AN ANALYSIS OF THE USE OF THE COMPUTER AS A DELIVERY SYSTEM IN THE INSTRUCTIONAL PROCESS

by

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ABSTRACT

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The use of computers in today's educational setting is a topic of much research, teacher concern, and national, state, and district level discussion. Topics of concern include optimum numbers of computers, the placement of these machines in the school building, and how to use them to their best advantage.

The purpose of this study was to review, analyze, critique, and draw implications from current literature on the application of computers in the schools. The information found in this study was used to formulate a set of recommendations for Princeton School District and the future of computer use there.

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CHAPTER I

Introduction

The use of computers in today's educational setting is a topic of much research, teacher concern, and national, state, and district level discussion. Many people believe in the notion that "more is better" and consequently vote to allot funds to more and more computers on site, more software application purchases, and more teacher education in the use of these applications. Others feel that it is not the number of dollars spent on computers that is important, but how the computers are integrated into the already existing curriculum (Dias, 1999). Research shows that the use of computers in schools has continued to evolve since their limited introduction in the early 70's. While at first teachers were, in a sense, "scared away" from computers by complex instruction in BASIC programming language, are they now scared away by time constraints, students knowing more than they do, and lack of training in what "integration" actually means? Some research suggests that exemplary technology-using teachers are using technology in the classrooms in ways that are constructivist (Berg, Benz, Lasley, & Raisch, 1998). Others agree by implying that to fully integrate the computer across the curriculum as a partner to the thinking curriculum, it would involve a radical change to the curriculum structure itself (Matos, 1999). Are current teachers willing to change their teaching styles in such a "radical" way in order to help their students construct meaning out of the world around them, and, as a result, adapt constructivism? Are districts willing to aid and support teachers in this process of growth?

Since the introduction of computers into the school setting, teachers have made an effort to become skilled in their use. Some teachers instinctively saw the great

educational potential of computers and worked to become knowledgeable about them. How did they go about this pursuit of knowledge? Did they go to workshops, classes, and in-services, or did they learn on their own through a process of trial and error? Which of these processes produced the greatest results, and why didn't all teachers take part? Why are many computers still collecting dust or just used to keep early finishers occupied during class? Some research suggests that teachers need more structured time to develop skills working with new technology-based educational tools (Warner & Atkins, 1999).

When teachers do use computers, what are they doing with them? A great number of computer software applications have been developed in the past thirty years. Which applications do teachers use most often with their students? Which applications do the teachers believe to be most important? Are there any discrepancies between what teachers believe to be most important and what the students actually are using? The answers to these questions will help determine the direction of future software purchases.

Other questions arise as to the actual benefits of computers in the classrooms. While the majority of the research is positive, there are critics to the use of computers in the elementary school. One group, the Alliance for Childhood, argues that Americans have been hoodwinked by the bells and whistles of ever-evolving educational technology products and their surface appeal to the instructional process (Branch, 2000). This group believes that computers should not be introduced to children until their last years of elementary school or later. Then there are the questions of optimum computer placement. Should the computers be in the classrooms, or should they be grouped together in a lab setting? What do teachers prefer, and which situation results in higher-quality computer usage?

As thousands of dollars are being spent on technology annually at local levels, major decisions need to be made concerning the direction of technology implementation. Questions need to be asked about present computer use before future directions and goals can be established. Administrators need to determine computer comfort and competency levels of their teachers in order to provide adequate in-servicing to address needs and concerns. Teachers need to be asked about computer applications with which they've had success and consider to be important for their students to master. Equipped with these answers, administrators, teachers, and parents will then need to collaborate in developing district technology standards and scope and sequences of when and how each objective can be obtained in the K-12 regular curriculum. Only after these needs have been addressed can schools move on into the future of technology.

Purpose of Study

The purpose of this study is to:

1) Review, analyze, critique, and draw implications from current literature on the application of computers in the schools and,

2) Formulate a set of recommendations for the Princeton School District based upon what is found in the literature.

