

# Effectiveness of Computers in the Classroom and Teachers' Training Needs for Successful Integration of Computers in Education

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## Abstract

In recent years, significant amount of money has been invested in computers in schools to improve teaching and learning. There are both advantages and disadvantages of using computers in education. Teachers also should have necessary skills and knowledge to successfully adapt computers in their practices. In-service technology teacher training is one of the most preferred methods in schools and other educational institutions to help teachers gain those skills and knowledge. The purpose of this paper, based on the current literature, is to investigate advantages and disadvantages of using computers in classroom, and the necessity of training, whether technology teacher training is the only solution to improve teachers' performance in using technology in the classroom.

**Keywords:** Educational technology; computers in education, technology teacher training

## Introduction

The literature has much information about effectiveness of computers in education. There are research studies supporting the notion that computers are very effective educational tools improving learning performance and motivation. However, on the other hand, computers have disadvantages in teaching and learning. Besides effectiveness of computers, there is extensive research on technology teacher training. There are different views on how to improve teachers' performance in integrating computers into the classrooms. Human performance specialists advocate that training is not always the solution for human performance problems. Non-instructional or management solutions would be applicable for certain situations (Rothwell & Kazanas, 1998).

The purpose of this paper is to describe advantages and disadvantages of computers as an educational tool, and discuss whether technology teacher training is the only solution to improve teachers' performance in using technology in the classroom and necessity of training.

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### **Advantages of Using Computers in Classroom Settings**

Technology has produced several positive outcomes in education, such as students' enhanced motivation, attitude and enjoyment, new peer interaction patterns (Schofield, 1995) and students' enhanced learning performance. The idea that computer use often enhances students' motivation and attitude has been experimented frequently in the recent years. It is supported by many studies that computers are able to enhance student motivation about, interest in and attention to classroom activities.

In a study, conducted by Kitabchi (1987) consisting of 30 fifth grade students in an inner city school, the effect of computer in mathematics, language-arts and social studies were measured. The results showed that the students had more positive attitudes towards the educational experience and their attitudes improved during the course of the study. Based on a meta analysis of 199 subjects of which 32 were conducted in elementary schools, 43 in high schools, 101 in universities and 24 in adult education centers, it was founded that students liked the classes better and developed more positive attitudes toward computers when they received computer help (Kulik & Kulik, 1987).

Students' motivation to learn can be enhanced in classroom by technology-based teaching. Having enhanced-motivation attitudes, students enjoy more, work harder and show more involvement in classroom while working on computers. Why are students motivated and enthusiastic with computers? The literature brings fourth some explanations for this question. The first is that students respond well to computers because they are relatively new in their school experience. The second is that students seem they like working on computers because computers introduce variety into the school routine. Another approach is that knowing how to use a computer would be useful to students in the later life (Schofield, 1995).

Educators have been concerned with interactions among students in a computer-supported instructional environment. Many think that students are isolated from the classroom's social environment when using computers. Yet, studies showed that when students deal with computer-related tasks, interaction among students increases. As a matter of fact, the interaction becomes a learning management tool and students' experiences in group work may have a direct effect on learning and achievement (Webb, 1989).

Peer interaction has been affected by several factors such as student characteristics, structure of the tasks, and reward structure. Besides those factors, locations of computers, the ratio of students to computers, and how teachers chose to handle the educational environment when there are more students than computers determine the pattern of interaction among students. Teachers may control collaboration among students through software. For example, to the extent that an

artificial intelligent tutor may be designed well enough to supply the help students need (Schofield, 1995).

One of the purposes of the education is to teach students necessary skills to prepare them for the job market. Even though there are some objections, numerous researchers indicate that the computer is a good tool to help move us towards that purpose. Many studies proved evidence to support the notion that students better learn in a computer-supported environment than traditional classroom environment.

Kulik (1994) conducted a meta analysis on more than 500 individual research studies of computer-based instruction. He found that on average, students who used computer based instruction scored at the 64<sup>th</sup> percentile on the tests of achievement compared to students in the control conditions without computers who scored at the 50<sup>th</sup> percentile. Also students learned more in less time when they received computer-based instruction. In a similar investigation, 219 research studies on the effect of technologies on learning and achievement across from 1990 to 1997 revealed that students in technology rich environments experienced positive effects on achievement in all major subject areas and showed increased achievement in preschools through higher education for both regular and special needs children (Sivin-Kachala, 1998).

