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# Implications of Learning Theories for Effective Technology Integration and Pre-service Teacher Training: A Critical Literature Review

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**ABSTRACT**

This review will explore the influences of technology integration into pre-service teacher education programs from the constructivist and behaviorist perspectives for the ultimate aim of improving student learning and pre-service teacher training. A wide range of research is cited, including research articles, books, comparison studies, case studies, government records, dissertations and web sites. The study concludes that technology integration representing learning from technology (behaviorist perspective) is not the most effective way to improve learning although it helps learners to perform the lower level subskills automatically. On the other hand, constructivist-learning environments representing learning with technology, which encourages learners to actively process and organize information by making internal cognitive connections, can well provide the theoretical framework for the effective technology integration.

*Keywords: Technology integration, Pre-service teacher training, Constructivism, Behaviorism*

## INTRODUCTION

Technology is having an impact on every aspect of modern life. Computers control our telephone routing and the engines in our cars. Washing machines can decide when our dishes and clothes are clean. In my opinion, it is time to more fully integrate technology into the educational settings since skillful use of technology supports the development of process skills such as, higher order skills, adaptability, and collaboration that are essential to success in our rapidly changing information age. I believe in Dewey's words that if we teach today as we taught yesterday, we rob our children of tomorrow (Dewey, 1916).

Technology allows us to better serve the diverse learning styles of our students and educate them for a wider range of intelligence. Everybody has different learning styles for meaningful learning but teachers cannot represent all the styles in a traditional classroom environment. However, with the flexibility and help of the technologies, we can design learning environments in which students can manage and construct their own representations of knowledge in their minds.

Teachers need to use a variety of teaching activities in their classrooms, and that variety should include technology whenever appropriate. Technology can be used not only as an information management tool, but also as a means of reaching students of diverse backgrounds (Sianjina, 2000). Use of technology can help teachers relate to today's students who are very media aware, prompt new approaches to curriculum, and encourage developments in teaching skills (Schwarz, 2000). It can also assist teachers in helping students make connections with a worldwide community (Davidson, 2000).

Appropriate use of technology is but one aspect of teaching that pre-service teachers must demonstrate as reflective practitioners who evaluate choices for presentation of content, for monitoring and measuring students' understanding of content, and for students' explorations of a variety of resources in the learning process. Technology exists in classrooms not just for the sake of its presence, but also to enhance the learning process. In a study conducted by Iding, Crosby, and Speitel (2002), pre-service teachers reported using computers for their own personal use were at least moderately proficient with computers, and had access to computers at schools and in individual classrooms, and were interested in learning more about using computers and technology for instructional and educational purposes. However, they appeared to be unaware of educational software that could be helpful in their teaching, and the majority did not use technology in many teaching-related tasks, including student portfolios, tutorials, demonstrations and simulations, and student collaboration in class and with students at other sites. Whetstone and Carr-Chellman (2001) also found that computers were seen as important to education; however, pre-service teachers did not appear to see the importance of their own pedagogical roles in implementing computers in classrooms. They showed a lack of anxiety and a lack of motivation toward computers, despite the importance they placed on computers in changing schools.

## PROBLEM

Extensive amount of research conducted to investigate teachers` experiences about the use of technology in their instruction suggests that majority of the teachers do not feel well prepared to integrate technology into their teaching. Therefore, my literature review will address the issue of whether a constructivist and collaborative learning environment using problem-solving activities and authentic technology integration cases could help pre-service teachers learn how to use technologies as supporting tools to enhance their teaching and students` learning. In this case, the following research questions were established in order to further identify the current range of information and research findings related to the problem.

- What is the meaning of "effective technology integration" and its consequences for learning and teaching? How does it affect the roles teachers and students play in the instruction?
- What are the implications and instructional strategies of learning theories (particularly behaviorism and constructivism) with regard to technology use in the learning process?
- How do the pre-service teachers need to be trained to implement the technology confidently, thoughtfully and effectively? What changes does such training require in educational environments?