CHAPTER II

Review of Literature

The computer as an educational tool has grown in popularity during the last three decades. Where once computers took up entire rooms, now there are laptop and palm versions available. Where once information was punched out on index-type cards, now much more information can be stored on ever-smaller CD-ROMs and floppy disks. As computer size has decreased, so has price, to the point of being affordable, even to small school districts and average-income families. Now that computers are the norm in most schools, one needs to step back and study their use. It needs to be determined whether or not they are, in fact, aiding in the educational process. It will be concluded in this paper that computers can be very beneficial to the educational process, particularly when integrated into the regular curriculum in a constructivist manner.

The first section of this chapter will focus on the progress of computer use as a delivery system in the teacher-learning process. In the second section, common computer applications now being used will be specified. In the third section, research on the criticisms of computer use by children will be shared, while in the fourth, exemplary uses in the integration of computers in the school setting will be discussed. The next section will deal with teacher training in the use of technology. Finally, in the last section of this review of literature, computer placement concerns will be explored.

Progress of Computer Use in Schools

The use of computers in schools has escalated in the last decade. Throughout the 20th century, our attitudes toward technology have changed . . . from wariness to

acceptance to selective voting with our dollars for what we think is significantly better, faster, smaller, lighter, easier to use, and more appealing to the eye (Ditlea, 2000). Where once a school was considered to be on the leading edge of technology if they had a lab of Apple IIe's, now having a number of PC and/or Mac labs is closer to the norm. Data from the National Center for Education Statistics showed approximately six students per instructional computer in public schools in 1998 ("Internet Access," 1999). The proportion of schools with Internet access has also increased rapidly-- from 35% in 1984 to 89% in 1998 ("Internet Access"). Not only is one finding more computer technology available in schools today, but students are also using it more. Statistics show that the percentage of 4th graders using computers at home or school to write stories or papers has risen from 23% in 1984 to 79% in 1996. Even more dramatically, the same statistic for 8th graders has jumped from 15% to 91% ("Condition of Education," 1998). It appears that computer use is here to stay, and consequently, teachers must set the instructional stage in ways that support these new learning environments.

Common Computer Applications

Ever since the development of the personal computer, claims have been made concerning the potential of computers as educational tools. Tikhomirov (cited in Matos) stated that just as the development of gasoline engines provided a tool for human physical activity, so the development of the computer provided a tool for mental activity . . . Tools are not just added to human activity; they transform it. This section will discuss the use of common computer applications as teacher tools, student tools, drill and practice tools, and finally, as curricular, or "transforming," tools. The section will conclude with a discussion of the evaluation of software applications.

Computers hold remarkable promise for teachers in terms of their day-to-day tasks. Much of the work of teaching involves record keeping, searching for new information, and creating collections of teaching material, as well as providing individual instruction (Provenzo, Brett, & McCloskey, 1999). Computers are valuable tools in accomplishing these tasks. Many schools are networked with attendance and grade information punched in daily and immediately available to office personnel and administrators. Many teachers use spreadsheet programs from Claris Works or Microsoft Works, or "packaged" programs such as Grade Quick to average student grades and report them to parents. Database programs help keep a teacher organized and make mail-merges and labels for home communication possible. Desktop publishing programs such as Adobe Pagemaker and Word Perfect allow for the creation of professional looking class newsletters, while word processing programs help the teacher to make and easily modify worksheets, handouts, and tests. Presentation software such as Hyper Studio and Microsoft Office's PowerPoint application provide teachers with opportunities to create interesting multi-media presentations that can be modified and reused from year to year. The World Wide Web provides teachers with up-to-date information that may be difficult to find elsewhere. Many teachers have begun to communicate with parents via e-mail. With all these potential uses, computers have become time-savers and have enhanced the teaching profession.

While the computer has aided in the day-to-day tasks of the teacher, the same is true of the student. The computer as a student tool has virtually replaced the typewriter of old. Instead of taking "typing" classes in high school as was the case just a decade or two ago, students now learn "keyboarding" already in the elementary grades. There are

keyboarding texts and keyboarding programs such as Kid Keys, Mario Teaches Typing, and Read, Write and Type to help children learn this valuable skill. Students as young as first grade use Microsoft Word, Claris Works, and Kid Pix to publish and illustrate their stories. Older students are taught to work with database, spreadsheet, and desktop publishing programs to accomplish their educational goals. Just as teachers use the World Wide Web to find information, students are also being taught to do searches to find answers to their questions. Teachers are exposing their students to the Internet for the wealth of information that can be found on it. Most textbooks and school libraries do not have the up-to-date information that new technologies are able to provide. It is noted, however, that educators don't necessarily perceive the internet as a replacement of traditional texts, but instead view it as an additional resource for students to use (Karchmer, 2000).