Cooperative learning environments contribute to acceptance and an enhanced self-esteem of students who feel like "outsiders". Students can be actively engaged in relevant and integrated curriculums through computer-based simulations. The cooperative nature of software can provide students with opportunities to demonstrate their strengths and gain class status in ways which would be difficult in competitive-based class environments. Using the collaborative learning software as a springboard, students can become involved in researching and presenting solutions to their own local environmental concerns. Technology can simulate real-life environments and promote learning by doing (Mandell, Sorge, & Russell, 2002).

Teachers and textbooks cannot provide all information necessary for contemporary problem solving and decision making. Current data and authentic learning opportunities can be brought into the classroom through the Internet, changing where and how students learn. Every other informational resource is out of date the day it is issued or published (Brauer, 1995). Success in the next century will depend on access to information. Students can gain that access and exposure to various ideas through telecommunications experiences. Students can share ideas with keypals from different cultures, discuss projects with scientists and other professionals, receive validation of their thoughts, ideas, and language with authentic writing through discussion groups.

As Flake (1995) mentioned, today there is an increasing awareness that students need to construct their own knowledge. The teacher's role is more of a

facilitator of a learning environment. The teacher can pose problems and raise questions with students. The students can investigate problems, pursue answers to questions, and hopefully, generate many more related questions of their own, for which they then investigate. This process of learning cannot be set in a tight framework, where everyone is investigating the same problem at the same time. Computers can become a very active part of such an environment. Then, she continues; "computers provide an excellent feedback system for students who know how to make effective use of it. Students can ask themselves "what will happen if..." input relevant information into the computer, and get feedback, which could either verify or refute the students' conjectures" (p.44). Observations of phenomena coming from the computer also could raise further questions for the students to investigate. Students can learn to pursue their own questions and get their own feedback, rather than being dependent upon an adult authority figure.

New technologies are transforming our world, both inside and outside the classroom. They are radically altering our activities and changing our sense of reality. Technology can empower teachers' creativity and students' responsibility for their own learning. Learning and teaching can become a more visual experience. The accumulated wealth of resources can be accessible to our classroom through new technologies (D'Ignazio, 1995). They offer the possibility to transform educational institutions to ones who are more just, who take advantage of a diverse student population, and who foster the understanding and appreciation of different cultures and different learning styles. Technology provides educators with tools to address equity and access issues, to accelerate students' linguistic and conceptual development, to provide support for students who learn in different ways, and to create authentic and meaningful learning experiences.

#### **Disadvantages of Using Computers in Classroom Settings**

The technology implementations are not free of risk. Once the technology starts diffusing into schools it brings unique problems. Some of the important problems are equity and access, time to plan and implement the technology, and teachers' resistance to change.

In the technology-based educational change, which could be school-wide, district-wide and state-wide, equity and access refers to whether each individual student utilizes computers or the technology at the same level and under the same conditions. The following variables would explain the obstacles that may cause inequity in the computer access: "Geographic region, socioeconomic status, gender, various kinds of handicaps, and special learner groups within school" (Knupfer, 1995, 169). The research indicates that women, the handicapped and the poor have less access to computers (Anderson, Welch & Harris, 1984).

Some other factors also may determine the equal access, such as familiarity with hardware and software, the classroom structure, time, students' skill levels and locations of computers. Becker (1985) found that computers are primarily used by above-average students. Interestingly, his study revealed that placement of computers within libraries promoted more equal usage of computers between above- and below-average students.

Successful technology adaptation requires careful planning and plenty of time. However, teachers already undergo time shortage with their current tasks (Knupfer, 1995; Hardy, 1998). Time necessary for technology adaptation is not just limited to the planning. Teachers also have to commit some time to learn how to plan the technology integration into curriculum and develop appropriate materials. After all, they will need classroom time to implement the technology. In the current education system, besides other necessary classroom events, not enough time is left to carry out instructionally sound and proper computer activities (Dupagne & Krendl, 1992). The literature confirms that teachers who are motivated to use the computer technology in their teaching are more likely to do so if time is provided to develop materials (Hardy, 1998).

