

# The Historical Development of Instructional Technology Integration in K-12 Education

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“People don’t change when you tell them they should. They change when they tell themselves they must.”

Thomas L. Friedman, *The World is Flat: A Brief History of the 21<sup>st</sup> Century*, p. 462.

In 1970, Alvin Toffler wrote *Future Shock* and he also declared a new epoch had begun. This new epoch would be characterized by ever accelerating change; and those who are most adaptable are the only ones who will survive. Marc Prensky (2006) recognizes this change and how it is affecting education when he calls the children born into this new age “digital natives” (p. 8). What both of these individuals have in common is a vision of the world that has fundamentally changed in the last half of the 20<sup>th</sup> century; thus, we are living in a new period in human history. Larry Cuban (1993; 2001; 2004) recognizes this change but he contends that education has not changed to match it, while others such as Henry Becker (2001) see change occurring in education albeit at a slower, more measured pace. So, what is the truth, not from an epistemological or ontological point of view, but from a practical point of view? Is change occurring in education to match the change that is occurring throughout the world?

In 2001, Larry Cuban wrote a stinging rebuke of the educational technology movement in *Oversold and Underused: Computers in the Classroom*. This book undermines the educational technology movement which had been gaining momentum throughout the 1990s with the support of some very powerful allies in government and in business (Ferending, 2003; Cuban, 2004). These “policy elites” (Ferending, 2003, p. 243) included President Bill Clinton and House

Speaker Newt Gingrich and together with the lobbying efforts from the business community (Cuban) pushed through Congress some far-reaching legislation that reshaped the role that technology was supposed to play in education in the 21<sup>st</sup> century (see question 2). The impetus for technology's rise in prominence is the argument that if education does not embrace technology that education will become irrelevant (Ferending). This "technological determinism" (Ferending, p. 82) argument and the rhetoric of inevitability that resulted was so pervasive and so persuasive during the 1990s that the voices of the critics like Neil Postman (1992) were silenced resulting in legislation being passed allowing for money to flow readily (see question 2) without any of the policy elites questioning its efficacy (Ferending).

By 2001 the political climate had changed with the election of President George W. Bush and the public's sentiment had changed with the publication of *Oversold and Underused* (Cuban). The reaction was almost immediate. Henry Becker and Jason L. Ravitz (2001) gave a presentation at the American Education Research Association Conference: *Computer Use by Teachers: Are Cuban's Predictions Correct?* Sheekey (2003) edited a book that elicited responses from educational technology programs that were succeeding entitled *How to Ensure Ed/Tech is not Oversold and Underused*.

At the same time that critics of technology in education were regaining their voice, developments in the political arena with the passage of *No Child Left Behind Act of 2001* (NCLB) were creating significant problems for the integration of technology into the K-12 environment. NCLB represented the culmination of 18 years of effort to apply business practices (Ferending, 2003; Cuban, 2004) to education with the stipulation that each school will be held accountable for how their students perform on a standardized test (see question 2). With the

pressures exerted by this law, schools and teachers are more reluctant to try technology integration strategies (Ferending, 2003).

Cuban's (2001) main thesis is that technology was being used only as a first-order of change. There are two types of change: first-order change and second-order change (Cuban, 1993; Fullan, 1993; Ertmer, 1999; Moursand, 2002). In first-order change current practices are not changed, they are altered superficially to adapt to a new situation. Moursand calls this the amplification stage of change; current practices are just amplified not fundamentally changed. Ertmer calls this type of change external change, or change that is external to the individual; change which "adjust' current practices, in an incremental fashion, making it more effective or efficient, while leaving underlying beliefs unchallenged" (p. 48). Second-order change is fundamental change; "second-order changes confront fundamental beliefs about current practice, thus leading to new goals, structures, or roles" (Ertmer, p. 48). Moursand calls this second-order change revolutionary, whereas, Ertmer calls it internal. Both researchers are referring to deep, internalize changes in belief structures.

Although Cuban (2001) wrote that he did not find many teachers who had fundamentally changed their belief structures, he reported that of the 13 teachers who were interviewed and shadowed four reported changes their classroom practices as a result of the infusion of technology. Four of thirteen teachers only represent a minority, but according to Everett Rogers' (2003) theory of the diffusion of innovations, the number needed to create a critical mass of adopters in any successful innovation is somewhere between 10% and 20%. Taking into account Rogers' (2003) theory, one could look at Cuban's (2001) findings differently.

In the journal article about this same study, Cuban, Kirkpatrick, and Peck (2001) also discovered that teachers' age, experience, and gender were not factors in explaining why

technology was not being used in constructivist ways. What this study found is that a teacher's belief structure about teaching and learning is one of the most important factors that inhibited a teacher's adoption of the technology integration pedagogy. This coincides with research from Becker (2001), Windschitl and Sahl (2002), and Hernandez-Ramos (2005). What must be remembered is that the diffusion of innovation is a social process (Rogers, 2003), and that "an important factor regarding the adoption rate of an innovation is its compatibility with the values, beliefs, and past experiences of individuals in the social system" (p. 4). With this understanding of the rate of adoption technology integration will most likely take longer than expected because most teachers would have to change their belief structure. What Cuban et al. also confirmed was that the time to learn how to use this technology, the lack of training in the use of this technology, and the unreliability of this technology were significant inhibitors to the adoption of technology integration strategies.