Computers have also traditionally been used as drill and practice tools. Drill and practice courseware programs are designed to provide immediate corrective interventions in the learning process when continuously monitored performance measures indicate incorrect responses (Beyer & Apple, 1998). Software applications such as Word Munchers, Number Munchers, and Math Blaster are fun, interactive programs used to expand students' reading, grammar, vocabulary, and math skills. Students are able to return to these programs to work multiple times on skillbuilding without some of the problems of paper and pencil drill and practice exercises. These programs also have "levels" that teachers can pre-set for students of varying abilities. Educators have known for a long time that technology can help students learn basic skills (McNabb, 1999). Skills such as addition and multiplication facts require numerous repetitions before

mastery is attained for some students. A fun, interactive, game format may be just what these students need. Consequently, there is a place for such programs in the classroom, but a rather small place (Roberts, Carter, Friel, & Miller, 1988).

The fourth, and most important, emerging use of computers in the schools is that of a curricular tool. This consists of software based on constructivist models which provide the students with the opportunity to construct knowledge and understanding through interaction with the computer. Students integrate new ideas into their prior knowledge to make sense or meaning. They use computers as cognitive tools or to produce student media (Dias, 1999). Simulation software such as Sim City, Oregon Trail, and Where in the World is Carmen Sandiego? require students to make decisions, and they receive feedback based on the decisions and plans they put into effect. Students are put into situations in which they have to both initiate new ideas and compare and evaluate different and unique results (Roberts et al, 1988). The Kid Pix application also fits under this "constructivist" umbrella. Because the program is open-ended, the children decide how to make the best use of the program and tools it provides in order to achieve their own goals. When used as a curricular tool, computers, through their power to simulate, can create engaging real-world environments in which students can use academic skills to explore multifaceted, multidisciplinary problems (Roberts et al, 1988).

Because computer software and the site licenses required to network programs is so costly, it is important to carefully evaluate purchases in advance. First, one should consider the program content and decide whether or not it is consistent with the school's instructional objectives. Next, the methodology should be studied. Is it based on sound learning theory? Does it use behaviorist models or open-ended, constructivist

approaches? Finally, one must evaluate the actual utilization. Is it user-friendly? Can children run the program on their own or with little assistance? If it is a drill and practice application, can it be stopped at any time? Can students re-enter where they left off; and can teachers change the parameters? All these factors should be studied before making major software investments.

Criticism of Computer Use

While the number of computers in schools continues to grow, the amount of literature criticizing the use of computers in schools also continues to grow. The main focuses of criticism are in the areas of software application quality and the use of the internet.

Opponents to computer use in the elementary school ask that one take a critical look at each software application used and whether or not it really aids in the learning process. Many see current uses of computers as inadequate, often driven by technology issues rather than learning issues ("Future of Learning," 1999). Just because children--particularly young ones-- are performing tasks that look technologically sophisticated, does not mean they are learning anything important. Moreover, the activity inevitably takes time and attention away from other types of learning (Healy, 1998). Healy goes on to suggest that we should temper our enchantment with a critical look at whether anything educational is really being accomplished. The characteristics of drill and practice courseware, for example, legitimize behavioral performances over other types of educational goals . . . . This may be adequate for beginning skill building but may mitigate against higher levels of learning (Beyer & Apple, 1998). Other problems center on the longevity of computer software applications. According to Stoll (1999), today it's

impossible to keep up with the latest software releases. Computers are sold with pre-installed programs; within a year at least some of them become obsolete. Within a few years, the disk cries out for updates. The Alliance for Childhood, in their criticism of computer use in the elementary schools, states that the focus should be on nurturing a child using connection with other people and with real objects, like crayons (Mendels, 1999).

