Chapter 12
Successful Implementation of Technology to Teach Science: Research Implications

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ABSTRACT

In this review of recent literature on the use of technology to teach science content, 143 articles from 8 science education journals were selected and analyzed for the use of technologies in teaching science, pedagogies employed, and successes of the implementations. The resultant data provides a snapshot on how technology is being used in the teaching and learning of science, and the research methods used to explore these issues. Levels of research and levels of success were developed and applied to the article data set to characterize the types of research and technology implementations described in the literature. Articles that showed high levels of successful implementation of technology along with a high level of research were explored and explained in greater detail. The review underscores the research trend toward using technology to illustrate abstract concepts and make objects that are invisible to the naked eye, visible and malleable in computer modeling programs. Implications for successful use of technology to teach science are discussed.

INTRODUCTION

Science and technology have long been linked. New discoveries in science have helped lead to advancements in new technologies and improvements in existing technologies, in turn, aid in new developments in science. Science education and technology have also shown the same link. Science teachers often have been eager to embrace new technologies to help students learn science con-

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tent, and engage in authentic science experiences. These early adapting teachers have believed that by embracing new technologies they can help their students better learn science. While this is one of the primary reasons for implementing technology into the science classroom, there are often residual affective factors to consider, such as increasing students' interest in science, motivating students to learn, and improving students' self-efficacy in learning science.

Not only are teachers seeking ways to use technology to improve learning in science, science education researchers also have been exploring new ways technology tools can be used to teach science. A review of the research literature in this field reveals many claims of success of technology implementation. In some cases, success is attributed to student learning gains, whereas in other studies students' engagement in, and enthusiasm for, learning science is attributed to the technology use. Studies in the field of technology use in science teaching vary greatly in how they substantiate successful technology implementation. This review is an attempt to look at the last 10 years of science education research on the use of technology to teach science to define successful implementation of technology.

BACKGROUND

Business leaders are calling for technologically and scientifically literate workers to enhance U.S. corporations' competitive edge in the global marketplace (Friedman, 2005). Technology enthusiasts tout the motivational potential of educational technologies to promote and improve students' problem solving abilities. Technology advocates have underscored the potential of computer technologies as a panacea for improving students' scientific literacy and 21st century skills—a necessary skill base for success in the increasingly competitive global marketplace (Metiri Group, 2003). Likewise, the National Research Council (NRC, 1996) and the American Association for Advancement in Science (AAAS, 1993, 2000) recommend using technology to foster student experiences analogous to those carried out by scientists—such as data collection and analysis, constructing and manipulating models, and communicating results—as well as to help students construct conceptual understandings of abstract science concepts.

The call for increased use of technology in schools is evident in the dramatic increase in computer availability in classrooms today. From 1988 to 2009 there has been a dramatic drop in the computer to student ratio from 1:30 in 1988 to 1:5.3 in 2009 (Gray, Thomas, & Lewis, 2010). The National Center for Education Statistics (NCES) reported that in 2009 97% of all teachers had access to at least one computer in the classroom, 93% of which offered Internet access (Gray et al., 2010). With the increased accessibility of classroom computers, one might expect the instructional use of computers also to rise. A ten-year review of NCES data, however, suggests the rise in use has been less than what might be expected (NCES, 2000; Gray et al., 2010). As Table 1 illustrates, teachers have increased their use of computers from 1999 to 2009 by 44%. However, the greatest increase was attributed to their use of the Internet to support student research (64% gain). Other areas showing significant gains included the use of graphics (e.g., digital images, animations) to illustrate concepts (34% gain), the use of drill and practice programs to promote student learning (19% gain), and using computers to support problem solving and data analysis (18% gain).

These data suggest a growing number of teachers are employing technology, often referred to as educational technology, when used for instructional purposes, to support student learning in science. Although technology enthusiasts and education and government leaders promote the use of technology in schools, does its use make a difference in student learning? Do specific educational technology tools impact students' attitudes