Chapter 23
Emerging Educational Technologies and Science Education:
A Multifaceted Research Approach

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INTRODUCTION

"The truth is that the want of common education with us is not from our poverty, but from the want of an orderly system. More money is now paid for the education of a part than would be paid for that of the whole if systematically arranged."

--Thomas Jefferson to Joseph C. Cabell, 1820.

When discussing emerging educational technologies, the complaint around the globe is common enough: we may be outfitting schools with classrooms of the future, but teaching methods remain mired in the past. In the six articles that follow we describe our research on choosing and applying emerging educational technologies in the light of what we know about best practice teaching methods. Whereas many well-respected experts have addressed the need for new methodologies, we chose to focus on the *process of choosing* the technologies themselves. We set out to determine how to evaluate the individual promise an educational technology may hold and to provide guidelines to those who choose and use the technologies for teaching and learning.

The research was conducted by a team in the United States from the NASA-sponsored Classroom of the Future at the Center for Educational Technologies® in Wheeling, West Virginia. Among our team of researchers and instructional designers, the process was dubbed "benchmarking." A multi-

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faceted, two-phase approach was developed that blended classic research methodology with those used in market research studies. We gathered data and expertise from a variety of sources, including academic research articles, industry reports, interviews with leaders and national trend-setters, and the experiences of our own veteran staff.

Among the international community, NASA is well respected. Materials created to achieve NASA's educational goals are typically highly regarded as well. In our experience, NASA curriculum developers strive to incorporate innovative, effective uses of a broad range of educational technologies into their program offerings. This process involves a great deal of experimentation that is time-consuming, risky, and costly. As developers of educational websites, CD-ROMs, informal education programs, and teacher professional development experiences, the NASA-sponsored Classroom of the Future™ often faces the question of how to make the best use of educational technologies to inspire, engage, and educate.

To effectively integrate technology into NASA educational offerings, instructional designers should begin with an examination of the capabilities and limitation of various technologies—how particular ones could best support their curricular goals and how to use them for maximum impact (Bromley, 1997, 1998; Bruce & Hogan, 1998; Summerville & Reid-Griffin, 2008). Moreover, research has found that designers and developers need to be aware of the contextual factors, or *enabling conditions,* of the technology they plan to use (Downing & Holtz, 2008; Zhao, Byers, Pugh, & Sheldon, 2001). A list that succinctly identifies which educational technologies are better and why would become an indispensable tool for classroom teachers. In the past, coupling a constantly evolving field of education with the highly dynamic nature of technology development has made such a task nearly impossible. As soon as a list is generated, it becomes outdated.

Given how rapidly educational technologies change, this study sought to create a means by which decisions about capabilities and limitations, and effective use of classroom technologies could be made in a just-in-time fashion. In addition to the traditional conclusions and implications for future work found in academic research, pragmatic recommendations were also posed for instructional designers, developers, and classroom users of educational technologies. Practical principles and metrics were derived from exemplars with thoughts that these principles would be durable across range types of technologies, over multiple generations of products, and in most every country.

Phase One

The initial phase of the project involved the following activities and is covered in more detail in subsequent articles in this issue.

- Milestones and seminal works conducted on the topic of benchmarking educational technologies were examined over 15 years worth of research studies. Investigations sought criteria for effective educational technologies; specifically, implementations and applications that resulted in design principles, decision-making principles, or measurables for gauging effectiveness.
- An 18-month investigation examined US National Science Foundation trends, determining the degree to which program solicitations included educational technologies.
- A cross-section of *pacesetters* in the realm of educational technologies were considered, including futurists, authors, journal editors, government officials, and leaders of professional organizations. Subjects were asked how they gauge the effectiveness of educational technologies and which technologies hold promise for improving the teaching and learning process.
- Lists of promising educational technologies, tools, websites, resources, software,