## METHODOLOGY

For my literature search, I reviewed research articles, books, comparison studies, case studies, government records, dissertations and web sites. Most of the literature is from 1990 to 2003. My primary sources include *Journal of Research on Technology in Education, Journal of Research on Computing in Education, Journal of Technology and Teacher Education, Educational Technology, Educational Technology Research and Development, Computers & Education, International Journal of Instructional Media, Computers in Human Behavior, and Phi Delta Kappan.* I performed my search through Wilson Web database that provides access to multiple information resources such as full-text journals and periodicals, encyclopedias, government publications, and scholarly books. I located research articles by using several keywords such as *technology integration, learning, teacher training, pre-service teachers, computers, constructivism, behaviorism, staff development, multimedia, hypermedia, Internet, and computer-assisted instruction*. Afterwards, I began to search ERIC with different combinations of these terms. To locate more information, I searched the Library of University of Illinois at Urbana-Champaign for journals and books related to technology integration, and browsed through their contents manually.

I organize my review around two broad categories of studies. The first category includes studies that have effective technology integration to improve learning as the primary concern of the research. These studies are generally concerned with the theoretical framework of technology use. The second category reviews the studies that look at the training programs for pre-service teachers. The research includes the need for teachers and teacher trainers to assume new roles, acquire new skills, and adopt new teaching approaches as they integrate technology into their teaching.

## EFFECTIVE TECHNOLOGY INTEGRATION AND LEARNING

Scheffler and Logan (1999) emphasize that integrating technology not only involves the attainment of computer skills but also consists of a process in which learners try, fail, access, evaluate, analyze and apply meaningful tasks including but not limited to researching, analyzing data, applying and representing knowledge, communication and collaborating. Thus, the integration of technology into education means using it as a tool to teach subject matter, and to promote problem-solving and higher-order thinking skills. It is neither computer literacy nor computer awareness. It means using the computer where it is the best medium to support the learning goal. It requires changes in a school. The entire school community of students, parents, teachers and administrators has to accept that computers are a part of everyday school life. Becker (1994) notes that a social network of computer-using teachers and organizational support from both school and district resources are important factors that contribute to the successful technology integration.

Hadley and Sheingold (1993) suggest that technology is most valuable to teaching and learning once teachers integrate it as a tool into everyday classroom practice and into subject-matter curricula. It is only through integrated practices that they can realize the hopeful and idealistic claims for technology (Collins, 1991). This requires readily and flexibly incorporating technologies into their everyday practice in relation to the subject matter they teach. Incorporating technology effectively involves (a) engaging students in active learning, (b) relying less on whole-group instruction, and (c) encouraging more independent and self-motivated learning (Hadley & Sheingold, 1993).

Williams and Williams (1997) note that effective technology use should incorporate a variety of applications that focus on problem-solving and help development of creativity,

adaptability and collaborative problem-solving skills. Healy (1998) argues against the integration of technology by schools where that integration is uncriticised and unquestioned, and where schools are basically jumping on a very costly bandwagon. However, she concedes that where their use is well planned, computers can "ground education in projects that have intrinsic meaning, while still teaching critical skills of symbolic analysis and a core base of integrated knowledge" (p. 296).

Much discussion about technology and education has focused on the question of how technology facilitates teaching and learning. Honey and Moeller (1990) state that the most important element affecting how and whether teachers use technology in their teaching is their pedagogical beliefs on learning and instruction. They examined teachers` perceptions of how and why they do or do not use technology in their teaching and concluded that high-tech teachers engaged their students in collaboration, project-oriented work, hands-on activities, inquiry and discovery-based learning. They suggested a transition from traditional to constructivist paradigm in both teachers` beliefs and educational system in order to benefit from technology as much as possible. Hannafin and Freeman (1995) agree that teachers` beliefs about knowledge acquisition and effective uses of technology are correlated with the ways they use technology in their classrooms. The teacher's view of learning, then, could be another factor to successful technology integration.

## A. Learning with Technology: Constructivist Perspective

In educational uses of technology, Jonassen and Reeves (1996) make a distinction between learning from computers and learning with computers. Much of the early research and development with technologies considered the enhanced learning that could be achieved when computers played an important and key role in delivering content and creating learning opportunities to help students make meaning and develop an understanding. In such settings, there was a distinctly diminished role for the teacher. Jonassen (1991) suggests that the more opportunistic and effective uses of technologies in classrooms are those where learning is achieved with the aid of technology, and the resulting environment is one where the technology supports and scaffolds the learning rather than being the object or derivative of the learning. McClintock (1992) also states that in a constructivist-learning environment, technology plays an acknowledged and purposeful role in the day-to-day activities, but does not become the object of instruction. When used in a constructivist manner, students utilize technologies to a) manipulate data, b) explore relationships, c) intentionally and actively process information, d) construct personal and socially shared meaning and e) reflect on the learning process (Jonassen, Peck & Wilson, 1999).

