International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2009, Vol. 5, Issue 2, pp. 161-171

Effective technology integration: Old topic, new thoughts

Bude Su
California State University Monterey Bay, USA

ABSTRACT

Although teachers are aware of the importance of technology integration into daily process of teaching and learning, they tend to face a number of barriers when it comes to effectively integrating technology into their curricula. While some barriers are resource related, others originate from fundamental beliefs and processes of current education system. In this paper, the author first demonstrates why a systemic change is needed for effective technology integration in Kindergarten through Grade 12 (K-12). Then, by reviewing the relevant literature on barriers to technology integration, she points out the most fundamental barriers. Finally, the stages of change that individuals tend to go through in the context of K-12 technology integration is discussed.

Keywords: *Technology Integration; Systemic Change; Barriers in K-12.*

INTRODUCTION

Technology is often seen as a barometer of the development of a given society; few would contest the tremendous impact that advances in technology have had on our lives. While there are those who address the negative influences that technology may have on human society, it is clear that technology has brought about irreversible change to the world. This point has been noted by Bill Gates et al. long time ago: “One thing is clear. We don’t have the option of turning away from the future. No one gets to vote on whether technology is going to change our lives” (1995, p.74). Thus rather than debating whether or not to adopt a new technology in the classroom, educators should acknowledge the reality of technologically-induced change and concentrate on how to help teachers to effectively use the new technologies in their teaching and learning so that student learning is further enhanced.

Financially, the U.S. government has been very supportive of K-12 technology integration. In 2002 alone, the U.S. federal government invested approximately 3.2 billon dollars on K-12 technology related projects (Market Data Retrieval (MDR) 2003). A recent survey of teacher education programs throughout the country shows that about 50% of all institutions with teacher education programs for initial licensure offer stand-alone courses in educational technology in their programs (Kleiner, Thomas & Lewis 2007). This survey report further reveals that majority of institutions agree that their graduates have the skills and experience to integrate technology into teaching. However, they also report a number of barriers that prevent teacher candidates from using technology within program coursework and field experiences. Clearly, having advanced facilities and stand-along technology training do not guarantee that teachers can effectively integrate technology into classroom teaching. This reality often makes educators wonder about what barriers are preventing teachers from effectively using technology, where they are, and how they can be overcome.

EFFECTIVE TECHNOLOGY INTEGRATION NEEDS SYSTEMIC CHANGE

Defining a vision of effective technology integration

For clarity, Reigeluth and Joseph (2002) distinguish between *technology integration* and *technology transformation*. They point out that *technology integration* focuses on "how to use technology to support the way teaching is currently done in the schools" (p.9) whereas *technology transformation* emphasizes the use of technology to teach that which was not possible when the technology was unavailable. The underlying logic of the latter is that the most effective use of technology in education requires fundamental changes in the way we teach and learn in schools. Ertmer (2005, 1999) uses *technology integration* to refer to *technology transformation* as defined by Reigeluth and Joseph. In her view, technology adds value to the curriculum not by its "quantitative changes" such as "doing more of the same in less time", but by its "qualitative changes" such as "accomplishing more authentic and complex goals." Clearly, Ertmer emphasizes the effectiveness of technology in education over its efficiency. This paper follows Ertmer's definition of *technology integration* and calls it *effective technology integration* which is very much similar to Reigeluth and Joseph's *technology transformation*. Therefore, *effective technology integration* should bring qualitative changes to the education instead of merely using technology to continue the old way of teaching and learning.

Why systemic change is needed

Reigeluth (1994) points out that systemic change is a paradigm shift that "entails replacing the *whole* thing" because "a fundamental change in one aspect of a system requires fundamental changes in other aspects in order for it to be successful" (p.3). Education as a social enterprise is a very complex system that involves many stakeholders such as teachers, students, parents, administrators, business partners and policy makers. To effectively integrate technology, these people will either affect or be affected by the change. In order to illustrate why effective technology integration needs systemic change, the author discusses a few critical factors below. Although these factors are by no means exhaustive, how well they work together definitely influences how effective the technology integration can be.

Teaching and learning in the classroom

Many technology integration projects have failed in the past because they lacked successful classroom and curriculum integration strategies. After analyzing 102 cases where technology was integrated into the classroom curriculum, Johnson et al. (2000) recommended focusing on three variables that can enhance the chances of successful integration: adequate software programs that allow students to create, manipulate, and produce; problem-based assignments; and constructivist learning environments. If we take a close look at these three variables, their constructivist nature requires a fundamental shift in the process of teaching and learning in the classroom. In Table 1, the changes (from traditional to constructivist) necessary for effective technology integration in daily teaching and learning is analyzed using the seven relationships defined by Frick (1991).