Teachers show resistance to educational change in which they should use educational computing. Two concerns are critical for teachers exhibiting the resistance: concerns about their machine skills and concerns about taking a risk (Andris, 1996). Teachers are supposed to be competent about computer machine-related skills for classroom and lab activities at least at the elementary level. Though, usually teachers learn those skills through, if possible, school or district supported training and peer tutoring after for a while they do not value their "computer machine skills". "Although these teachers agree that their machine skills improve over time as they operate computers, they distinguish those skills from other teaching skills and do not recognize them as relevant to their [teaching] job" and they do not think, "operating computers make them a better teacher" (p. 95).

It takes time for teachers to become familiar with computer hardware and software. Because technology vendors continuously upgrade their products and schools always acquire new equipment and computer programs this is a recurrent problem in schools. Teachers indicate that until becoming accustomed to computers and programs their schools have teaching with them becomes less efficient and less productive than teaching with classical methods. They think using unfamiliar computer materials and their consistent level of classroom performance as well as effectiveness of their lessons.

### **Technology Teacher Training**

The literature indicates that lack of educational technology training prevents teachers from the use of computers in schools and an appropriate training increases teachers' comfort level, enthusiasm, confidence and skills to use technology



(McNamara & Pedigo, 1995). Hardy (1998) states that seven-year continuous training and experience are necessary to become a comfortable and confident user of educational technology. Of the seven years, teachers need five years to get used to the technology and then they start expanding the use by adapting some computer applications, such as tutorial programs and drill and practice software.

Several training programs have been tried out and discussed by researchers. McNamara and Pedigo (1995) depicted a training program that is composed of three levels: awareness, development of skills, and applications of knowledge. In the awareness stage, the training focuses on basic knowledge about computers. After that, equipment operation and the use of computer applications should be taught. In the last stage, applications of knowledge, the main theme should be integrating computers into the curriculum and using the computer for classroom management.

In another approach, the training is designed in such a way that teachers consecutively become technology assistant, technology teacher and technology leader. The technology assistant is capable of manipulating computer hardware and running computer applications at least with the help of the manuals. Technology teachers are able to evaluate educational software and integrate them into the curriculum without supervision. Technology leaders can use the technology with different pedagogical approaches, such as cooperative learning and constructivism, and use advanced multimedia and Internet applications (Guffey, 1998).

Siegel (1995) proposed a three level teacher-training program. At the end of the first level, teachers become familiar with some specific hardware and software. During the second level, teachers learn evaluating educational software to implement in the classroom. In the last level, teachers become capable of producing ideas on the technology integration.

After training, teachers should gain several competencies important for the technology adaptation in education. Teachers should be competent computer users (McNamara & Pedigo, 1995; Guffey, 1998; Siegel, 1995; Hardy, 1998; Walters, 1992, Willis, 1994). This includes understanding and operating of major computer parts such as monitor, modem and sound card as well as major computer peripherals including printer, scanner, cameras etc. Software competencies are installing and running operating systems, educational software and tool software, such as word-processing, spreadsheets, presentation and database (Guffey, 1998; Siegel, 1995; Willis, 1994).

Besides computer and software skills, teachers should be trained on the pedagogical issues and classroom management. Teachers have to be knowledgeable about instructional design models, integrating computers into the curriculum, computer assisted instruction and evaluating educational software to use in the classroom (McNamara & Pedigo, 1995; Forcheri & Molfino, 1986; Siegel, 1995;

Walters, 1992). Also, teachers are able to use the computer as a classroom management tool, such as keeping journals and reports about students and taking attendance (Hardy, 1998). Programming and Internet are other important competencies for teachers to possess (Becker, 1994).

The literature proposes the following tips and strategies to improve the effectiveness of a teacher training program: The training priority should be given to volunteer teachers; the training should be given by experienced classroom teachers or teacher trainers; the training should provide teachers with practical examples and extensive hands-on experiences with computers; the teachers should instantly use new technology skills in their classes; and teachers should be provided follow-up support after the training (McNamara & Pedigo, 1995; Wetze, Zambo & Buss, 1996; Siegel, 1995; Gilmore, 1995; Tally, 1995).

### **Technology Training and Teacher Performance**

Are teachers really employing computers effectively in the classroom? Is there a difference between how they should utilize computers and how they are currently using them in the classroom? Those questions concerning teachers' performance to adapt computers into curriculum are important to answer. Human performance technologists employ systematic models to identify deficits in human performance, investigate their causes and bring solutions.