"The technological applications which support learning in such ways are often described as cognitive tools" (Lajoie & Derry, 1993, p. 32), and more research is now showing the benefits to be derived from such applications. Cognitive tools describe such applications as (a) calculators, (b) databases, (c) spreadsheets, (d) communications software, (e) semantic network tools, and (f) knowledge construction tools. The critical attribute of cognitive tools is not in the information and knowledge that they carry, but the forms of learner activity and engagement that they support and encourage. Cognitive tools still need the informed teacher to design and supervise the learning activity, but they act to amplify and distribute the cognitive tasks through their design and application.

Jonassen (2000) also developed the idea of mindtools: computer based tools and learning environments that have been "adapted or developed to function as intellectual partners with the learner in order to engage and facilitate critical thinking and higher-order learning" (p. 11). According to him, the role of a mindtool is to extend the learner's

cognitive functioning during the learning process, and to engage the learner in operations while constructing knowledge that they would not have been able to accomplish otherwise. "Mindtools enable learners to become critical thinkers. When using cognitive tools, learners engage in knowledge construction rather than knowledge reproduction" (Jonassen, 2000, p. 18). By using commonly available software, learners employ technology to both construct and represent knowledge.

Computers can successfully enhance the problem solving abilities of the students by using project-based learning (PBL) activities; because they are used, most often, in an environment where people are drawn to collaborate naturally as a result of their cultural expectations. Tretten and Zachariou (1995) carried out an assessment of PBL in four elementary schools by administering teacher questionnaires and interviews, and a survey of parents. The informants reported that PBL had a variety of positive benefits for students, such as, attitudes towards learning, work habits, problem-solving capabilities and self-esteem. According to a three-year study of mathematical instruction, Boaler (1999) reported that PBL schools had better national examination results than did traditional schools, and the PBL students developed a more flexible form of mathematical knowledge that they were able to apply in a range of settings. Learning, which occurs in the context of problem solving, is more likely to be retained and applied than inert knowledge acquired through more traditional teaching methods.

A study by Ryba and Brown (2000), conducted in two classrooms in an elementary school in New Zealand, found that teachers' beliefs about themselves and their roles in the classroom, as well as their philosophy of education had a central place in shaping the nature of their computer use. Those teachers who saw learner-centered classrooms and authentic learning tasks as central to the success of their students were more likely to use the technology on a continuing basis.

Means and Olson (1997) found that technology increased the complexity with which students could deal successfully and created a multiplicity of roles, leading to student specialization. It allowed in-depth exploration of a smaller number of ideas and related facts around authentic, challenging tasks. They further state:

When students are using technology as a tool or a support for communicating with others,

they are in an active role rather than the passive role of recipient of information transmitted by a teacher, textbook, or broadcast. The student is actively making choices about how to generate, obtain manipulate, or display information. (p. 125)

Hypermedia allows users to enter virtual environments that include text, sound, visual images, animation and video. Ayersman (1996) found that the use of hypermedia applications promoted deep comprehension and enhanced listening comprehension, story production and decoding skills and improved ability to discover links among people, places, events and issues within historical contexts. Riddle (1995) investigated that students using hypermedia demonstrated increased ability to convey insight and individuality, greater descriptive detail, and unique perspectives. In the USA, The Challenge 2000 Multimedia Project supported by multimedia gives students opportunities to use technology effectively in the planning, development and presentation of their projects (Thomas, 2000). Students who took part in this project had better results than comparison students on content mastery, audience sensitivity and coherent design.

In addition to hypermedia applications, the Internet may provide a rich source of outside information resources that allow students to address complex problems. The Internet connects teachers and students to people outside the school environment, providing access to expertise not available locally. Irving (1991) conducted a two-year study in six schools in which students were given access to on-line information services.