***Table 1**. Fundamental changes needed for effective technology integration*

Relationships	Traditional learning environment	Constructivist learning environment
Teacher-student	Teacher-centered instruction where students listen to the lecture and ask questions for clarification. The teacher acts as a "sage on the stage."	Student-centered learning where students are actively involved with learning where the teacher acts as a "guide on the side."
Student-content	Students are often given content which may not be best suited for a given individual situation. This in turn results an un-engaging relationship between the student and the provided content.	The subject matter offered to students is authentic and tailored to individual needs. The customized content is most useful personally and also allows students to make progress at their own pace.
Teacher-content	Teachers have learnt the content long before, most likely when they were college students. The provided teaching resources such as textbooks don't change much over the years.	Teachers are learning all the time. Technology enables teachers to re-design and modify the provided teaching resources for better teaching and learning outcomes in various situations.
Student-context	Students are arranged into classes by age. A typical activity is to listen to the lectures and respond to questions.	With new technologies, students can interact across age differences. Combinations of peer-assisted and self-directed learning will be encouraged and supported.
Teacher-context	Teachers usually stay in the school all day long interacting with students and preparing for lessons. It is not rare that teachers grade student work at home.	Teachers can have flexible schedules in terms of when to be at school. Teachers can access student homework and progress reports electronically. The increased flexibility in the work schedule will make teaching more attractive to many.
Content-context	The content is provided in a static textbook or in a didactic manner to students.	Advanced technology allows for a highly interactive learning context where content is provided in an engaging manner.

As seen in Table 1, it is necessary to change the fundamental teaching and learning process if we want to take advantage of the new technologies in K-12 education. The instructional methods, classroom activities, the content delivery formats, the role of teachers and students, etc. all need some level of modification when technology comes to play an integral part in the classroom. Effective technology integration requires much more than dealing with the technology alone. Actually it is less about technology than about pedagogy that can best assist student learning.

Standards and student learning assessment

National and state education standards set the criteria for learning outcomes. The assumption is that there should be a concrete set of knowledge and skills that each grade level of students should acquire, for which the teachers are responsible in helping the students meet. If these guidelines do not change, teachers won't have much flexibility in using available technologies in innovative ways. Since effective technology integration will inevitably bring changes in educational practices, the corresponding standards should be adjusted to meet the changed educational practices. Otherwise, it will hinder the effective use of technology in education.

In terms of student learning assessment, educators believe that assessment drives instruction (Gardner 1993; Castle et al., 2006). The current format of standardized tests needs to be changed if a constructivist learning environments is to be nurtured. Mastery-based and performance-based tests should be encouraged instead of using standardized tests to sort students (Reigeluth & Joseph 2000). Needless to say, technology integration will not be effective if the measurement of student learning outcome is incompatible with the daily teaching and learning change. In the United States, hopefully, the U.S. Department of Education is addressing some of the major concerns of NCLB act by introducing new flexibility into law (Guilfoyle, 2006).

Administrative and social support

Many studies show that for a technology integration project to be successful, school administrative support is essential (Guilfoyle, 2006, Strudler et al. 2003, Thompson 2003). With strong administrative support, teachers can be given the time and the resources to use technologies not only in their own teaching but also in sharing their experiences with other teachers. Besides school support, the process of technology integration can be expedited if parents and the community also show their respect and appreciation for such changes.

Teacher professional development

Teachers decide what happens in the classroom and how the integration is carried out in daily practice. Therefore, a teacher's knowledge, beliefs and attitudes toward technology integration can have a significant impact on its successful implementation. Although teachers are required to have a certain number of hours of professional development each year, these professional development sessions tend to be useless when it comes to the practice of technology integration. Professional development sessions that do not teach what is needed in classroom practice naturally raise a great deal of frustration among teachers.

