Introduction

Billions have already been spent on computers and networking infrastructure in schools worldwide, and there are plans to spend billions more in the current millennium—but are these dollars providing the educational results that warrant such an expenditure? Numerous research essays, case studies and dissertations have reported that the effects of instructional technology on classroom pedagogy, test scores and systemic reform initiatives are not easy to identify (Becker & Ravitz, 1999; Watkins, 1991; King, 1998), yet the race on behalf of school systems to get their schools wired in the shortest period of time dominates the educational landscape.

More questions arise. Why aren't teachers from all subject areas and year levels currently using technology as an effective teaching and learning tool? Why is it common practice to send students to the computer lab, circumventing the potential for students to make a contextual connection between technology and what they're learning in the classroom? Why is there such zeal to buy newer, faster and more powerful computers whose capabilities extend well beyond the conventional instructional paradigm of most classroom teachers? In essence, we are missing a golden opportunity for students to make connections between the use of technology and its practical application in real-life situations.

As we begin the 21st century, prevailing instructional computing practices fall into four general categories (not listed in any particular order):

1. Basic skills acquisition
2. Application training
3. Reward stations
4. "Chromed" student products

Basic skills acquisition entails using the computer to reinforce or enhance student literacy and computation skills using an integrated learning system (ILS), computer-managed instruction (CMI), computer-assisted instruction (CAI), drill-and-practice applications or a tutorial program. Application training, regardless of its setting (e.g. corporate training facility, military installation, year three computer lab), involves rows of seated participants responding to a single facilitator while learning the skills necessary to use a particular software application, multimedia tool or Internet portal. Reward stations represent the educational phenomenon of rewarding students with "computer time" once they have successfully finished some type of "real" work at their desk, implying that using a computer doesn't involve authentic work. While these first three "uses" of computers may seem fairly obvious, the last category warrants additional discussion.

"Chromed" student products are exhibitions such as student-generated web pages, multimedia projects or presentations that would suddenly lose their lustre if the medium (the computer) were removed completely or separated from the content and process skills embedded in the project. In other words, they are long on fluff and short on meat. Chromed student products generally show a lot of pizzazz, but typically are shallow in content and hover on the lower end of Bloom's taxonomy (i.e. remembering, understanding; Bloom, Englehart, Furst, Hill & Krathwohl, 1956). Chromed student products are the least detectable because they often showcase selected technology content standards (creating a web page, designing a PowerPoint presentation, manipulating a spreadsheet program) or a popular approach to computer use (WebQuests, virtual excursions) but give only tacit attention to the content and typically employ lower levels of cognitive processing.

Unfortunately, the wording of some content standards for technology often lead to the creation of these shallow, low-end student products. For example, one set of performance standards for teachers suggests that teachers should be skilled in technology and knowledgeable about using technology to support instruction and enhance student learning. To demonstrate competency based on this example performance standard, the teacher would need to:

- apply technology to the delivery of standards-based instruction
- use technology to increase student achievement
- utilise technology to manage and communicate information
- apply technology to data-driven assessments of learning
- instruct students in basic technology skills

Competency could be attained with many of these performance indicators by simply escorting students to a computer lab for computer skills training or a daily dose of computer-based instruction designed to increase test scores.

To compound the problem, typical instruments used for measuring technology implementation may focus overwhelmingly on superficial knowledge and skills associated with instructional technology and virtually ignore issues devoted to instruction, assessment and curriculum design. Technology survey queries such as "Can turn on/off a computer", "Can create a web page" or "Can incorporate the spell check feature of a word processor" do not measure any substantive "integration" practices involving complex thinking skills, in-depth examination of the content or authentic student products. So is it enough to know how to perform a skill or do we need to ask what will be done with the knowledge?

Why is there no higher standard for current instructional practices linked to technology use? How can we go about unleashing the potential of technology as an effective learning tool? This book describes a new way of viewing instructional technology—a view that focuses less on the technology and more on the curriculum, instruction and assessment practices associated with its use. Referred to as the New Technology Infrastructure, this declaration of technology interdependence attempts to alert educators to the need for a revitalised instructional infrastructure that provides a foundation for integrating current technology and future innovations into classrooms of the 21st century.

Performance assessments should integrate several instructional activities that precede them, allow multiple solutions, relate to students' prior knowledge, have personal meaning and be challenging. Those that foster problem solving provide students the opportunity to

- revisit the problem from several perspectives,
- conduct investigations (sometimes students design their own),
- interpret data, and
- plan courses of action.

The ultimate goal is for students to identify expected standards, internalise the necessary criteria for reaching them and monitor their own progress.

Experiential Learning

In the New Technology Infrastructure, the Target Technology Level combines well-defined and student-centred performance tasks with an experiential instructional design that moves students from awareness to action using the available computers as tools. Experiential learning dates back to the works and philosophy of John Dewey and encompasses those instructional practices that rely on real-life experiences as the basis for learning. The fundamental characteristic of Dewey's educational philosophy involves the "organic connection between education and personal experience" (Dewey, 1938). According to Dewey, the educator's task is to ensure the continuity of present experiences with future experiences. In this context, quality learning experiences

- provide the learner with a sense of direction and purpose,
- are encased in a well-defined context, and
- include linkage between past and future experiences.

Several instructional design models encourage teachers to take quality performance tasks and launch them into experiential instructional designs that seamlessly use computers not as the focus of the learning, but as an integral part of the learning process. A brief summary of some of the more popular models follows.

Experiential-Based Action Model

Referred to as EBAM, the Experiential-Based Action Model, conceptualised by Moersch (1994), divides the curriculum development process into a series of components called stages (Figure 10).

performance measures that assess not only content understanding, but higher-order thinking. Using exclusive ILS or tutorial programs, or teaching concepts and processes in isolation will no longer prove to be acceptable, effective or even efficient.

New Breed of Educators

In the mid-1980s a colleague told me that sooner or later teachers would be bound to change and jump on the technology bandwagon or face extinction. It would be safe to say that many of our colleagues resisting the implementation of instructional computing have gone on to greener pastures. The good news is that a new breed of educator is entering the P–12 classroom, more sophisticated than ever with using computers to create multimedia presentations, design web pages and manipulate a FileMaker Pro database. The bad news is that to a large extent, higher education has failed to prepare these educators to integrate the technology in the classroom at the Target Technology Level.

Inexpensive Hardware

Remember the first personal computer or even the first calculators and their price tags? Today, you can purchase a general-purpose personal computer or even a laptop for less than $500. Need I say more? As the prices spiral downward and the technology ascends in terms of speed, power and portability, the issue about providing schools with sufficient computers should ultimately become a nonissue.

Web-Based Instructional Units

Vendor-supported websites, as well as online courses sponsored by higher education, will no doubt increase in sophistication based on the standardised testing being selected by schools. We should also see more sophisticated teacher-created curriculum units that utilise more of the resources of the web than they currently do. User-friendly web interfaces that are not only easy to use, but allow users to immediately post their sites to the web will dominate the educational arena. The creation of more elaborate Internet portals that allow teachers to design, implement and assess instruction will divert attention away from the triviality of having to link sites, post to the web and hassle with compatibility problems and put the focus on piquing students' interest and encouraging academic achievement using dynamic web-based instructional models.