The project was designed to stimulate students' use of a variety of information resources and the study of contemporary topics. Conclusions of the study were that "on-line services provided immediate, on-demand and up to date material not available in or near the schools, and access to specific information on topics for which school books either did not exist or were not in the school resource collection" (p. 225). Constructivist learning works well with web-based activities. Students entering this environment bring with them their prior knowledge. They engage in a web-based activity such as searching the Internet, gathering information, organizing their thoughts, or communicating with peers via email thus adding to their cognitive infrastructure.

**B. Learning from Technology: Behaviorist Perspective**

Use of technology from the behaviorist perspective mirrors traditional classroom practice: users are relatively passive, the content and interaction between the user and the software are predetermined, and there is a limited repertoire of acceptable responses (Jonassen, 2000). The acquisition of facts through repeated practice and rote memory, or learning from the technology, is the goal of instruction (Jonassen & Reeves, 1996).

Computer assisted instruction (CAI), integrated learning systems, drill-practice programs, computer-based tutoring systems, and assessment software are some of the technologies designed based on the behaviorist learning theory (Jonassen, 2000). CAI and integrated learning systems have been readily adopted in many schools in the USA as they closely match the traditional routine of classroom life. Jonassen argues that CAI can increase achievement because it leads to automaticity of lower-level skills through extended practice. A computer that is endlessly patient with the learner monitors this practice. In the tutorial form of computer-assisted instruction, the computer provides additional information to the learner if an incorrect answer is supplied. This continues until the learner is successful. Skinner's views of immediate positive reinforcement following a correct answer are directly applicable to drill-and-practice and tutorial forms of CAI (Yaakub, 1998).

Technology integration from this perspective is commonly used to increase student motivation. In a study exploring differences in teachers` uses of technology and their perceptions of the value or role of technology, Ertmer, Addison, Lane, Ross, and Woods (1999) found that majority of the teachers in elementary schools in the USA perceived technology as an incentive or behavioral reward in order to motivate students to complete their assignments and make lessons more interesting to students. At the time of the study, the teachers in this study were using technology for drill-and-practice activities and as a presentation tool to support their lessons. Almost all uses observed by the researchers, as well as those described by the teachers, involved the application of some type of instructional game or informational CD-ROMs. The study revealed that their integration of technology was mainly related to its usage to employ computers as presentation tools providing additional resources and engaging visuals to enhance lessons, to motivate students and to promote the belief that students need to use technology to be prepared for the future.

**Studies for Effectiveness of Computer-Assisted Instruction**

Literally, hundreds of research studies have been conducted regarding the effects of CAI. From the analysis of twelve meta-analyses of the effectiveness of CAI programs developed primarily prior to 1990, Kulik and Kulik (1991) conclude that students usually learn more and in less time with computer-based instruction. In Fletcher`s (1990; cited in

Yaakub, 1998) meta-analysis of the effectiveness of computer-controlled interactive videodisc instruction at three different settings: higher education, industrial training, and military training, the overall effect size for military training was found .39, indicating an improvement in student performance from 50% to 65% for the computer-based group. The effect sizes for industrial training and higher education, on the other hand, were .51 and .69, respectively, suggesting that achievement scores in interactive videodisc instruction were moderately higher than those in conventional instruction. Having reviewed a number of meta-analysis on CAI effectiveness, Kulik (1994) concluded that students enjoyed being taught by CAI and developed more positive attitudes toward computers in CAI classes but they had similar attitude toward subject matter when compared to students in traditional classes. Fletcher, Hawley and Piele (1990) found that CAI affected educational gains including reductions in the needs, class size, cost and time for training.

In the area of technical education and training, Gokhale (1996) assessed the effectiveness of computer simulation for enhancing higher order thinking. By conducting experimental research design in which the experimental group was given CAI type instruction based on a simulation program while the control group was given instruction in a laboratory format, Gokhale found that students who used the simulation software performed significantly better on problem solving tests than control students. Gokhale explained the effectiveness of the simulation indicating that the computer simulation offered students the opportunity to engage interactively with the computer on experiments with electronic devices. Therefore, the students who worked with computers were able to focus on mental activities whereas laboratory students had to deal with laboratory equipments requiring extra focus on both physical and mental activities.