This paper now will focus on three issues: Identifying performance discrepancies and determining their importance, considering alternative solutions for those discrepancies and considering training solutions.

#### *Teachers' Performance Discrepancy in the Use of Educational Technology*

In the last 20 years, the numbers of computers have increased significantly in schools. However, a significant percentage of new teachers have not used computers for instructional purposes (Wild, 1996; Hardy, 1998). On the other hand, even though some teachers try to adapt the computer in their lessons they are not able to achieve an appropriate integration (Dunn & Ridgway, 1991). Most of the time computers are employed in an unproductive manner and isolated from the classroom. For instance, they are substituted for paper-and-pencil individual worksheet activities and used as a tool to reward and punish students due to their behaviors (Becker, 1992). In high schools only 31 percent of the student computer time is devoted to the support of academic subjects. Computers should be further integrated into the actual curriculum.

As can be seen from the information above, teachers do not utilize computers at the expected level. What are the consequences of teachers' performance gap in using technology in classroom? Some believe computers are not able to provide a significant improvement in students' learning (Cormack, 1995). On the contrary, it

is also advocated that well designed technology supported lessons are able to improve students' learning performance and decreases the learning time. Students' attitude towards learning is increased, as well (Dusic, 1998). Considering the issue from educational system change perspective, Branson (1998) assigned an important role to technology to carry out the transition from current teaching-centered educational system (which is considered to reach its final efficiency limits and does not become better) to new learning-centered education system. It is reasonable to think that teachers who use technology in teaching and learning could bring about significant changes in education, which positively affects society.

#### *Training Solutions to Close the Gap*

According to the Mager and Pipe (1997) training can be considered as an appropriate solution for low performance if one does not have enough job related knowledge and skills. In connection with this, if teachers have lack of skills and knowledge to adapt technology in the classroom, training can be helpful. So the question is "do deficits in the technology knowledge and skills prevent teachers from employing technology to teach?"

Walters (1992) indicated that only 20 percent of new teachers believe that they were prepared to use computers in instruction. Even though having positive attitude towards technology, very high percentage of teachers, around 90%, are not confident about their computer literacy skills and knowledge (Dupagne & Krendl 1992). Moreover, student teachers do not know the basic computer skills and designing computer-supported lesson plans (Cormack, 1995). Usually, they have not been educated about and exposed to systematic ways to integrate technology during their educations because collages of education have not fully adapted technology courses into their programs, not met student-teachers' computer education need (Pugalee, 1998) and the faculties in those colleges lack the expertise in both technical and pedagogical skills in educational technology (Hardy, 1998; Wild, 1996). This limits the prospective teachers' competencies and knowledge of integrating technology in the curriculum.

The information above coming from the technology teacher training literature indicates that teachers often lack the skills and knowledge to use technology. There is a considerable need to provide teachers with training in how to appropriately design and deliver instruction that incorporates technology (Pugalee, 1998). Usually exemplary computer using teachers work in school districts that heavily invest in staff development program and they have more formal training in using and teaching with the computer (Becker, 1994). Not surprisingly, many technology experts agree that an ongoing barrier to implementing technology in school continues to be the lack of appropriate training for teachers (Hardy, 1998). If they are provided with time and support for in-service training they may gain positive



attitudes towards technology and easily learn planning and using the computers, so that technology integration can be successfully achieved in schools (Dupagne & Krendl, 1992; Sheingold & Hadley, 1990).

#### *Alternative Solutions*

Technology teacher training, alone, is not capable of solving the multidimensional problems related to technology integration in education. Besides the training need there are several other obstacles preventing teachers from successfully using technology to teach. Mager and Pipe (1997) consider four factors that may cause low performance: Unclear performance expectations, inadequate resources and feedback, punishing desired performance and rewarding poor performance.

As far as clear expectations are concerned, the technology integration is still a vague concept. Having conducted several studies about technology and education, researchers have failed to produce concrete and practical criteria with regard to the best ways of using computers in classroom and teachers are not provided with clear-cut expectations to successfully implement the technology.