In spite of these inhibitors, Cuban, Kirkpatrick, and Peck (2001) theorized that there may be two other explanations for this lack of progress in the adoption of technology integration strategies: the technology revolution is a slow process, "small changes accumulating over time create a slow-motion transformation" (p. 826); and the context of high schools emphasizes structure and time rigidity. Cuban et al. rejected the first explanation as implausible; but accepted the second explanation as valid. By rejecting the first explanation, Cuban et al. were ignoring a large body of research in diffusion of innovations indicating that adoption of innovation can take a very long time (Rogers, 2003). Rogers discusses education diffusion research that was done by Paul Mort at Columbia University, "Paul Mort and his colleagues found that a considerable time lag was required for the adoption of educational innovations. 'The average American school lags

25 years behind the best practice' (Mort, 1953)" (p. 61). Cuban and his colleagues may have been premature in declaring this diffusion as failed.

Associated with the lack of time and the lack of training that were mentioned by Cuban, Kirkpatrick, and Peck (2001), is one factor that this study mentioned which has not been mentioned anywhere else in the literature but plays a significant role in the lack of progress on this issue: "teacher turnover undermines the implementing and institutionalizing of technological innovations and contributes to maintaining common teaching practices" (p. 829). Teacher attrition is probably an underlying reason that the diffusion of technology integration is slower in being adopted than is the average educational innovation. Even though teacher attrition is not mentioned in the educational technology literature, it is a regularly discussed topic in educational administration literature and is recognized as a major problem for school districts in achieving a quality teacher workforce (Darling-Hammond, 2003). This literature indicates that 33% of all first-year teachers will leave the teaching profession within the first five years. Since, as Ertmer (1999) points out, it takes five years for a teacher to evolve from a direct instruction teacher to a constructivist teacher, and since there is such a high teacher turnover rate, it can be reasonably assumed that one of the reasons that most schools have not achieved the necessary number of technology integration early adopters to reach that critical mass stage is teacher attrition.

Pedro Hernández-Ramos (2005) did a follow-up study four years later in the same school district that is the subject of Cuban's (2001) study. Even though he did not work with the same teachers, Hernandez-Ramos' findings are significant in that they confirm Cuban's findings. In contrast, Becker (2001) cast doubt on the Cuban findings. Using responses from thousands of teachers nationwide, Becker finds circumstances in which teachers did transform their teaching styles along constructivist lines. This contradiction is easily explained using Rogers' (2003)

diffusion of innovations research. Of the five perceived attributes of innovations, the most important attributes are relative advantage and compatibility. Becker finds teachers who had adopted a constructivist pedagogy; and for those teachers, technology integration is relatively advantageous and is compatible with their beliefs about teaching and learning. When weighing the merits of Cuban's findings against Becker's findings does one choose to believe the glass is half empty or half full.

Henry Becker's (2001) study tries to discern what factors contributed to a teacher's utilization of technology integration along constructivist lines. Becker finds that there are four predictors that determine which teachers utilize technology a constructivist approach to teaching and learning: 1) the teacher's technical expertise and use of computers for professional use, 2) teacher involvement in informal leadership roles within and outside of school, 3) the number of computers within the teacher's own classroom, and 4) the teacher's philosophical belief in teaching and learning. In addition to these predictors, Becker further discovers that there are three inhibitors to the use of technology integration practices. The first is the lack of access to computers within the teacher's classroom. This research indicates that if a teacher has five to eight computers in the classroom, that teacher is twice as likely to use computers in a constructivist manner. The second barrier that Becker identifies is the organizational structure of high schools where "the day is carved up into different classes" (p. 5) and where the teachers feel pressured to cover large amounts of curricula. The third barrier is teachers' lack of technical expertise with using computers. These last two inhibitors coincide with the findings of Cuban (2001).

These philosophical beliefs mentioned by Cuban (2001) and Becker (2001) and many others are based upon a teacher's belief concerning how students learn best. There are two

different teaching methods being used by teachers today. The first one is based on the behaviorist philosophy of B. F. Skinner (1953) and his stimulus and response methods of teaching. This teaching method is known as direct instruction and it thinks of the student as a passive recipient of knowledge; it creates the role of teacher as the dispenser of all knowledge. This model when used with computers, turns the computer into an electronic tutor providing programmed instruction primarily for remediation. Reeves (1998) called this method of using computers as “learning from” (p. 4) computers.

The second method of teaching being used today is based on the philosophy of Jean Piaget (Jacob, 1984) and it is called constructivism. It is based on the concepts that students construct their own knowledge by building upon prior knowledge. The student is an active participant in creating this knowledge, not a passive recipient. In the constructivist model, the teacher becomes the guide, the facilitator, helping the students construct their own knowledge. This model of teaching when used with computers turns the computer into a cognitive tool (Reeves, 1998) to be used by the student in the student’s quest to construct and display knowledge. Reeves called this method of using computers as “learning with” (p. 4) computers.