There are also other CAI effectiveness studies in the literature that do not favor CAI. Becker (1992) found numerous methodological problems with many studies that have demonstrated positive effects of using CAI. In his meta-analysis of 100 studies, he concludes that differences in CAI users and non-users are too small to have educational significance. Yuill (1991) conducted a study in order to explore the effects of computerized problem-solving simulations on the undergrad nursing students` critical thinking skills. Both CAI and control groups were given the same coursework except that the former was given the computerized simulations as a supplement. In addition, CAI students had several activities to assess patients` conditions from their nursing history, obtain information from physical exams, identify patients` problems, and plan suitable nursing care. After the experiment, the Watson-Glaser Critical Thinking Appraisal Test was administered to measure gains in critical thinking ability. The results revealed that the computer simulations had no effect on critical thinking ability. Yuill also measured the gains in cognitive knowledge by means of a test given after the experiment. There was no significant difference found in terms of performance between the CAI and control groups.

In another experimental study in technical education, Spotts (1992) examined the effectiveness of a multimedia based CAI that was designed to teach the fundamental of pneumatics to an automotive manufacturer's employees. Participants were randomly assigned to experimental group given multimedia CAI instruction and control group given conventional instruction. Similar course materials were used and the same total instructional time of eight hours was allocated in both groups. The multimedia CAI instruction tracked employees` performance, provided feedback and remedial lessons, and allowed branching of learning paths. A posttest measuring the amount of new information acquired and retained after training was employed to determine the achievement scores. The results concluded that the multimedia CAI and control groups did not differ significantly in terms of achievement gains.

The evidence shows that technology use in a constructivist way, which engages and facilitates students in critical thinking and higher order learning, is more effective than applications that attempt to make repetitive skill practice. The research indicates that the contribution of technology to teaching and learning is just beginning to be seen. While new technologies developed for learning alter the ways students interact and learn, teachers should design new learning environments to make the most of the technologies. It is in this sense that teacher educators should prepare future teachers to work effectively in these new learning environments. The next section, therefore, review the research studies dealing with the new roles teachers will need to assume, teacher resistance to those roles, and the type of training best suited to prepare teachers to use technology effectively.

## TRAINING PRE-SERVICE TEACHERS TO USE TECHNOLOGY

According to a 1999 National Center for Educational Statistics study on teacher quality in the USA, only 20% of all teachers feel very well prepared to integrate technology into their teaching (U.S Department of Education, 1999). Similarly, Matthews (1998) examined technology use by rural teachers and found that more than one half of the teachers perceived themselves as novices in all aspects of technology use, and almost one third to one half of the teachers never actually used technology for educational purposes. His study also revealed that fewer than 30% of the public teachers used Internet applications in their classrooms although U.S Department of Education (1999) reported that the number schools with Internet connection increased by 43% between 1994 and 1997.

Although several reports refer to equipment, software, time, and training as the most common barriers to the integration of technology, the elimination of these barriers does not necessarily facilitate a smooth transition to technology use by classroom teachers (Hall, 1997). Teachers may not have had the necessary training and experience in using technology during their pre-service education. Even those who have received professional development in pre-service years may not feel fully comfortable with their technology skills and knowledge; therefore they may feel unprepared for technology integration (Ponsessa, 1996; Loveless, 1996). In a study by Strudler, McKinney, Jones and Quinn (1999), teachers stated that technology integration attempts were not only time consuming but also frustrating since they had not been properly trained during their pre-service years. According to the most recent research by National Center for Education Statistic (NCES, 2000), in the USA, nearly 70 percent of teachers do not feel well prepared to use computers and the Internet in their teaching. Similarly, in a survey of 4,049 elementary and secondary school teachers, less than 20% viewed themselves as very well prepared to incorporate technology into instruction (Archer, 1999).

