J. H., Ringstaff, C., and Dwyer, D. C. (1990). *Teaching in high-tech environments: Classroom management revisited.* Paper presented at the annual meeting of the American Educational Research Association, Boston. (ERIC Document Reproduction Service No. ED327172)

Saurino, D. R., Bouma, A., & Gumnoe, B. (March, 1999). *Science classroom management techniques using graphing calculator technology: A collaborative team action research approach.* Paper presented at the annual meeting of the National Association of Research in Science Teaching, Boston. (ERIC Document Reproduction Service No. ED429828)

Starr, L. (2004). Managing technology: Tips from the experts. Retrieved March 23, 2004, from http://www.education-world.com/a_tech/tech/tech110.shtml

Sumner, S. (2000). Parent communication? Try a classroom web page. Retrieved March 23, 2004, from http://www.4teachers.org/testimony/sumner/index.shtml

Technology counts: Leveraging education. (2003). Retrieved March 22, 2004, from http://www.edweek.com/sreports/tc03/

Weiser, M. (1995). Ubiquitous computing movies. Retrieved March 23, 2004, from http://www.ubiq.com/hypertext/weiser/UbiMovies.html

Xu, C. (2002). Teaching mathematics: Implementation of a learning information system in a middle school special education program. (Doctoral dissertation, University of Nebraska, Lincoln, NE.). Retrieved from the Digital Dissertations database. Publication No. AAT 3074113 unpublished.