If a teacher’s belief structure is a critical component in whether or not that teacher adopts technology integration instructional practices, then is it possible to change the belief structure. The short answer is yes (Dwyer, 1995; Ertmer, 1999; Rogers, 2003), but it takes a great deal of time and a tremendous amount of professional learning opportunities. The reason that the National Educational Technology Plan (U.S. Department of Education, Office of Educational Technology, 2004) listed that educational technology has failed to live up to its promise is that there is inadequate training for the teachers who had to implement technology into the classroom. This is a rather simplistic approach to this problem because the adoption of

technology integration involves educational change (Fullan, 2001) and the diffusion of innovation (Rogers); educational change never involves a simplistic solution; and the diffusion of innovation especially in education takes a great deal of time. Michael Fullan, in his authoritative study of educational change, reports that change is never simple, “putting ideas into practice [is] a far more complex process than people realize” (p. 5). Furthermore, Fullan reports that people do not “resist change as much as they don’t know how to cope with it” (p. xii). This inability to cope with change is caused by a feeling of “loss, anxiety, and struggle” (p. 30). Change, or innovation, takes teachers out of their comfort zone creating uncertainty and anxiety (Fullan; Rogers). Therefore, to ensure the successful adoption of any educational change it is essential that teachers who are on the front line of any educational reform must have a shared meaning of that change (Fullan; Sergiovanni, 2006) of why this reform will benefit the teaching and the learning experience before the teacher will embrace it. Rogers points out that the diffusion of innovation takes place within a social system; however, as Sherry and Gibson (2002) explain there are problems applying Rogers’ diffusion theory to schools because a school system is not a single social system. The educational system “is a centralized organization with embedded systems consisting of teachers within classrooms, within schools, within districts” (Sherry & Gibson, p. 179).

Fullan (2001) believes that a shared meaning helps alleviate the anxiety of implementing any educational change. Without this shared meaning any reform effort is doomed to fail because any educational reform must ultimately be translated into a change in practice on the part of teachers (Fullan). Therefore, getting teachers to understand and to internalize the importance of adopting an educational innovation and then to put that reform into practice in their classroom is the key to implementing a successful innovation. In addition, Fullan argues that, “First, change



will always fail until we find some way of developing infrastructures and processes that engage teachers in developing new understandings. Second, it turns out that we are talking not about surface meaning, but rather a deep meaning about new approaches to teaching and learning” (p. 37). It is this deep meaning that goes to the heart of educational change that is necessary in implementing technology integration strategies.

The reason that educational change efforts often fail (Cuban, 1993; Cuban, 1998; Fullan, 2001) is because that they do not often take into account the culture of the schools. As Cuban (1993) points out the culture of a school is one of the most important factors in the success or in the failure of any educational technology reform agenda; a thesis supported by Fullan. Furthermore, Fullan also describes the need to change the culture of the classroom and of the school. Fullan calls this change in culture as “reculturing” (p. 34); this reculturing represents the questioning and the changing of ones beliefs and habits. When it comes to adopting educational technology along constructivist concepts this reculturing must occur because if it does not then the adoption of this reform will only take place at the first order of change (Cuban, 1993; Ertmer, 1999; Cuban, 2001 Moursand, 2002). Furthermore, Becker (2001), Cuban (2001), and Hernandez-Ramos (2005) all found that the educational technology reform movement was not causing a reculturing in every classrooms. One of the reasons for this, according to Fullan, is because for any reform to be successful at the classroom level it must have the support of the layer above – the school leaders – a position supported by Hernandez-Ramos (2005), and Staples, Pugach, and Himes (2005) (see question 3).

If teachers’ philosophical belief structures about teaching and learning are a barrier to successfully implementing technology integration strategies (Dwyer, 1995; Becker, 2001; Cuban, 2001; Windchitl & Sahl, 2002; Hernandez-Ramos, 2005;) then one way to alter those

beliefs is through professional learning opportunities; however, altering these beliefs, as Dwyer (1995), Cuban (2001) and Windchitl and Sahl (2002) found out, is a very difficult task.

Brinkerhoff (2006) points out that “transitioning teachers from novice technology users to effective technology integrators capable of supporting student learning generally takes three to five years” (p. 38). Brinkerhoff came to the conclusion that this change is a process, and is not an event; even though, Brinkerhoff’s “long-duration” (p. 22) professional development study lasted two years, this length of time was insufficient.

The lessons that can be learned from reviewing the history of technology integration in the K-12 educational environment is that technology integration is not easy to implement because it represents a second-order change. There are some steps that can be taken to help teachers make that change such as increasing the number of computers in their classroom (Becker, 2001); but the most important step that can be taken is to develop a process of professional learning that creates a shared meaning about technology. It is this shared meaning which will allow teachers to overcome their uncertainty and anxiety caused by this change. Ironically, a journalist Thomas Friedman (2005) said it best when describing the economic changes that are sweeping the globe, “People don’t change when you tell them they should. They change when they tell themselves they must” (p. 462). Somehow, teachers must be convinced that implementing technology integration pedagogy will improve student learning because when they are, teachers will tell themselves that they must change.

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