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Design Principles for 21st-Century Educational Technology:
Connecting Theory and Practice

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ABSTRACT

Design principles are universal and may be translated onto the newest trends and emergent technologies. In this research study we combined the perspectives provided by two sources to create a set of recommended design principles for technology-enhanced learning environments. One source was the How People Learn framework (Bransford, Brown, & Cocking, 2000). The second source was a series of interviews conducted with pacesetters in the field of educational technologies. With the knowledge gained from these two sources, we created our own set of design principles. These principles can guide the evaluation of how educational technologies are used or help instructional designers in creating exemplary ways to implement technologies.

Keywords: *criterion; design principle; educational technology; instructional design; learning environment; metacognition; pacesetter*

INTRODUCTION

Hundreds of millions of dollars have been spent in recent years to improve and maintain technology infrastructure for schools. Now policymakers and the public want to know what impact this technology has had on student learning. To answer that question, states and school districts need parameters for evaluating their technology-related activities and using the data to guide their decision making. However, researchers have cautioned against drawing inappropriate cause-and-effect conclusions based on experimental studies (Olson & Wisher, 2002; Russell, 2001). What scientifically based evi-

dence is available on the impact of educational technology often is focused on the degree to which a particular technology leads to changes in learning or teaching. In fact, a better way of judging the impact of new technologies is to examine how they are used and the context in which the use occurs (Zhao, Byers, Pugh, & Sheldon, 2001).

Instructional designers and researchers have stressed the need for robust design principles to guide the production of products and programs (e.g., Kali, 2006; Kali, Spitulnik, & Linn, 2004; Underwood et al., 2005). In this research we also chose to emphasize design principles because they are universal, and they translate to the newest trends and emergent technologies. To do so, we set out to combine the latest research perspectives with the most current leadership perspectives. We began by summarizing key perspectives of the How People Learn (HPL) framework for learning environments. The HPL framework is widely respected and provides recommendations that can be applied to the design of technology-enhanced learning environments. We interviewed pacesetters in educational technologies and reported emerging themes based on the thoughts of those pacesetters. These sources provided the foundation for creating our own set of recommended design principles for technology-enhanced learning environments. This approach combined the best of the past with fresh perspectives from the present.

Important Principles about Learning and Teaching

The National Academy of Sciences *How People Learn* book synthesized decades of research on how people learn to develop a framework for understanding the connections between cognition and instruction (Bransford et al., 2000). This report is widely embraced as a seminal work for educators and researchers alike. In fact, How People Learn is becoming widely accepted as a theoretical framework, and that is how we use it here. That work provided the theoretical foundation for designing and conducting the interview study of the pacesetters.

Although the HPL framework provides many important teaching and learning implications, we highlight four of the principles that have particular importance in the design of technology-enhanced learning environments. Each has a solid research base as well as important implications for how teachers teach. Each principle also helps designers think about technology's role in the design and delivery of effective learning environments.

One important principle about the way people learn is that "students come to the classroom with preconceptions about how the world works" (Bransford et al., 2000, p. 14), which include beliefs and prior knowledge acquired through various experiences (e.g., Lin, 2001; Pressley et al., 1992). This learning principle suggests that students start to make sense of the world at a very young age. In many cases students already hold multiple conflicting views before learning new information; as a result, they create their repertoire of views without reflecting on their existing knowledge. This principle implies that designers of effective technology-enhanced learning or instruction should build on students' preconceptions and learning styles, allow decision making, and foster students' multiple intelligences.

Another HPL principle is that "to develop competence in an area of inquiry, students must have a deep foundation of factual knowledge, understand facts and ideas in the context of a conceptual framework, and organize knowledge in ways that facilitate retrieval and application" (Bransford et al., 2000, p. 16). Numerous studies comparing performance by experts and novices have shown that experts not only obtain richly structured knowledge bases that allow them to plan a task, notice patterns, generate reasonable arguments, and draw analogies to other problems, but they also exhibit more organized conceptual frameworks that allow for greater transfer.

This learning principle suggests effective learning environments are knowledge centered