One may ask whether the effectively integrated technology can expedite the entire K-12 education process so that students may just need six years to complete K-12 education instead of twelve years. While thinking outside of the box is always encouraged, I argue that education should not be treated like a business process where speed is always emphasized. Acquiring academic knowledge is only one aspect of the education process. Thinking back on my own education, I realize that I learned so much more than the academic content in my K-12 years. My initial world view and values were nurtured in those years and these perspectives formed the basis for my subsequent development. If the whole society is a super system, the changes in K-12 education system have to be in equilibrium within the super system. The society may not need students to graduate high schools when they are only 11-13 years old. While our educational system should provide a certain level of flexibility over learning at different paces and graduating at different ages, educators need to keep in mind that K-12 education is not only about teaching academic content to students, but also fostering many other skills and values for the next generation who will be running the country and making decisions for the society in the near future.

Taken together, I argue that effective technology integration should take all critical components and their interrelationships into account. While a systemic approach does not guarantee ultimate success, it increases the chance of successful technology integration. IBM Credit was able to dramatically decrease the processing time and cut the costs by radically changing the procedure of financing purchase while effectively integrating technology into the new process. Similarly, effective technology integration in K-12 on the one hand requires changes in the fundamental process of teaching and learning, on the other hand it also needs changes in aspects such as teacher professional development and education standards. Without such a systemic change, technology integration efforts can hardly be effective. Yet questions remain: how can such a systemic change be carried out in reality? Where to start and who should initiate it? Further studies are needed in this field if the idea of systemic change is to be implemented in practice. Otherwise, systemic change will merely remain a discussion topic.

BARRIERS TO TECHNOLOGY INTEGRATION

There are numerous empirical studies and conceptual articles that have identified a number of barriers that teachers face when it comes to technology integration in teaching and learning. Three representative studies have been selected for scrutiny in this section.

The Office of Technology Assessment (OTA) of the U.S. Congress has been studying teacher use of computer-based technology in schools since 1986 (OTA 1995). To deepen its understanding of the current state of new technology utilization in K-12 schools, the OTA carried out an in-depth study from1993 to 1995. During this period, OTA personnel visited a number of schools of all different grade levels across the nation. Hundreds of educators including teachers, administrators, and K-12 researchers were interviewed in person or by telephone. The final report identified a number of common barriers to the use of technology in schools (OTA 1995): lack of time, access to technologies, vision or rationale for technology use, training, technical and administrative support, funding, inappropriate materials, and not compatible with current assessment practices.

Quality Education Data Inc. (QED) (Quality Education Data 1995) conducted an education technology survey of 600 teachers and media coordinators, 300 principals, and 100 district administrators to determine electronic technology usage, attitudes towards it, and barriers to its utilization. Seven barriers to computer-based technology integration were identified in this study: lack of workshops and training, time to learn how to use, access to equipment, class time for use, relevance to the curriculum, motivation, and funding.

Zhao et al. (2002) conducted a qualitative study to empirically address the question of “why don’t teachers innovate when they are given computers?” They selected 10 teachers from a pool of over 100 teachers who participated in a technology integration program. These teachers were monitored for about a year in an effort to determine which factors promoted or hindered the teachers’ effective use of technology in the classrooms. They found a number of critical factors affecting the overall success of classroom technology integration. The barriers mentioned in these three studies are summarized in Table 2.

Table 2: *Barriers to technology integration*

	Barriers	OTA	QED	Zhao et al.
1	Lack of time to learn	X	X	
2	Lack of class time for use	X	X	
3	Lack of access to technologies	X	X	X
4	Lack of training	X	X	X
5	Lack of technical/administrative/social support	X		X
6	Lack of funding	X	X	
7	Lack of control over inappropriate materials	X		
8	Lack of motivation and social awareness		X	X
9	Incompatible with current assessment practices	X		X
10	Lack of vision or rationale for technology use/lack of relevance to the curriculum/ Incompatible with pedagogical belief	X	X	X
11	Incompatible with school culture			X

Most of the barriers identified above tend to be external to teachers and are more resource-related. However, in recent years as computer-based technologies have become more and more available in K-12 settings, educators have begun to notice that the more critical barriers to technology integration are in fact those that are internal to teachers (Ertmer 2005; Hasselbring 2000; Zhao 2002). Since the internal barriers usually lie within a teacher's underlying value system concerning teaching and learning, they are not easily identifiable as barriers. Ertmer used the classification of "first-order and second-order barriers" to describe the external and internal barriers to teacher technology integration (1999). First-order barriers are those that are often seen initially as "the" obstacles, e.g., the issues of adequate access to the technologies, training, and support without which it is almost impossible to talk about technology integration. However, overcoming these first-order barriers does not necessarily indicate that technology integration and the effective and innovative use of technology will naturally follow.

