Integrating Technology in Classrooms: We have met the enemy and he is us.

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Introduction: Technology, computers, and schools now; failings and doubts

At the cusp of the millennium and in a period marked by the availability of computers and by an information explosion, technology spending in education is at an all time high. At present, U.S. K-12 technology budgets exceed $3.5 billion annually, and further increased spending has been proposed. A recent government report recommended increasing that budget to approximately $13 billion, the equivalent of five percent of all K-12 spending (President's Committee of Advisors on Educational Technology, 1998). Currently, however, computers remain apart from the mainstream of the curriculum and are not integrated, as say, simpler technologies such as books or overhead projectors.

The impetus for computer use in schools is driven in large part by changes in business practices (Cuban, 1995, Kerr, 1996). Indeed, much of the recent economic boom was considered to be driven by computer-encouraged productivity increases (Drucker, 1999). While technology has transformed the manner in which businesses operate, its impact in schools has been modest. While there is a belief that computers could improve educational productivity and help schools to teach more efficiently, evidence to support this belief is scarce. Indeed, the educational landscape is littered (figuratively, if not literally) with the debris of failed technologies.

An emerging backlash has begun to criticize computer use in schools. Some suggest that technology spending has been responsible for diverting limited financial resources from more worthy causes and the emphasis on the use of computers has been blamed for constricting the quality of educational experiences. There have also been complaints about the vocational focus on the development of computer-based skills needed in the business community rather than on the academic needs of individual students (c.f. Oppenheimer, 1997).

Heeding these criticisms, it is important to consider the potential of computers in education. Given the limited impacts of earlier infusions of educational technology, there appears to be little cause to believe that contemporary technology will be more effective than its predecessors. There remains, however, a belief among some educational technologists that computers have the potential to transform educational practice.

The notion that students can learn better with computers is based on the belief that a relationship exists between technology and knowledge. However, this relationship is frequently misunderstood. Technology, by one definition, is an embodiment of knowledge (Saettler, 1990) and, significantly, we also use a wide range of technologies in our pursuit of knowledge (Clark, 1997). Recognizing and understanding the relationship between technology and learning, from the pencil to the computer, should help us improve our educational systems.

The value of the computer in education may be clarified by distinguishing between using it as a transmission device or as a learning device. We believe that too much emphasis has been placed on learning *from* technology (e.g. viewing educational television, completing computer drills and tutorials, etc.) rather than learning *with* technology.

The difference, beyond semantics, is critical to technology's integration into the curriculum. When technology is used simply to deliver content, the only educational benefits that can be anticipated are improved access and educational efficiency. In contrast, improved educational *effectiveness* requires using technology to enable learners to explore, expand, and to enhance their own capabilities; i.e. to create their own knowledge. Instead of using technology to deliver educational materials, our goal should be to develop learning environments in which students more effectively generate knowledge using the technology (Jonassen, 1996; Hannafin, 2000).

It is this generative capability of computers that powers our argument that computers should be integrated into the curriculum. Our end goal in education, and as educational technologists, should be to develop and instill knowledge, not information.

In this paper we will consider the potential of technology in education, examine what it means to "integrate" technology in the classroom, outline barriers to technology integration, and consider several implications for effective technology use. We begin by noting doubts regarding computer use in schools and outlining the potential of computers. Next, we define the term "integration" and examine various levels of educational technology use. Subsequently, we consider the idea of integration through the use of the metaphor of human rights; learning from the barriers and problems of the Civil Rights Movement. We examine barriers to computer integration into the

curriculum and conclude with several imp lications of our observations that are intended to guide teacher education and support professional development for in-service teachers.

The nature of integration

Computer integration occurs along a spectrum of effectiveness and involvement. At one end, computers may be available to assist with various tasks, but their impact on educational activities is minimal. At the other end, a lively curriculum may fully integrate their use as part of normal growth and change. In practice, most teachers fall somewhere in between.

Hooper and Rieber (1994) noted five points in the passage to integration: familiarization, utilization, integration, reorientation, and evolution. Beyond an examination of technology, these layers also illustrate a view of education in general. They suggest the extent to which a teacher -- or curriculum -- is willing to adapt and innovate.