In spite of large investment in purchasing hardware and software in schools, even more than the amounts spent for the staff training and professional development, teachers complain about inadequacy of technology equipment and resources. There might be several reasons of that: the current average computer/student ratio (even though increased significantly in the recent years) might be still a low proportion; many broken and malfunctioning computers are sitting in classrooms or computer labs due to lack of technical support; and the compatibility between new and old technologies is lost due to the rapid growth in the computer technology. Old computers do not support new versions of software and hardware. The last two reasons may indicate that, even though significant number of computers appears in the inventories of schools they are practically not useable (Wetzel, Zambo & Buss, 1996).

Feedback is an important mechanism to improve human performance. Behaviorist psychologists have carried out a significant number of research studies on feedback and how to provide it and when. However, the educational technology literature lacks information about how effective feedback should be provided to teachers as reinforcement for their technology integration practices in the classroom and information about who should do it. Technology coordinators could do this but few schools have fulltime technology coordinators and they are overloaded with many different tasks including teaching computer literacy, maintaining computer lab etc. Basically, they are not able to allocate time to observe and provide feedback for the teachers.

One of the most controversial issues in education is student evaluation. Usually, students are required to take standardized performance tests and teachers are held accountable for the students' scores. Researchers indicate that different learning processes require different evaluation procedures. For instance, standardized tests are usually associated with instructivist/behaviorist type of teaching. Yet, the literature shows that teachers prefer to use technology in a more student-centered/constructivist way that is not properly evaluated by performance tests. So, evaluating computer-supported instruction through an inappropriate means and holding computer-using teachers accountable for students' low scores based on an inappropriate evaluation technique would be punishing the computer-using teachers as well as rewarding the non-computer using teachers because their students have a greater chance to show better performance on standardized tests.

### **CONCLUSION**

Most educators would disagree with the idea that using computers in classrooms will not produce any learning. Computers, if carefully planned and implemented for the right reasons, can improve students' motivation and performance.

According to the literature, teachers do not have enough competencies to integrate computers in the classroom and they do not get sufficient in-service training. Pre-service teachers also graduate from colleges of education with a very little exposure to and knowledge about educational technology. It is clear that there is a substantial need to provide teachers with educational technology training.

However, the training should not be considered alone. Teachers have to be provided with additional assistants such as job aids, performance support systems (PSS) supporting the training, and role models. They need to be provided with alternative visions of what teaching with technology looks like and opportunities to experience alternative approaches in supporting context. Teachers need opportunities to observe peers working with technology and access to mentors or coaching support as they implement changes in their own teaching (Albion & Ertmer, 2002). Moreover, there is a need to develop a school/district (or broader) level system or policy that coordinate and manage the technology integration and implementations by incorporating technology into curriculum in schools. This system or policy should define what is expected from educational technology and how it will be judged, how teachers have to employ technology in classroom, what technology and non-technology resources will be available for teachers and what incentives will be given to them.

## References

- Albion, P. R. & Ertmer, P. A. (2002). Beyond the Foundations: The Role of Vision and Belief in Teachers' Preparation for Integration of Technology. *Tech-Trends for Leaders in Education and Training*, 46(5), 34-38.
- Anderson, R. E., Welch, W. W. & Harris, L. J. (1984). Inequities in Opportunities for Computer Literacy. *The computing Teacher*, 11(8), 10-12.
- Andris, M. E. (1996). *An Apple for the Teacher: Computers and Works in Elementary Schools*. California: Crowin Press.
- Becker, H. J. (1992). Top-Down Versus Grass Roots Decision-Making about Computer Acquisition and Use in American Schools. (*ERIC Document Reproduction Service No. ED356769*).
- Becker, H. J. (1994). How Exemplary Computer-Using Teachers Differ From Other Teachers: Implications for Realizing the Potential of Computers in Schools. *Journal of Research on Computing in Education*, 26(3), 291-321.
- Branson, R. K. (1998). Teaching-Centered Schooling Has Reached Its Upper Limit: It Does Not Get Any Better Than This. *Current Directions in Psychological Science*, 7(4), 126-135.
- Brauer, R. (1995). The Internet as School, or Welcome to Our MUD Room. *Technos*, 4(3), 14-21.
- Cormack, V. M. (1995). Training Pre-Service Teachers in Applying Computer Technology to Lesson Planning as a Component of the Elementary School Methods Curriculum. (*ERIC Document Reproduction Service No. ED382190*).
- D'Ignazio, F. (1995). The Technology Administrator's Field of Dreams. Dream Number 2: Technology as a Solution. *Learning and Leading with Technology*, 23(3), 43-44.
- Dunn, S. & Ridgway, J. (1991). Computer Use During Primary School Teaching Practice. *Journal of Computer Assisted Learning*, 7(1), 7-17.
- Dupagne, M. & Krendl, K. A. (1992). Teachers' Attitude Toward Computers: A Review of the Literature. *Journal of Research on Computing in Education*, 24(3), 420-429.
- Flake, J. L. (1995). *Elementary and Middle School Mathematics Learning in a Technology Age*. Tallahassee: Florida State University.