There may be several factors for teachers' feelings of being unprepared to use instructional technologies. First, when professional development is available, teachers typically receive only basic knowledge about the way they should operate the computers and software, not information on how to integrate the technology into instruction or on how to assess its benefits (Hasselbring, Barron & Risko, 2000). Although they report desiring to use computers, and have gained adequate technical skills, they lack pedagogical knowledge about how to implement computers within the more routine tasks of teaching and managing their classrooms (Novak & Knowles, 1991; Hruskocy, 1999). In cases where technology-based instruction has been successful, the research suggests that it is most often the result of using the computer to deliver well-designed and well-managed instruction (Hasselbring & Williams Glaser, 1999). Thus, the focus is placed on the

teacher's actions in the classroom rather than on the technologies that were utilized in educational setting.

Second, the lack of teachers` beliefs about their ability to use technology in instruction (self-efficacy and self-confidence) has been shown to influence the levels of technology use by pre-service teachers (Albion, 1996). Olivier and Shapiro (1993) argues that observing models increase one's feelings of confidence. However, Faison (1996) found that teacher educators failed to model instructional technology use and did not require students to use technology in their classrooms and field-based assignments. Therefore, role models and motivational factors should be included in pre-service education programs. Likewise, Beaver (1990) examined the amount of anxiety undergone by pre-service teachers at a major university in the USA. According to the survey results, students reported a high level of anxiety when asked whether they felt prepared to use technology in their future teaching; because more than half of the students were not required to use it in their education courses. By developing and employing Attitudes towards Computer Technologies (ACT) and Self-Efficacy for Computer Technologies (SCT) instruments, Delcourt and Kinzie (1993) assessed pre-service teachers` perceived usefulness of and comfort level with specific computer technologies. They administered the instruments to 328 students enrolled in teacher education programs in the USA, and concluded that there was a strong association between time spent using computers and students` attitudes and self-efficacy.

Further, teachers may sometimes resist using technologies based on their feelings of discomfort, dislike and even fear of technology (Stone, 1998). Hannafin and Savenye (1993) reported several possible explanations for teacher resistance to using computers. These reasons included a) doubt that computers improve learning outcomes, b) resentment of the computer as a competitor for student's attention, c) unsupportive administrators, d) increased time and effort required of the teacher and e) fear of losing control of center stage, and fear of looking stupid in front of the class. For effective technology integration, they further stated that there needed to be a fundamental shift in the role of teacher in order to benefit from the interactive nature of the technology and its capacity to enable student-centered exploration. The teacher can no longer be a dispenser of information to relatively passive learners. They stressed that technology-oriented teacher's new role was described in the literature as manager of information, coach, guide, organizer, initiator and diagnostician. They put the role of traditional lecturer and imparter of knowledge at one end and the role of coach, observer, and facilitator at the other end of a continuum, and concluded that the traditional end of the continuum embraces behaviorist learning theory while the other end is likely to embrace constructivism.

Hannafin and Freeman (1995) investigated pre-service and in-service teachers` beliefs on knowledge acquisition by means of a survey touching on knowledge acquisition views from objectivism to constructivism. They found that experienced teachers had a tendency to embrace objectivist view of learning whereas pre-service teachers held a constructivist notion of learning. Based on the interview results, they also concluded that external sources of influence and classroom management issues might create an environment that favors implementation of objectivist-based computer software programs rather than those that are grounded in the constructivist perspective.

In the USA, many schools have spent an extensive amount of money to purchase computers or to upgrade their instructional computing capacity with the hope that the mere presence of these technologies will promote positive instructional changes. However, they were quick to discover that technology alone does little to support changes in the way teachers think about teaching and the way students think about learning. These types of changes emphasize a modification in a teacher's pedagogical belief system, not simply a

change in the tools that are used to facilitate this process (Hasselbring, Barron & Risko, 2000). Change will not occur by simply adding a course or recruiting a new faculty member who understands technology. What is required is a transformation of the culture of teacher education, one in which technology is seen as changing relationships between students and teachers and between learners and knowledge.

Dexter, Anderson, and Becker (1999) examined the use of computer technologies by teachers and their perceptions of the impact of computers on changes they made in their classroom practices. Their informants, who completed a questionnaire and a series of semi-structured interviews, included 47 teachers from 20 elementary and secondary schools in the USA. The teachers were categorized as being constructivist, weak constructivist and substantially constructivist according to their responses on the questionnaire. Through the interviews, the researchers determined that the teachers that fell into the weak or substantially constructivist categories felt that technology helped them change but they did not acknowledge it as the catalyst for change towards more constructivist practices. Rather, they recognized that reflection upon experience, classes taken during their undergrad education, context and culture of their school and school-wide initiatives and programs had the most profound effects on changing their teaching styles than mere presence of technology. In a similar vein, Roblyer and Erlanger (1998) agreed in their research that teachers responded differently to technology integration because of their prior experiences with technology as pre-service teachers as well as the encouragement provided in their past and present educational environments.