Familiarization occurs when teachers are initially exposed to a new technology. At this stage, technology use is not extensive, and little or no impact is made on the curriculum.

Utilization involves using technology to support and improve the efficiency of the existing curriculum. At this level, computers may simply be used to perform tasks faster and more efficiently. However, qualitative changes in the curriculum are few. As the instructional method does not change, little change in performance should be expected. For example, drill and practice lessons on a CD-ROM are probably about as effective as the same lessons printed in a book. Over the history of education, diverse technologies have been used primarily for functional efficiency, that is, having more students exposed to the same lecture and having lessons codified for broad distribution (Saettler, 1990).

The integration level is marked by the inclusion of activities that could not be attempted without the technology. For example, the computer may act as an enabling force in the curriculum, allowing new instructional methods to be used. Using the computer as a cognitive tool (Jonassen, 1996) in the assembly, examination, or presentation of materials by learners illustrates this type of use.

Reorientation represents a scalar difference in technology use; substantial and significant computer use occurs, causing a re-directioning of the curriculum. Not only may different instructional methods be attempted in the classroom, but the entire curriculum may adopt methods only possible through computer use. One such example is the use of a specific software package in all the classes across a school, and an attendant redesign of the area curriculum. Using Geometer's Sketchpad for all geometry classes, with assignments, exams, and scope all reexamined for use with the software represents such a reorientation.

At the evolutionary level, the specific technologies become less important. Rather, media are differentiated by their capabilities for different methods of instruction. What is significant is the level of innovation, adoption, change, and improvement that occurs in the classroom.

To illustrate how a teacher at the reorientation or evolutionary levels might use technology, imagine how this person might integrate the *potato* as a technology. When would the potato be considered truly integrated into the curriculum? When *some* teachers use potatoes? Or when the curriculum is reorganized to include the potato, and all its capabilities, while teachers continue to develop and evaluate its role in the curriculum. One could imagine counting with potatoes, making art with potato stamps, using potatoes to demonstrate galvanic or osmotic concepts in chemistry, and the potato as the centerpiece in studies of American and Irish history. It is not the specific vegetable that is important for effective use, but rather how the potato is used, and how the teacher and curriculum can take advantage of the unique characteristics of the potato. Moreover, having enough potatoes is not the problem; it is more important to focus on how instructional methods can take advantage of the specific capabilities of the potato to stimu late learning.

The concept of vegetables being fungible, i.e., interchangeable, is an extension of a well-known metaphor in the educational technology field, Clark's (1983, 1994) grocery truck. He argued that as the truck has little influence on the nutrition derived from groceries, the media delivering instruction makes no difference in learning. However, the manner in which a technology is used governs its educational potential. Inherent in the method of strictly comparing technologies by common capabilities, Clark ignores their unique capabilities. A teacher at the evolutionary level could develop exceptional student learners with a potato, while a less developed teacher using high end Silicon Graphics workstations would achieve about the same results as with a simple overhead, in just about the same manner. Different technologies, whether potatoes or computers, have specific advantages that must be recognized and used to fulfill their potential. It is the recognition of the specific advantages that drives improvement in instructional method.

Exploring meaning: Integration as metaphor

The term *integration* may provide us with a useful metaphor to guide technology use. American Society has a strong connection between the term 'integration' and the Civil Rights Movement of the late 20th Century. Integration is a multifaceted process involving equal rights, equal opportunity, and full involvement into society for all citizens, regardless of race; it is a movement that remains in process. We may be able to use cursory observations of the integration process and the terms *ghetto* and *tokenism* to shed light on how technology can be integrated into the curriculum.

Through painful experience, we recognize different levels of integration; integration compelled by law or by edict often falls short of true and complete integration. When integration is forced on society, only token participation (i.e. minimal and by quota) often occurs. When computers are restricted to a ghetto, value is limited for the curriculum as a whole.

Tokenism is clearly evident in how some schools have used computers. For example, some school districts provide a computer for each classroom. While such a policy ensures that all classrooms have computer access, little substantive change can be expected when individual access is so minimal. As with token racial integration, only limited change occurs.