- Forcheri, P. & Molfino, M. T. (1986). Teacher Training in Computers and Education: A Two-Year Experience. *Computer Education*, 10(1), 137-143.
- Gilmore, A. M. (1995). Turning Teachers on to Computers: Evaluation of a Teacher Development Program. *Journal of Research on Computing in Education*, 27(3), 251-169.
- Guffey, S. J. (1998). Curriculum and Technology: Integration Through Modeling. (ERIC Document Reproduction Service No. ED418075).
- Hardy, J. V. (1998). Teacher Attitudes Toward and Knowledge of Computer Technology. *Computers in the Schools*, 14(3), 119-136.
- Kitabchi, G. (1987). Evaluation of the Apple Classroom Tomorrow. (ERIC Document Reproduction Service No. ED295600).
- Knupfer N. N. (1995). Teachers and Educational Computing: Changing Roles and Changing Pedagogy. In R. Muffoletto & N. N. Knupfer (ed.) *Computers in Education: Social, Political, and Historical Perspectives* (163-180). New Jersey: Hampton Press.
- Kulik, J. & Kulik, C. C. (1987). Computer-Based instruction: What 2000 Evaluations Say. (ERIC Document Reproduction Service No. ED285521).
- Kulik, J. A. (1994). Meta-Analytic Studies of Findings on Computer Based Instruction. In E. L. Baker and H. F. O'Neil (ed.). *Technology Assessment in Education and Training* (9-33). New Jersey: Lawrence Erlbaum.
- Mager, R. F. & Pipe, P. (1997). *Analyzing Performance Problems*. Atlanta: CEP.
- Mandell, S., Sorge, D.H. & Russell, J.D. (2002). Tips for Technology Integration. *Tech-Trends for Leaders in Education and Training*, 46(5), 39-43.
- McNamara, S. & Pedigo, M. L. (1995). Development of an Individualized Computer Training Model for Classroom Teachers. (ERIC Document Reproduction Service No. ED384596).
- Pugalee, D. K. (1998). The Study of the Impact of Teacher Training in Using Internet Resources for Mathematics and Science Instruction. *Journal of Research on Computing in Education*, 31(1), 78-88.
- Rothwell, W. J., & Kazanas, H. C. (1998). *Mastering the Instructional Design Process: A systematic Approach*. San Francisco: Jossey-Bass Inc.
- Schofield, J. W. (1995). *Computers and Classroom Culture*. New York: Cambridge University Press.

- Sheingold, K. & Hadley, M. (1990). *Accomplished Teachers: Integrating Computers into Classroom Practice*. Center for Technology in Education: Bank Street College of Education.
- Siegel, J. (1995). The State of Teacher Training. *Electronic Learning*, 14(8), 43-50.
- Sivin-Kachala, J. (1998). *Report on the Effectiveness of Technology in Schools, 1990-1997*. Software Publisher Association.
- Tally, B. (1995). Developmental Training. *Electronic Learning*, 15(1), 14-15.
- Walters, J. T. (1992). Technology in the Curriculum: The Inclusion Solution. (*ERIC Document Reproduction Service No. ED350281*).
- Webb, N. M. (1989). Peer Interaction and Learning in Small Groups. *International Journal of Educational Research*, 13(1), 21-39.
- Wetzel, K., Zambo, R. & Buss, R. (1996). Innovations in Integrating Technology into Student Teaching Experience. *Journal of Research on Computing in Education*, 29(2), 196-214.
- Wild, M. (1996). Technology Refusal: Rationalizing the Failure of Student and Beginning Teachers to Use Computers. *British Journal of Educational Technology*, 27(2), 134-143.
- Willis, J. E. (1994). Technology and Teacher Education Annual. (*ERIC Document Reproduction Service No. ED392388*).