More criticism is centered on the quality of CD-ROM and web "books." One author compares them to comic books: Flipping through these old comic books, I'm struck by their resemblance to today's educational multimedia. Dialogue gets condensed, soliloquies abbreviated, characters dropped. The main element on each page is pictures; words are inserted almost as a second thought (Stoll, 1999). Stoll has similar criticisms regarding CD-ROM encyclopedias when he states that these software encyclopedias, so rich with pictures, have almost no depth. The unfortunate fact is that people, both children and adults alike, neither like nor expect long, densely written texts on their computer screens. What actually sells these programs is the glitzy animation and pretty, life-like pictures.

Similar criticisms arise concerning the use, by children, of the World Wide Web. The main complaint, by far, is the amount of advertisements that students are subjected to. According to Stoll, it's impossible to browse the web without swimming a river of flashing advertisement. While search engines were designed to aid in surfing the web, they deliver as much misleading information as they offer useful pointers. Their searches lack depth and breadth: The search engines typically ignore between 60 and 90 percent of all web pages (Stoll, 1999). Another problem with the web is the longevity of web sites.

Web sites come and go like champagne bubbles-- last week's hot site is today's file-not-found error. Information ages faster than software (Stoll, 1999). While many are convinced that the internet and the Web can improve education, one is urged not to over-extol its value. True education requires interchange and discussion. We need to remain cognizant that effective education requires experts to guide students through the process of learning (Mendels, 2000).

In conclusion, school districts must give serious consideration to criticisms concerning software application quality and the use of the World Wide Web. Districts must ponder whether we are weakening an entire generation of young people by prematurely distracting-- almost hypnotizing them-- with the clever capabilities of digital technology (Branch, 2000). Schools must be careful that poor implementation of software doesn't turn learning time into trivial game-playing (Healy, 1998). Those in charge of software purchasing must realize that software design and production is big business with substantial profits to be made in the computer industry. Unfortunately, as Beyers and Apple (1998) see it, if it can be packaged to fit computerized instruction, it will be, even if it is inappropriate, less effective than the methods that teachers have developed after years of hard practical work, or less sound educationally or economically.

Exemplary Use of Computers

There is a continually growing amount of literature concerning the future of computer use in the elementary schools. Much of this literature concludes that computers do play an important role if used in a constructivist setting and smoothly integrated into the existing curriculum. These exemplary uses will be discussed in this section.

According to Brooks and Brooks (1999), the main goals of constructivism are that students take responsibility for their own learning, become autonomous thinkers, develop integrated understandings of concepts, and pose--and seek answers to--important questions. The computer can be a powerful tool in this quest. It can provide a highly interactive environment in which students discover their own knowledge ("Future Of Learning," 1999). If this is to occur, however, the teacher has to learn to accept and embrace a new role, that of facilitator. According to Sprague and Dede (1999), the teacher no longer has to be in charge every minute, but can give some control over to the students and the technology. In a recent study by Berg et al. (1998), exemplary technology use in elementary classrooms was identified and described. What was discovered was that many of these exemplary technology uses were consistent with constructivist thought. Students were found to be using technology as a tool to explore new information and produce new products. Students were actively engaged in learning, processing new information and "making it their own." Berg et al. further discovered that technology coordinators in their study saw authoring multimedia presentations, using the Internet, research, writing and desktop publishing, and problem solving as the most important uses of technology. When students are assigned to attack a problem of their own choosing and develop a hypermedia presentation around it, they embrace this problem as their own and are intrinsically motivated to produce quality work. Hypermedia is a new term for multimedia authoring tools which combine text, sound, animation, and graphics to create reports or projects. Because the use of hypermedia almost inevitably puts the student in charge of developing a project and constructing both

knowledge and problem-solving strategies, it is one of the applications that may most drastically change education as we know it (Healy, 1998).