One can also imagine a curriculum where computers are ghettoized, located far from the mainstream learning activities. They are not a part of the regular schooling, but held as a separate, albeit special, element in schooling often called "computer labs". Here as well, there is no integration, but what is more accurately described as segregation. Access is controlled, limited, and divergent and informal uses denied. Clearly, integration into the curriculum will also not occur through the computer ghetto. Exceptional results may occur in limited areas, but that progress will not extend across the curriculum until the computer leaves the single-use room, and is dispersed physically and pedagogically.

The goal of an integrated society builds on the notion that all races freely interact, and the values, cultures, and creations of each is shared and cherished. So too, we envision a curriculum where technology use is determined by its capability to support learning. In such an environment computers would be used as an active part of the classroom; where technology is not a special event, but rather as a normal part of the classroom and curriculum.

Obstacles to computers integration

Given the substantial investment in computers and internet access, what are the impediments that remain to full and vibrant use of computers in the curriculum? Presumably, there is more to effective and integrated use of computers than simply installing the technology.

Ertmer (2000) addresses technology integration and identifies two sets of obstacles in education. They are first order obstacles, which include problems involving hardware, access, and technical support; and second order obstacles, such as changes in pedagogy, or personal preferences that influence an individual's acceptance of new ideas.

First order obstacles are clearly quantifiable and demonstrate the level of our commitment to new technologies. They are at the forefront of both our current engagement with technology and the belief that computers will improve education. Society is working diligently to overcome these obstacles as demonstrated by the number of computers installed, and the quest to wire all schools to the Internet: 86% of all K-12 students have access to computers either through home or school; over 95% of all schools have computers installed (NPR/Milliken, 2000). With "5 *zillion*" computers already installed in the K-12 educational system, is it any wonder that vast improvements in the quality of education are anticipated?

Yet, it is an examination of second order obstacles that may explain our failure in this "Great Leap Forward" and provide insights into potential success. The real need for change is not with access to the machines, support or software; the 'problem' is within. It is pedagogical, curricular, and methodological. The concept of technological integration into the classroom may be as much about evaluation, change, and reflection of the curriculum as it is about computers. It's personal: We have met the enemy and he is us (Kelly, 1954 et. seq.).

The computer will affect how the curriculum is organized, what is taught, and how instruction is conceptualized, and structured. They will affect how and what people learn.

Implications

As discussed, successful integration is more than a story of numbers. It involves a series of changes and re-orientations that are less dependent on the number of computers in a school or classroom, and more dependent on other human factors. While teachers use computers at about the same rate as the rest of society (Cuban, 2000), integration of the computer into the curriculum often lags primarily due to soft factors (Ertmer, 2000). While

teachers use computers for managerial tasks, it appears that use has not extended to their instructional methods. The implications of these observations may be summarized into a series of heuristics:

It's the method, stupid. (With apologies to James Carville). The critical element in any educational environment is the instructional method, not the means by which it is delivered. Computers, whether integrated or not, are not the sole determinant for the curriculum nor do they guarantee success. The questions behind the integration of technology into the curriculum are not solely about computers; they are also about educational improvement.

Attributing improvement or lack thereof to the use of computers is a simplistic answer to questions of educational quality; the true source of success is woven into the entire fabric of the educational enterprise. The value of computers comes from their enabling new instructional methods and procedures.

Central to the effective use of computers is an understanding that computers affording new and different instructional practices in teaching. Traditional and existing methods won't work any better through computer use. Merely changing the delivery medium will not improve quality. What must change is the instructional method.

Imagine the differences between a creative, skilled teacher *without* computers and a less endowed teacher *with* computers. Which teacher would we rather be with in a classroom? Clearly, the former would be more effective on a number of levels. The creative and skilled teacher utilizes the materials at hand to present the curriculum in an appropriate, engaging, and intriguing manner.