Second-order barriers are those that are embedded in a teacher's philosophy of teaching and learning, they are more hidden and deeply rooted in daily practice (Ertmer 1999, 2005). Number 10 in the above table are examples of a second-order barriers: lack of vision or rationale for technology use, lack of relevance to the curriculum, and incompatible with pedagogical belief. If the old ways of teaching and learning don't change, teachers will continue to perceive technologies as something incompatible with their professional practice. This barrier will inevitably result in ineffective use of the technologies. All three empirical studies cited above point out the existence of these fundamental barriers.

Educators seem to have realized that the fundamental process of teaching and learning has to be changed if the technology is going to add a measurable value to education. Old assumptions about how teaching and learning turn out to be the most difficult barriers to overcome. If we take a look at the current K-12 education, such old assumptions (i.e., traditional ways of teaching & learning) are still prevalent in many schools. Therefore, it is not difficult to understand why about 90% of teachers do not effectively integrate technology (MDR 2003) even after the first-order barriers are substantially reduced.

STAGES OF CHANGE: ADDRESSING THE BARRIERS

Effective technology integration is a multi-sided challenge that requires much more than buying computers and connecting to Internet. While overcoming first-order barriers is critical, it is more difficult and time consuming to overcome the second-order barriers since it requires individuals to change their attitudes, beliefs, and behaviors. As mentioned in the previous section, teachers' beliefs and philosophies that are incompatible with technology mediated change is a major barrier to effective integration of technology in a K-12 setting. The main difficulty to overcome such barriers is that people tend to resist change when their old assumptions and values are challenged. Teachers need to "experience conflict within their expectations" first when the new technology requires a change in their pedagogy (Wetzel 2001). Therefore, any technology integration needs time to be implemented. Many have indicated that change is a process, and the process of individual change tends to follow certain stages (Hall & Hord 2001; Prochaska et al. 1994; Rogers 2003; Scott & Jaffe 1989). Although these change process models in the literature are developed in different disciplines including education, health, agriculture, and business, they tend to have a great deal of similarities (see table 3).

Table 3: *Stages of change in the literature*

Hall & Hord (Stages of concerns)	Prochaska et al. (Stages of change)	Rogers (Stages in the innovation-decision process)	Scott & Jaffe (Phases of transition through change)
• Awareness • Informational • Personal • Management • Consequence • Collaboration • Refocusing	• Precontemplation • Contemplation • Preparation • Action • Maintenance • Termination	• Knowledge stage • Persuasion stage • Decision stage • Implementation • Confirmation	• Denial • Resistance • Exploration • Commitment

I will use some of the key common ideas of these stages of change models to discuss K-12 technology integration in the following section. Although there are different stakeholders in K-12 education, individuals tend to follow the same pattern when it comes to change (Rogers 2003; Hall & Hord 2001).

Most change starts with pre-contemplation

At the stage of pre-contemplation, "it isn't that they can't see the solution, it is that they can't see the problem" (Chesterton, as cited in Prochaska et al., 1994, p.40). If individuals do not believe there is a problem, they don't think about changing their habits. This is precisely the most serious barrier to K-12 technology integration. Because the teachers and administrators believe the old approach of teaching and learning is sufficient, they are reluctant to use new technologies in an innovative way to enhance the learning outcomes. Therefore, pre-contemplators resist change. Rogers (2003) suggests that people at this stage need more information and knowledge about the problematic situation. When an individual becomes more aware of the problems, she or he becomes more receptive to change. According to former secretary of Education, Richard Riley, the top 10 in-demand jobs in 2010 did not exist in 2004 (Abel, 2006). This means that today's educators are preparing students for jobs that don't even exist yet. Clearly, the old approach of teaching and learning is no longer sufficient to address today's education needs.

Knowledge change precedes behavioral change

All the change models above tend to agree that individuals need to update their knowledge about the problem and its possible solutions before they accept the solution in a behavioral manner. It is also believed that a successful innovation should achieve human attitude change before human behavior change (Miller 1994). Developing a common vision of how to effectively use technology to accomplish educational goals is the first step toward changing practitioners' knowledge and attitude about technology integration (Fullan 2001;). Ertmer (2005) further indicates that modeling, reflection, and collaboration are good strategies to show teachers what technology can do for them and their students, how it can be done effectively, and how they can start. Without these stages of knowledge change, it is hardly possible to expect behavioral changes in daily practice.

