The Digital Learning Environment: What the Research Tells Us

A summary of the current research shaping the evolution of a digital learning environment

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The Digital Classroom

Since 1983, the federal government has invested over $40 billion in educational technology for the K-12 classroom. These federal dollars have come in various forms, such as E-Rate funding, Technology Literacy Challenge Funds (TLCF), and Preparing Tomorrow's Teachers to Use Technology (PT3), in which each source of funding had a specific function (McMillan-Culp, Honey, & Mandinach, 2003). For example, E-Rate supplies funding to schools with the expectation that every student will have access to the Internet. The goal of the TLCF program was to provide computers in the classroom, and funding has been provided through PT3 to train pre-service teachers on the use of technology in the classroom (Dickard, 2003).

In January of 2002, the federal *No Child Left Behind (NCLB) Act of 2001* mandated the integration of technology into the curriculum of public schools in the United States. This landmark legislation provides federal dollars through Title II, Part D, Enhancing Education Through Technology (EETT), with the stipulation that both state and local educational agencies develop a comprehensive plan for the integrated use of educational technology into instruction and curricula to improve teaching and student achievement. The deadline placed on educators is "that technology will be fully integrated into the curricula and instruction of the schools by December 31, 2006" (U.S. Department of Education, 2002).

At the beginning of the new millennium, the National Center for Educational Statistics (2002) defined technology integration as the assimilation of technology resources and technology-enabled practices as a routine and seamless element of the day, so that students are prepared to use technology for the workforce. Technology is a tool to be employed by students in all curriculum areas to acquire new knowledge and skills, analyze and synthesize that data, then construct a product that demonstrates their knowledge (Partnership for 21st Century Skills, 2002). Hence, researchers have concluded that technology integration entails the educators' and students' seamless use of technology as a tool to accomplish a given task in a disciplined study that promotes higher order thinking skills.

The integration of technology in the classroom is a process that involves change in an educational system and occurs over a period of time (NCES, 2002). The attainment of this goal entails a reform in an educator's method for the delivery of instruction with students. The National School Boards Association (2002) stated that the integration of technology is as much about change as it is about technology, as educators must reform their teaching to integrate technology. Researchers have concluded, "The magic lay not exclusively in the technology, but in the interweaving of a systematic program of education reform with the judicious use of technology-based resources" (Chang, Henriquez, Honey, Light, Moeller, & Ross, 1998, p. 43).

This process of change takes time, as a culture or environment must be developed in the classroom that embraces technology as a "natural" part of the everyday work routine (NCES, 20003). According to Sandholtz, Ringstaff, and Dwyer (1997), there is an evolution of thought and practice during the process of change that teachers undergo with the integration of technology. At each stage of the process, the teacher adopts and implements technology in the curriculum (Dooley, 1999; Hall & Hord, 2001; Painter, 2001; and Sandholtz, Ringstaff, and Dwyer, 1997). The integration of technology in the educational system is a time-consuming process, as teachers must change their beliefs about teaching and learning.

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The Digital Learning Environment

The passage of NCLB reinforced the belief that all children can learn and that high standards must be set for all children. While this federal law is a start for preparing students to develop their academic skills for the 21st century, more attention must be paid to developing those technology skills that will typically be required in 21st century communities and workplaces. The Partnership for 21st Century Skills, a consortium of leaders and educators in business and education in both public and private organizations, identified those learning skills in three broad categories: information and communication skills; thinking and problem skills; and interpersonal and self-directional skills.

A Digital Educator creates a learning environment in the classroom that provides the opportunity for students to develop both academic skills and 21st century skills. The digital classroom is conducive for all students by expanding the classroom beyond the four walls into the community. Students are engaged in authentic tasks that have a connection to the real world. In addition, the digital classroom involves all partners of the learning community such as teachers, students, parents, business partners, and higher education experts.

Educators must develop an environment in the classroom so that students can be empowered and develop a passion for learning. Jonassen (1995) has determined that for meaningful learning to occur in the classroom, educators must employ five teaching strategies: active, constructive, collaborative, authentic, and intentional or reflective learning. Zemelman (1998) expanded upon this concept to develop standards for best practices that include student-centered, experiential, holistic, authentic, expressive, reflective, social, collaborative, democratic, cognitive, developmental, constructive, and challenging. The common thread in this type of environment entails educators providing students with the opportunity to be engaged in the learning process.

Learning with Technology

The traditional use of the computer in the classroom has been to teach or tutor students. Thomas Reeves (1998) describes this process as learning "from" computers in which the primary goal is to increase students' basic skills and knowledge. Learning from computers takes on a variety of tutoring systems, such as computer-based instruction (CBI), computer-assisted instruction (CAI), and integrated learning systems (ILS), in which content is provided from the computer (Ringstaff & Kelley, 2002).