Start at the beginning. Although it is necessary to place computers where they will be used most effectively, it is critical to develop the skills and attitudes of new and in-service teachers toward their effective use of computers in the curriculum. Our primary ability to influence education on a broad scale lies with the preparation of new teachers, and through that route must come improved and integrated uses of computers as cognitive tools and media. Computers, like teachers, must encourage learners' skills to investigate and involve themselves in their studies.

Technology courses in teacher preparation programs can help alleviate new teachers' technology fears, provide them with new skills for their work, and possibly, give new teachers the ability to instill those computer enhanced investigative skills in their own studies.

Critical to the enhanced use of computers and their true integration into the curriculum is the development of teachers' skills to levels beyond introductory use. Teachers must develop skills beyond the rote use of simplistic applications. (For example, use of a computerized grade book is faster, more accurate, and more efficient, but merely improves an existing process; it does not change the nature of the activity or the educational process.)

In our educational system, we learn to use writing, reading, mathematics, and scientific inquiry as media for enquiry (Hokanson & Hooper, 2000). Used in a representational manner, writing, for example, can be used to record the verbiage of the classroom. Writing used in a generative manner, to expand and explore a classroom discussion, is much more effective at encouraging learners to develop new ideas and stimulating retention of the material examined. Engaged learning, where the student is motivated and involved in developing ideas as part of the learning process, is more effective at developing cognitive skills and information retention. Engaged media, where the unique characteristics of the media are used to investigate and generate will be similarly more effective.

The future of technology is <u>not</u> to make education easier, but rather to make learning more effective. Technology use often focuses on making education easier and more efficient. Yet learning requires effort and is often time consuming. For example, we retain more information when we are forced to use or manipulate ideas: Strategies that force us to summarize, restate, or invent have important cognitive benefits. Similarly, higher levels of cognition also benefit from mental exertion (c.f. Jonassen, 1996, Salomon, 1983, Kozma, 1991).

Imagine the best teacher we have experienced. Did that teacher make learning easier, or or require less work and involvement? Or did that teacher, in some way, get us to work harder, to put in more effort and thought, and thereby to develop our own skills and understanding?

As with the best teachers, educational computer uses should require that more cognitive effort goes into the computer (i.e. is provided by the learner) than comes out (i.e. is delivered by the system). Learners should provide ideas, structures, information, and in some cases motivation to the learning process.

Conclusion

We began this investigation with several commonly cited criticisms about contemporary uses of computers in education. Although much money has been spent, and much effort expended to install computers and internet access in to the nation's schools, few improvements in educational outcomes have occurred. We believe that computer technology has not been used effectively, following the pattern of other earlier technologies used for education such as television, film, and radio.

This notion of effective technology use parallels recent theoretical developments in our understanding about how people learn, in particular the shift from instruction to knowledge construction, i.e. the understanding that learners create their own knowledge. Using computers in a generative (as opposed to representative) manner is central to effective educational use. That is, the most effective methods require users to actively investigate, create, and generate ideas, rather than to watch passively.

The range of computer technology integration is broad and includes different levels of involvement and use, which are tied to a curriculum and instructor's ability to accept and use new technologies. Given this extensive and diverse range, it is logical to believe that there are more impediments to computer integration than simple hardware access; recent research by Ertmer (2000) supports this implication. We found similar impediments to integration in our comparison to civil rights integration; while numbers and dictums may mandate and quantify certain actions, the soft and subjective beliefs of a society (or a curriculum) restrain progress. The most substantial impediments to computer integration are subjective and informal, restricting evolution of education.

Our implications focused on two primary areas of required change. First, progress in the area will occur indirectly, and will be influenced through the development of pre-service and through improvement of in-service teachers. The ability – or acceptance – of a new or different technology into a given curriculum is based on the understanding and nature of the teachers. Our second area focused on the nature of computer use and needed curricular evolution. Any technology may be used to improve education, but it is the nature of that use that makes change occur.

As educational technologists, we also know that the changes that can be wrought with the varied technologies are not the panacea for all the ills of education. The lack of effective use may be a symptom of larger changes needed to the system. It's not just about computers, it's about education. Whether teachers accept computers…or potatoes…or any other cognitive enhancement is derived from the culture of their school, from the culture of their society, and from their understanding of the nature of teaching and education.

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