Technology has also impacted pre-service teacher education programs at many universities. As an example, new initiatives for prospective teachers enable them to view best practices via streaming video over the web. When incorporated with online discussions and teacher/facilitator annotations, the support a teacher needs in implementing a vision or changing a practice is greatly enhanced (Herbert, 1999). According to the study conducted by Howard, McGee, Schwartz, and Purcell (2000), living-and-learning environments for the training can foster rapid changes in teachers` epistemological beliefs. Results indicated that teacher epistemology became significantly more constructivist on three of four measured epistemological dimensions, and the training program was very effective and that certain epistemological dimensions are subject to change. Teachers learned about constructivism by doing constructivism. Individually and collaboratively, teachers learned how to use the technologies by incorporating them into the design of lesson plans. In retrospect, trainers observed that one of the most powerful influences for epistemological change was the teacher-to-teacher encounter. Moreover, Davis and Resta (2002) concluded that electronic collaboration that was not constrained by time and space was an effective means of providing additional mentoring and support to beginning teachers in their first years of teaching.

Ismat (1995) found that half of the educators reported being prepared to use drill-and-practice tutorials, games, word processing and publishing applications, however less than 10% felt competent to use multimedia and presentation packages, electronic network collaboration capabilities, or problem-solving applications. Parallel results were obtained from a national survey in the USA. The most common use of technologies among all elementary and secondary schoolteachers surveyed were word processing and skill-practice games while the rare uses included spreadsheets, databases, simulations and exploratory type software. Most of the teachers identified improving computer skills when asked to classify their objectives for student computer use; consequently, they were not using technology for information analysis, exploration and other higher order and critical thinking skills that are crucial for conceptual understanding (Education Week, 1999).

Hasselbring, Barron and Risko (2000) asserted that early efforts to introduce pre-service teachers to technology were addressed by offering stand-alone courses usually focusing on acquisition of programming language. However, many of the leading schools of education quickly became dissatisfied with the results of these attempts and decided to place emphasis on using technology as an instructional tool (Erion & Moeller, 1991). It quickly became apparent that stand-alone technology courses were of limited value to pre-service teachers, primarily because the approach did not provide aspiring teachers with an instructional model for using technology in classrooms (Callister & Burbles, 1990). Accordingly, several schools of education abandoned the stand-alone courses in favor of the integration of technology into the entire educational curriculum offered to pre-service teachers. Other schools maintained that a fundamental course could provide a solid foundation for integration in other courses (Hasselbring, Barron & Risko, 2000). In a similar vein, Wetzel (1993) argued that pre-service training programs should require a core course in educational technology coupled with technological experiences woven throughout the method courses. Strudler and Wetzel (1999) also recommended combining technology integration courses with regular teacher education courses.

Vannatta and Beyerbach (2000) also pointed out that technology integration must be connected to course content, objectives, and assignments, and addressed much earlier in the teacher education programs. According to their study, the majority of pre-service teachers reported a change in their vision that included a more constructivist approach, where a variety of technologies and applications are used to create products, facilitate processes, and analyze problems. Halpin (1999) found the similar result in his study that consisted of 73 pre-service teachers in an integrated elementary methods course prior to their teaching experiences. The results of this study indicate that the integration of computer literacy training into methods courses did provide future teachers with the confidence to transfer their computer skills into their classrooms based on their own exploratory experiences. Halpin maintains:

It is important to integrate the use of computer applications into the pre-service methods courses already in existence to give the teachers the opportunity to experience exactly how technology can be an integral part of the daily operations of the classroom (p. 137).