Just as important as constructivism in the future of computers in the school, is their integration into the already existing curriculum. Linking technology with core instructional objectives is what makes good, effective use of technology (McNabb, 1999). Current thought is that within the context of teaching a specific concept, technology tools will be used when appropriate. When students need instruction on how to use the technology, the teacher can use the curricular context to teach the needed technology skills, and then return to curricular instruction using the technology as a tool to enhance the learning. At the Secretary's Conference on Educational Technology in Washington, D.C., in July of 1999,

> several school district representatives reported replacing student technology competency requirements with technology/content area integration standards as a basis for benchmarking grade-level technology integration. Their rationale was that this shift emphasizes technology's supportive role in teaching and learning rather than making technology use an end in itself. (McNabb, 1999)

Dias (1999) also sees computer use as just one part of the daily activities taking place in the classrooms. She states that technology is integrated when it is used in a seamless manner to support and extend curriculum objectives and to engage students in meaningful learning. Her gauge of technology's success is whether or not it enriches an activity or helps students to demonstrate what they know in new and creative ways. Why is

computer integration a “better” approach to literacy? Lockard, Abrams, & Many (1994) offer four reasons:

> First, integration puts the emphasis squarely where it belongs: on the curriculum, not on the computer. Second, there is no need to add new objectives to the school’s curriculum to deal with computers. Instead, existing objectives are enhanced with computer applications. . . Third, the computer becomes a partner, not a competitor. Any lingering fears that teachers may be displaced by computers can be vanquished. Fourth, integration treats the computer in a natural way, as one fundamental tool for learning and living.

Technology is not the key to the learning experience, according to Sprague and Dede (1999), it is just the infrastructure that makes (a teacher’s) efforts productive and sustainable. The key to an effective learning experience is the student-centered, meaningful, and engaging experience itself. Classrooms where students are fully engaged in meaningful learning using a variety of instructional technologies to meet their goals are electrifying. However, technology integration is a growth process. It takes time. . . It can take years to complete the process (Dias, 1999). Among recommendations found for effective integration was this:

> For the technologies to be used optimally, teachers must be comfortable with a constructivist, or project-based, problem-solving approach to

> learning; they must be willing to tolerate students' progressing independently and at widely varying paces; they must trust students to sometimes know more than they do and to take on the role of expert teacher and they must be flexible enough to change directions when technical glitches occur (Foa, Schwab, & Johnson, 1996).

To effectively integrate technology into the curriculum takes time, teacher dedication, and creativity, but it is necessary, since learning about our world is inherently interdisciplinary (Brooks & Brooks, 1999).

Teacher Training

While it is clear that the future of computer use in the schools lies in the integration of technology throughout the curriculum, it is unclear how to achieve that end. Even though Education Week's Technology Counts '99 survey states that 97% of all teachers surveyed use a computer at home and/or at school for professional activities, a 1999 U.S. Department of Education study found that only 20% of teachers feel well prepared to effectively integrate technology in the classroom (cited in Warner & Akins, 1999). It seems that teachers are being trained in, and appear quite comfortable with, using the computer for professional uses such as e-mailing and word processing, however, they are not being adequately prepared to integrate computers into their curriculum. A fundamental challenge for many teachers is using computers to create innovative learning opportunities for students . . . but far too many teachers receive little or no training (Dias, 1999). In a recent survey some 42% of teachers had six or more hours of basic-skills training within the past year compared with just 29% of teachers

who had that much curriculum-integration training ("Technology Counts '99"). According to Judith Renyi (1996), the teacher of tomorrow no longer finds a curriculum in a textbook . . . One or two workshops on how to access the Internet are not the answer to the far more complex question of how to enhance student learning. In fact, the amount of training currently needed to make a novice computer-using teacher feel capable of thinking about curriculum change is in the range of 1000 hours, a long way from a one-shot training session (Roberts, Carter, Friel, & Miller, 1988). To search for the answer, one has to look into both preservice and inservice teacher training; specifically, moving teachers away from using computers for drill and practice toward a more integrated approach (Dias, 1999). Teacher preparation and support are key . . . When you move away from canned programs that do the teaching to flexible uses of technology tools, the teacher's role as activity designer, classroom facilitator, and learning evaluator is critical (Education Technology, 1999).

While one might assume that new teachers have the advantage here since they are fresh out of college and benefactors of the latest trends in education, that is not necessarily the case. That same Technology Counts '99 survey cites that teachers who have been in the classroom five years or fewer are no more likely to use digital content than those who have been teaching for more than twenty years. Perhaps the solution to the teacher training dilemma lies in requirements for graduation or licensure. One organization, the International Society for Technology in Education (ISTE), has formulated a list of technology standards that all candidates seeking initial certification or endorsements in teacher preparation programs should have opportunities to meet. These recommendations include sections on basic computer/technology operations, personal and

professional use of technology, and application of technology in instruction ("ISTE Recommended Foundations").