The term learning "with" computers refers to students using technology as a tool for problem solving, conceptual development, and critical thinking (Culp, Hawkins, & Honey, 1999; Sandholtz, Ringstaff, & Dwyer, 1997; Means, 1994; Reeves, 1998). When the computer takes on the role of a cognitive tool, it is an intellectual partner to enable higher order learning (Reeves, 1998). Rather than treating students as recipients of knowledge, Jonassen and Reeves (1996) proposed that computers be used as a cognitive tool allowing students to use the computer to interpret and organize their knowledge. The computer is used as a tool allowing teachers and students to control the curriculum and instruction. Examples of tool–based software include spreadsheets, databases, and multimedia software (Ringstaff & Kelley, 2002).

The more advanced uses of the computer support the constructivist view of learning in which the teacher is a facilitator of learning rather than the classroom's only source of knowledge (Trilling & Hood, 1999; Penuel & Means, 1999; Statham & Torrell, 1999). In studies of students using the computer as a tool for instruction, teachers have reported it provides them the opportunity to create a student-centered environment. The teachers become more open to multiple perspectives on problems and are willing to experiment in their teaching (Knapp & Glenn, 1996).

Authentic Instruction

Authentic instruction is based on the premise that students' work in the classroom should prepare them for the intellectual tasks that will be demanded of them as adults. In essence, authentic instruction "stands for intellectual accomplishments that are worthwhile, significant, and meaningful, such as those undertaken by successful adults" (Newmann, 1996, p. 23). In 1990, the U.S. Department of Education's Office of Educational Research and Improvement funded the University of Wisconsin's Center on Organization and Restructuring of Schools to conduct a five-year study on school restructuring to support authentic learning (Newmann & Wehlage, 1995; Newmann, 1996). The researchers visited over 60 schools across the country and observed students engaged in

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activities to create projects, compile portfolios, analyze data, and so on. The researchers recognized and appreciated the active learning in the classrooms but were concerned:

> "Assuming the central purpose of teaching is to help students to use their minds well, then education reform must involve more than innovation in teaching technique, method, or procedure. The merit of any technique, whether conventional or innovative, must be judged on its capacity to improve the intellectual quality of student performance" (Newmann, Secada & Wehlage, 1995, p.3).

Based on their research, Newmann and Wehlage outlined three criteria that are consistent with authentic instruction: (1) students construct meaning and produce knowledge, (2) students use disciplined inquiry to construct meaning, and (3) students aim their work toward production of discourse, products, and performances that have value or meaning beyond success in school (1993, p. 8).

The first criterion requires students to construct meaning and knowledge. This involves "organizing, interpreting, evaluating, or synthesizing prior knowledge to solve new problems" (Newmann, Bryk & Nagaoka, 2001, p. 19). From this perspective, teaching is seen as a means to facilitate active student mental processing by encouraging students to consider all alternatives and view issues holistically, rather than in segmented parts.

The second criterion, disciplined inquiry, requires students to "make use of deep knowledge and engage in substantive conversations" (Peterson, 1997, p. 1). Students delve into specific content areas and acquire the knowledge base of facts, vocabularies, concepts, and theories necessary for their inquiry. Disciplined inquiry also involves interactions and communication with teachers and peers, as students strive to develop and understand the disciplinary relationships and present their ideas (Newmann, Bryk & Nagaoka, 2001).

The final criterion of authentic instruction is for the task to "have meaning or value apart from documenting the competence of the learner" (Newman, Secada & Wehlage, 1995, p.11). The concept of value beyond school involves the transfer of knowledge to an area that has personal significance for the students. Instructional activities might include integrating experiences in the community (outside school) with activities in the classroom. When students are involved in an activity that has no value beyond measuring their success in school, "success in these tasks often carries no adaptive value, because large numbers of students consider school to only be a restricted, even an insignificant, arena of personal experience" (Newmann, Marks & Gamoran, 1996, p. 286).

Standards for Authentic Instruction

Authentic instruction is meaningful instruction. Teachers are able to move students beyond memorization of facts by creating experiences that demand sustained, disciplined, and critical thinking on topics that have relevance to life beyond school. To help teachers assess the "authenticity" of classroom tasks and experiences, Newmann and Wehlage (1993) formulated five standards. Each standard is considered a continuous construct, usually measured on a scale of 1 to 5. The standards are:

1. Higher order thinking
2. Depth of knowledge
3. Connectedness to the world beyond the classroom
4. Substantive conversation
5. Social support for student achievement

These standards are designed to "represent in a quantitative sense the degree of authentic instruction observed within discrete class periods" (Newmann & Wehlage, 1993, p. 11). The standards can be used as research tools or as a framework for teachers to plan and critique their goals, strategies, and outcomes. Newmann and Wehlage caution, however, that the standards are not exhaustive; there is no specific hierarchy of importance among the standards; and achieving a high level of performance on all standards in most lessons is "probably not possible" (1993, p. 11).