Each stage does not necessarily lead to the next

Although there is a sequential pattern in the stages of change, it is possible to be caught at one stage or another. Hall & Hord (2001) point out that the flow of stages of concerns is not always guaranteed in an individual change process. For example, if the principal is supportive, if the perceived result is positive, and if the change is carefully facilitated, then teachers can move from earlier stages to later ones smoothly. However, in reality many "ifs" may not be present and thus results get stuck at one stage or even relapse to earlier stages. In technology integration, this remains a vital issue, especially in the move from the "action" stage to the "maintenance" stage. For example, Zhao et al. (2003) report that one teacher, Willa, has been inspired to use computers in her classroom in an innovative manner. However, "a single exposure to these new ideas may not have been enough to support the long-term and consistent application in the classroom" (p.493). Although Willa has tried the new way of using technology, it has not led her to the maintenance stage because she has lost "sight of the pedagogical basis for the technology" as the authors explain. It seems clear to us that each stage of change process needs a number of conditions that help nurture a conducive environment for individuals. Otherwise, the change process will be arrested in at a certain stage.

Trying to skip stages may result in failure

People who try to work on a stage that they are not yet ready for tend to fail in the end. For example, the "refocusing" stage (Hall & Hord 2001) requires a teacher to outgrow what she/he has been told and shown about the innovation. However, finding an innovative way to use the new technology effectively in own situation does not happen in a vacuum, no matter how positive the teacher's attitude toward such an innovation is. If the teacher did not go through the preparation stage such as getting adequate technical and pedagogical training first, his or her efforts to integrate technology in the classroom will face more challenges than those who have gone through the previous stages of change. Similarly, when administrators or other advocates of an innovation force teachers to use a certain technology in the classroom, the innovation tends to fail since teachers have not been given the time and effort to go through the previous stages of change and thus may not see the relevance or usefulness of the technology.

In short, individuals tend to follow a sequence of stages of change when faced with the challenge to adopt an innovation. When facing the same innovation, people within an organization can belong to different stages of change due to the individual differences such as in background and experience. "The stages of change can thus serve to classify individuals into segments on the basis of their readiness for behavior change, with a different program tailored to each individual" (Rogers 2003, p.201). Understanding teachers' stages of change in terms of technology

integration can help identify what teachers need in a timely manner and can thus expedite effective technology integration process.

Although the basic pattern of stages of change may suit people involved in all kinds of innovations and change processes, it is important to point out that educational innovation "rarely think[s] of students as participants in a process of change and organizational life" (Fullan 2001, p.151). Students are naturally treated as the beneficiaries of changes and their voices are seldom heard in the literature. It is possible that students are accustomed to follow what has been arranged for them and thus tend to be more receptive than adults when facing an innovation. More research is needed to determine whether students also tend to go through similar stages of change when it comes to technology integration in the classroom.

CONCLUSION

As more and more schools are equipped with modern technologies, the resource related first-order barriers tend to be eliminated a great deal, and the second-order barriers are realized as more fundamental barriers to technology integration in K-12 setting. Since these fundamental barriers are deeply rooted in teachers' pedagogical and psychological beliefs about teaching and learning, overcoming these barriers inevitably results in resistance. The stages of change models remind us that it takes time for a resister to become an effective user of technology in education. These models also tell us that individuals at different stages of change may need different kinds of support. Therefore, it will take a great deal of effort to accomplish effective technology integration in the daily teaching and learning process. One solution for making such qualitative change is to use a systemic change approach. Many critical components that are related to K-12 daily practice such as instructional methods, teacher and student roles, learning environments, assessment criteria, teacher development process and their interrelationships will be taken into consideration in a systemic change process. Making such fundamental changes is surely a challenge for many teachers, administrators, and other stakeholders. However, we know such a systemic change is doable as there are successful cases in the literature. Fullan (1993, p.26) remind us over a decade ago that "successful schools do not have fewer problems than other schools – they just cope with them better". If educators use a systemic approach to deal with both first- and second-order barriers, success will ultimately come.

REFERENCES

Abel, B. 2006. "The new frontier — The world", *The Magazine of Marquette University*. Retrieved on January 11, 2009 from http://www.marquette.edu/magazine/winter06/frontier.shtml

Castle, S., Fox, R. K., Souder, K.O. 2006, "Do Professional Development Schools (PDSs) Make a Difference? A Comparative Study of PDS and Non-PDS Teacher Candidates", Journal of Teacher Education, Vol. 57, No. 1, 65-80.