While we need to do a better job in preservice education, we also need to find better mechanisms to support today's teachers, only 20% of whom feel prepared to use technology for instruction (Education Technology, 1999). A possible solution is to structure preservice and inservice teacher education around constructivist principles. This would require major changes in theory and practice, but, as Brooks and Brooks (1999) see it, unless teachers are given ample opportunities to learn in constructivist settings and construct for themselves educational visions through which they can reflect on educational practices, the instructional programs they learn will be trivialized into "cookbook" procedures.

Maybe the teacher training dilemma could best be confronted through the school and country leadership. Principals are critical in setting expectations with respect to technology use, locating technology resources, and making it possible for teachers to receive professional development and planning time they need to integrate technology with instruction (Education Technology, 1999). Outside consultants might contribute to the integration of computers if they are used for in-service training in which teachers are paid to participate (Roberts, et al, 1988). It is reassuring to know that the government is also working to address these issues. The Congressional Web-Based Education Commission, a high-level government group established by Congressional legislation in 1998, has as two of its concerns, finding ways to improve and increase the amount of high-quality educational material on-line and how to provide appropriate training for

teachers so they can make the best use of new technology in their classrooms (Mendels, 2000).

In conclusion, this author sees two major predictors to teacher technology training effectiveness: time and focus of instruction. First, teachers need to be provided time to learn how to use both the hardware and software, time to plan, and time to collaborate with other teachers (Dias, 1999). Teachers need more opportunities built into their daily schedules to engage in reflective thinking with other teachers . . . to share new discoveries in the ever-changing world of technology (Warner & Akins, 1999). Secondly, the focus of preservice and inservice teacher technology education needs to shift from "basic technology skills" to "integrating technology into the curriculum." Furthermore, this inservice training needs to be on-going, since studies show that on-going professional development, including informal as well as formal supported activity, is far superior to one-shot training sessions (Education Technology, 1999). When these two changes occur, the students will be the ones to benefit from quality, integrated, computer instruction.

Computer Placement Concerns

Now that computers are being purchased in ever greater numbers for use in our schools, their optimum placement becomes a concern. Should these computers be put together in a lab situation, or should they be separated and placed into individual classrooms? There are advantages and disadvantages to each scenario.

The main benefit of setting up a computer lab in a school building is to get the greatest use, in terms of hours per school day, of a scarce resource (Roberts, et al., 1988). This lab could also be available for extended hours before or after school or open to the

public at night. It has the advantage of each child having his or her own computer and allows for time flexibility in that, for example, younger students could be scheduled for smaller blocks of time. Time on machine could be increased even more by having regular classroom teachers give the pre- and post-computer lessons in the classroom (Roberts, et al., 1988).

While time-use per machine is elevated in a lab situation, curriculum integration is more possible in the classroom environment.

> American schools have had a tendency to place computers in separate labs, rather than in classrooms. This is an important point because it means that students must go to a lab to use computers where there is less of a tendency to integrate the machines with everyday instruction. The machines are likely to become part of a separate activity, typically involving drill and practice exercises (Provenzo, et al., 1999).

Healy (1998) concurs by stating that a lab setup by itself may indicate a more didactic framework or one where technology hasn't really been integrated into the curriculum. Another advantage of having computers in the classroom is that they are available for use by the students or teacher at anytime. The time slot doesn't have to be planned in advance, so if a question or need arises, it can be handled immediately. Even though lab situations don't always lend themselves to integration, it is possible, because, as Dias (1999) states, technology integration does not happen in a particular location but in a

specific type of learning environment. It is up to the teacher to provide that learning environment.

In conclusion, this review of literature reveals that there has been significant progress in the use of computers in schools in the last decade. With the addition of this computer hardware comes new and sometimes complex responsibility for the school districts. Decisions must be made concerning what software to purchase, where to place the machines, and how best to utilize them. Teachers must be trained not just to operate the computers, but also to effectively integrate them into their curriculums. To make the most of this constantly evolving technology, certain steps must be undertaken by school districts.