Beyerbach, Walsh, and Vannatta (2001) conducted a research study to investigate teachers' thinking about and use of technology infusion and its role in student learning in the USA. This was a two-year evaluation study of a pre-service teacher technology infusion project in which teams of teacher educators and K-12 teachers collaborated to infuse technology in their respective teaching contexts, and to create links between these contexts. The results suggest that technology infusion to enhance teaching is a multifaceted process that takes time, support, and collaboration. A team approach, with practitioners from the K-12 and arts, sciences and education faculty, and undergraduate and graduate students offered a fruitful model for infusing technology both into teacher education and the schools where the students study and learn by doing. After participating the project, "pre-service teachers changed their views of technology infusion from thinking that they would teach and learn about technology to thinking they would use technology to support student learning" (Beyerbach et al., 2001, p. 105).

What the results of these studies all point to is a need to shift funding and research priorities from simply providing access to technology in schools to make sure that teachers are adequately trained and supported in both the technology skills and the pedagogical strategies to integrate technology into their teaching. The findings demonstrate a need for teachers, and teacher trainers, to assume new roles, acquire new skills, and adopt new teaching approaches as they integrate technology into their teaching. The evidence show

that although educational reform focused on the restructuring of education, incorporating constructivist and cognitive processing view of learning and integrating uses of technology in the school curriculum, most pre-service teachers have not had adequate training in the use of technology within the constructivist learning environment. As Sandholtz, Ringstaff, and Dwyer (1997) pointed out that professional development and teacher preparation programs have not caught up with the needs of teachers in learning the skills necessary for using technology to support constructivist learning environments. Research also shows that teachers become more effective in technology integration as long as they have adequate and proper training during their pre-service education, district-level and administrative supports and an opportunity to share their experiences with other teachers who use technology in their classrooms.

## CONCLUSION

The research concludes that the use of technology as a learning tool can make a measurable difference in student achievement, attitudes, and interaction with teachers and other students. Interactive, self-directed learning and higher order thinking can be fostered by technology, and that technology can have the greatest benefit when the environment is conducive to such experiences. The evidence shows that technology integration representing learning from technology (behaviorist perspective) is not the most effective way to improve learning, although it helps learners to perform the lower level subskills automatically. On the other hand, constructivist learning environments representing learning with technology, which encourages learners to actively process and organize information by making internal cognitive connections, can well provide the theoretical framework for the effective technology integration. Consequently, the change required is a shift of responsibility from the teacher to the learners. The key to making this transition is, of course, the teacher. This is how Willis and Raines (2001) explain:

Perhaps the time has come for the goal of education to change… The computer reinvented knowledge by giving us new ways to view the world and ourselves. Education must move from the statistic, mechanical view of the teacher as giver of knowledge to teacher/learner as integrator, guide, architect and facilitator. However, for this change to occur, educators must accept that the computer and its software are not replacements for the content of the discipline core of the curriculum, but are useful extensions that complement content. (http://www.thejournal.com/magazine/vault/A3638.cfm)

Research indicates that the benefits of technology integration do not happen in some miraculous way simply because the technology has been provided, and technology cannot be effective in the classroom without teachers who are knowledgeable about both the technology itself and how to use it to meet educational goals. Therefore, in order to accomplish the profound changes associated with the integration of technology in the overall learning environment, there is a real need for training pre-service teachers. As Brush and Bannon (1998) states, "Without appropriate leadership and training, educators will continue to use technology as a supplement to instruction rather than a tool to facilitate instruction" (p. 10). Pre-service teachers may not develop the necessary skills and application practices of technology integration unless they are presented with appropriate experiences (Mullen, 2001). Proper support and professional development activities should be incorporated into curriculum planning of colleges of education to enhance teaching and learning process.

Teachers' attitudes toward technology appear to be in constant state of change, but the research indicates that in recent years more teachers are using technology to support learning contexts as a result of appropriate training. Teachers tend to continue to teach and

use technologies within an objectivist model of teaching and learning, even though current educational reform movements are based on the constructivist paradigm of instruction (Bagley & Hunter, 1992). Although most teachers seek ways of improving their practice, and express enthusiasm for constructivist and other reform-based approaches, their underlying, and often largely unconscious beliefs about teaching and learning tend to diffuse efforts to establish constructivist learning environments (Schifter, 1996). Therefore, pre-service teachers should also be trained to learn new skills for facilitating learning in a technology-rich constructivist learning environment.

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