Ertmer, P. A. 1999, "Addressing first- and second-order barriers to change: strategies for technology integration". *Educational Technology Research and Development,* vol. 47, no.4, pp.47-61.

Ertmer, P. A. 2005, "Teacher Pedagogical Beliefs: The Final Frontier in Our Quest for Technology Integration?". *Educational Technology Research and Development,* vol. 53, no.4, pp.25-39.

Frick, T.W. 1991, *Restructuring Education through Technology*. Phi Delta Kappa Educational Foundation.

Fullan, M. 1993, *Changing Forces: Probing the Depths of Educational Reform*. London: Falmer Press.

Fullan, M. 2001, *The New Meaning of Educational Change*. New York, NY: Teacher College, Columbia University.

Gardner, H. 1993, *Multiple Intelligences: The Theory in Practice*. NY.

Gates, B., Myhnold, N., & Rinearson, P. 1995, *The Road Ahead*. New York: Viking: Penguin.

Guilfoyle, C. 2006. "NCLB: Is There Life Beyond Testing?" Educational Leadership, vol. 64, No.3, pp.8-13.

Hall, G.E. & Hord, S. M. 2001, *Implementing Change: Patterns, Principles, and Potholes.* Needham Heights, MA: Allyn and Bacon.

Hasselbring, T. S. S., Laurie Glaser, Candyce Williams Barron, Linda Risko, Victoria J. Snyder, Chris Rakestraw, John Campbell, Marilyn. 2000, *Literature Review: Technology To Support Teacher Development.*

Johnson, D. L., Maddux, C. D., & Liu, L. 2000, *Integration of technology into the classroom: case studies*. Binghamton, NY: the Haworth Press.

Kleiner, B., Thomas, N., & Lewis, L. 2007, *Educational Technology in Teacher Education Programs for Initial Licensure (NCES 2008-040,* Washington, DC: National Center for Education Statistics, Institute of Education Sciences, US Department of Education.

Market Data Retrieval, M. 2003, "Trends in the K-12 Education Market". Retrieved October 16, 2003, from *Trends in the K-12 Education Market*: http://www.schooldata.com/

Miller, N. 1994, "Toward a common vision: the change process in practice". In C.M. Reigeluth & R.J. Garfinkle (Ed.), *Systemic Change in Education*. Englewood Cliffs, NJ: Educational Technology Publications.

Office of Technology Assessment, U. S. C. 1995, *Teachers and Technology: Making the Connection* (No. OTA-EHR-616). Washington, DC: U.S. Government Printing Office.

Prochaska, J.O., Norcross, J.C., & Diclemente, C.C. 1994, *Changing for Good*. New York, NY: William Morrow and Company.

Quality Education Data 1995, *Education Technology Survey*, 1995.

Reigeluth, C.M. 1994, "The imperative for systemic change". In C.M. Reigeluth & R.J. Garfinkle (Ed.), *Systemic Change in Education*. Englewood Cliffs, NJ: Educational Technology Publications.

Reigeluth, C., & Joseph, R. 2002, "Beyond technology integration: the case for technology transformation". *Educational Technology,* vol. 42, no.4, pp.9-16.

Rogers, P. L. 2000, “Barriers to adopting emerging technologies in education”. *Journal of Educational Computing Research,* vol. 22, no.4, pp.455-472.

Rogers, E. M. 2003, *Diffusion of Innovations* (5th ed.). New York, NY: Free Press.

Scott, C.D., & Jaffe, D.T. 1989, *Managing Organizational Change*. Menlo Park, CA: Crisp.

Strudler, N., Archambault, L., Bendixen, L., Anderson, D., & Weiss, R. 2003, “Project thread: technology helping restructure educational access and delivery”. *Educational Technology Research and Development,* vol. 51, no.1, pp.41-56.

Thompson, A.D., Schmidt, D.A., & Davis, N.E. 2003, “Technology collaboratives for simultaneous renewal in teacher education”. *Educational Technology Research and Development,* vol. 51, no.1, pp.73-89.

Wetzel, D.R. 2001, A *Model for Pedagogical and Curricula Transformation with Technology*. National Educational computing Conference, “Building on the Future”, Chicago, IL.

Zhao, Y. P., Kevin Sheldon, Stephen Byers, Joe L. 2002, “Conditions for Classroom Technology Innovations”, *Teachers College Record, v*ol. 104, pp. 482