Chapter III

Critique, Conclusions, and Recommendations

Critique and Conclusions

From the literature reviewed, it can be drawn that the use of computers as a delivery system in the instructional process is where the future of education is headed. The very abundance of current literature proves to this researcher that it is a topic of much concern and deliberation. However, before deciding just how those computers will be used, several issues must be addressed.

Most schools, both public and private, have seen the potential benefits of computers and have embraced aggressive plans for hardware purchasing. Similarly, they have noted how the internet can make their students significantly more aware of the world beyond their small towns, and have consequently gone "on-line." But then what? What is happening beyond these physical changes? The research shows that although teachers are being trained in, and appear quite comfortable with, the use of the computer as a "teacher tool" for grading, e-mailing, and word processing; they are receiving very little training in how to use these computers with the students they teach. As a result, when these teachers are scheduled for lab time, they resort to drill and practice stand-bys or internet games that have very little connection with what's being learned in the classroom.

The research suggests that what should be happening is the integration of computers into the regular curriculum in a constructivist manner. Students should be using technology as a "curricular tool" to explore new information and produce new products. They shouldn't be taught separately in "computer class" except perhaps a specific skill such as keyboarding. Rather, the teacher should use the curricular context

itself when new technology skills are needed. Students will then be able to see the direct connection between their needs and the use of technology to meet those needs. They will become accustomed to utilizing higher order thinking skills such as problem-solving to create their product, and evaluation to rate and perhaps improve upon it. In this manner, technology will enrich the regular curriculum, not add to it.

This review of literature shows that teachers are not receiving the training they need to competently integrate computers into the curriculum in a constructivist manner. Such a task would require long hours of training and challenge the very way many teachers think of technology and their relationship with it. Such fundamental change is always very difficult to implement and frequently rejected. Consequently, school districts must help teachers in this process of change by providing in-service training, time to work through and experiment with the technology, and perhaps rewarding those who embrace the ideals and spearhead the change. Only with a cadre of teachers on board, modeling good technology integration, will change become a possibility, and eventually a reality.

Recommendations

For the use of computers in the Princeton School District to reach its fullest potential, several recommendations are necessary. The school district has been aggressive in the purchase of computer hardware. Currently there are two PC labs and a Mac lab on site, as well as a PC in every classroom. All are on-line. In actual numbers, this comes out to an admirable four students per computer. It is recommended that the district maintain this ratio and continue to provide timely maintenance when problems arise.

Because of the need for computer integration mentors on site, it is recommended that a group of volunteers be assembled. This group should consist of teachers across grade levels who envision integration ideals and are willing to put time into achieving those ideals at Princeton Public School. These mentors should be sent out, as a group, to any available integration workshops. During this training period, they should also be provided time (or compensated if working beyond the school day) to meet together and bounce integration ideas off each other.

It is recommended that the next step in this integration process should be faculty in-servicing. Quality instructors should be brought in to excite the staff and help them to realize the potential of technology integration. Teachers should also be provided time during such in-service days to "play around with" their computers and curriculum and think about what integration could mean in their particular fields. Just as important would be meetings of same-subject area teachers at the high school level and grade-level teachers at the elementary level to share ideas and learn from each other.

The teacher-mentor group should oversee software order requests, looking for constructivist approaches and how the software will help to meet instructional objectives. This group should keep abreast of what's on the market and make recommendations to teachers when they become aware of quality products.

As far as optimum placement of computers, given the advantages and disadvantages of each physical configuration, this author would recommend a combination of computer labs and one to three computers per classroom. Since one computer per classroom is currently the norm at Princeton Public School, perhaps some type of integration incentive program could be developed to "reward" deserving teachers

additional classroom computers. Just as Princeton currently has a "Creative Teaching Award" for teachers who work together across grade or subject levels on new and original teaching units, the district could also institute a new "Technology Integration Award" to reward teachers who are embracing the ideals of integration, sharing their successes with colleagues, and working to bring others "on board."

As stated earlier, computer integration into the curriculum will require change--change in philosophy, change in attitude, and change in actual teaching style. Change is often difficult. Only with true commitment by district administrators and staff can the future of computer use at Princeton Public School realize its fullest potential.

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