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Student Tools

Laptop Computers

An essential condition for the development of a digital learning environment is a classroom in which teachers and students have pervasive access to computers in their classroom (Fisher, Dwyer, & Yocam, 1996; Mann, 1999; and Stratham & Torell, 1999). Until recently, teachers have been hampered because of the scarcity of computers available for instructional use. Often computers are distributed in the classroom, centralized in one area of the school, or there is a combination of the two approaches (Mann, 1999; U.S. Department of Education Policy and Program Studies Service, 2003; and Zucker, 2004). Data vary on the optimal number of computers per classroom. However, researchers are clear that teachers need to have convenient, consistent, and frequent access to computers for the integration of technology in the curriculum (Mann, 1999; Kelley & Ringstaff, 2002; NCES, 1999; and Statham & Torrell, 1999).

Almost a decade ago, education reformers began implementing initiatives in which both students and teachers were provided their own laptop computer. Large-scale initiatives, such as those in the state of Maine, have placed 24/7 access to laptop computers in the hands of tens of thousands of teachers and students (Rockman, 2003; and Zucker, 2004). Another strategy has been to obtain a classroom set of laptop computers that is stored in a mobile cart, allowing access for any classroom in a school (Rockman, 2003). These mobile carts serve as portable labs that provide access to laptop computers for classroom use to complete a given task in the curricula.

Learner Activities in Laptop Classrooms. In a study conducted with fifth and sixth grade students in Walled Lake Consolidated Schools (Michigan), researchers sought to answer the following question: "Is teaching different in a laptop classroom?" (Lowther, Ross & Morrison, 2001, p. 3). The researchers conducted classroom observations in seven schools (four elementary and three middle). Their results showed, "In general, strategies promoting learner activity, such as cooperative learning, inquiry, sustained writing, and computer uses were more likely to be observed in Laptop classrooms" (p. 5). They also noted significant differences in the following areas:

1. Project-based learning (65% in laptop classrooms vs. 22% in non-laptop classrooms).
2. Independent inquiry/research (58% in laptop classrooms vs. 24% in non-laptop classrooms).
3. The use of computers as a learning tool (88% in laptop classrooms vs. 17% in non-laptop classrooms).

Digital Tools

Access to computers is only one tool in the arsenal of digital technology tools available for students and teachers. The Partnership for 21st Century Skills (2002) stated that technology includes computers, audio, video, multimedia tools and application software. Nearly a decade earlier, Reeves and Jonassen (1996) defined these technology tools as cognitive tools that provided the opportunity to enhance higher-order thinking skills in the classroom. Hence, digital tools include computers, digital cameras, digital video cameras, multimedia authoring software, and application software.

The selection of software is an important issue for digital classrooms—the applications must be relatively easy to use, yet provide new and better ways to educate students.

Graphic Organizers. This type of application program allows students to organize their thoughts and visualize concept relationships using various symbols, words, or digital pictures that can be linked together in a variety of meaningful ways. This type of program is frequently used for brainstorming and mapping ideas. With Inspiration, students are able to use visual representations to clarify their thinking, communicate their ideas, or reinforce their understanding of a concept. A similar program, Kidspiration, is geared toward primary students. In the classrooms observed in the Walled Lake Consolidated Schools study, Inspiration and Kidspiration were used extensively. In some lessons, the students created concept maps; in other lessons, the teachers created digital documents in Inspiration that served as templates for the students to manipulate.

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Spreadsheets. Spreadsheets, such as Excel and AppleWorks, provide tools for recording, analyzing, manipulating, and displaying data. They are versatile, require higher order thinking skills, and allow students to graphically display relationships to build and communicate concepts. In the classrooms in the Walled Lakes study, spreadsheets were often used as a tool for students to visually interpret the data they created or collected. The elementary teachers involved in the project did not feel it was essential for the students to know how to create formulas, so they often embedded spreadsheets into a word-processing document. For example, the teachers would create a "digital document" for the students to use when gathering data. Students entered the data into specified cells in the document, and a visual representation then appeared as a graph in the lower portion of the document. With this approach, students could focus on analyzing and interpreting the data instead of entering formulas.

Video Editing. Apple Computer's iMovie HD is a powerful, easy-to-learn tool for editing digital video, sequencing still images, and incorporating audio tracks. Creating iMovie HD projects allows students to be creative, while communicating information through a variety of media. iMovie HD is designed to be used with a digital video camera; however, the teachers can incorporate still pictures from a digital camera or from the Internet. This allows more flexibility and requires less time.

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