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The Value and Challenges of Using Learning Technologies to Support Students in Learning Science

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Tools help us perform difficult tasks, both physical and intellectual. We use a variety of tools such as hammers, shovels, and screwdrivers to help us perform physical tasks. Cognitively, we use graphs to see patterns in data and visual diagrams to summarise information. In schools, teachers use concept maps to help students see and make connections between concepts. New computer-based technology tools can also serve as cognitive tools. The World Wide Web allows scientists in remote locations to share information and communicate new developments rapidly and efficiently. New imagery tools enable doctors to probe the structures of the body. Three-dimensional graphs help scientists to visualize and interpret data in new ways. There is little doubt that technology tools have changed the way we do work.

New computer-based technology tools can also change what we do in science classrooms. New computer-based technology tools can extend learning by helping students perform cognitive tasks that otherwise might be too complex or difficult without the tools (Salomon, Perkins, & Tamar, 1991). In science classrooms, a wide variety of technology tools can support students in learning and in performing inquiry. For instance, students can access and share data through the World Wide Web, probes attached to microcomputers can gather data during investigations that otherwise might be too difficult or time intensive, graphing packages allow students to visualise data in different ways, and multimedia development tools allow learners to create linked-multiple representations to express their ideas. I refer to such technology tools as learning technologies because they have the potential to support students in learning (Krajcik, Blumenfeld, Marx, & Soloway, 2000).

To promote more in-depth student understanding of science, a number of researchers and policy groups (e.g., Brown & Campione, 1994; Krajcik et al., 2000; National Research Council (NRC), 1996) argue that students need to engage in sustained inquiry. Sustained inquiry activities include formulating authentic, meaningful questions, planning tasks, gathering resources and information, predicting outcomes, debating the value of information, evaluating information, collaborating with others, and reporting findings. To support students in these types of activities, other researchers argue that students need a full compliment of technology tools designed to meet the unique needs of learners (Bransford, Brown, & Cocking, 1999; Krajcik et al., 2000).

There are good reasons to believe the claim that learning technologies can support students in inquiry. Various learning technologies embedded within the curriculum can promote in-depth learning. They allow students to engage in aspects of inquiry that they would not otherwise be able to do. Learning technologies also allow students to explore "What if . . . ?" questions, and they allow students to use similar tools and engage in similar activities as scientists. The web, in recent years, has received particular attention because of the potential it holds. For instance, the web can provide students with access to current information as well as primary data sources. Yet challenges exist in using the web (Wallace, Kupperman, Krajcik, & Soloway, 2000). Students have difficulty locating and taking advantage of information. Moreover, many middle and high school students also have difficulty evaluating the resources they find. Teachers also face challenges in knowing how to use the World Wide Web to promote learning.

Learning technologies as tools hold promise to change science classrooms, support students in inquiry and promote deep learning of science concepts. Yet, although evidence is growing (Linn & Hsi, 2000; Krajcik & Starr, 2001), we still lack evidence about the impact of learning technologies to support student learning. Some educational researchers have even claimed that we have little if any evidence to support the effectiveness of technologies in helping students learn core disciplines such as science (Cuban & Kirkpatrick, 1998). We also know that teachers face challenges in using technology tools to teach; yet, we know little of how to support and educate teachers for this endeavor. Although our understanding has grown, we still have much to learn. The papers presented in this special issue of *Research in Science Education* are one attempt to fill that void. As a collection, the papers explore what students learn when technology rich learning environments are thoughtfully developed, the important and challenging role the teacher plays in supporting students using learning technologies, and how to design scaffolds embedded in technology tools to support students in performing difficult inquiry related tasks.

The first two articles present evidence to support the use of learning technologies to promote student learning. Williams and Linn in *WISE Inquiry in Fifth Grade Biology* present strong evidence of the impact of learning technologies to promote learning. They explore how the development of Web-Based Integrated Science Environment (WISE) project called *Plants in Space* that uses classroom investigations integrated with World Wide Web use can enable fifth grade students to increase their understanding of plant growth and development. Their findings clearly demonstrate that in such an environment students develop understandings of standard-based, important science concepts. Zembal-Saul and colleagues in *Scaffolding Prospective Science Teachers' Evidence-Based Arguments During an Investigation of Natural Selection* explore an area, the use of learning technologies with prospective teachers, that has received little attention by researchers and teacher educators. They engaged prospective secondary science teachers enrolled in an advanced methods course in an extended, complex, data-rich investigation using software designed specifically to support learners in making scientific explanations. They found that when used appropriately, scaffolding strategies embedded in software can support learners in articulating and developing evidence-based scientific explanations. Although these two papers present strong evidence to use technology rich learning environments, support across more diverse areas is still needed.

The next set of papers examines the important roles that teachers play in using learning technologies to promote learning and the challenges teachers face when using new learning technologies. Wallace in *The Internet as a Site for Changing Practice: The Case of Ms. Owens* explores the experiences of one high school chemistry teacher as she uses the Internet on her own as a tool for changing her practice. Ms. Owens' case suggests that reform by way of the World Wide Web is complex and challenging; that it makes demands on teacher knowledge and time; and that classroom enactments can differ from the practices called for by current reform efforts. Ng and Gunstone in *Students' Perceptions of the Effectiveness of the World Wide Web as a Research and Teaching Tool in Science Learning* explore the use of the World Wide Web as a research and teaching tool to promote self-directed learning in adolescent students. They show that the WWW had a number of positive effects on student learning including motivation for independent learning. However, the unedited and unstructured nature of the WWW calls for teachers to facilitate and guide students learning. In *Characteristics of Science Teachers Who Incorporate Web-Based Teaching*, Dori, Tal and Peled characterise and classify the ways junior high school science teachers incorporate Web-based learning environments and materials into their teaching. The identify four basic types of science teachers: the initiator and pathfinder, the follower and conformist, the avoider, and the antagonist. When given long-term support, these teachers enhance their teaching using web-based materials. The Dori and colleague piece points to the value of using sustained professional development to support teachers in the use of learning technologies. However, more studies are still needed in this area.

The last two papers explore how designers can develop scaffolds to support students in performing complex inquiry tasks. In *The Information Seeking Strategies of High School Science Students*, Lumpe and Butler explore the value of various interface features designed in a digital library to help students use digital resources more effectively. They found classroom performance for high school biology students was significantly correlated with the use of particular scaffolds. Fretz and colleagues in *An Investigation of Software Scaffolds Supporting Modeling Practices* assess the scaffolds designed into a dynamic modeling software tool in terms of their ability to support learners' use of modeling practices. They show that when carefully designed various types of scaffolds can support students in learning. Although these two papers provide direction on how to design scaffolds, we still have much to learn in this area.

This special issue was put together to bring forth the worthwhile contributions as well as the issues that still exist in using learning technologies to promote the teaching and learning of science. Although we have learned much to support the claims made by (Salomon et al., 1991; Krajcik et al., 2000), we still have much to explore. I hope you find the papers presented in this issue worthwhile and that they will lend some insight into the effectiveness and challenges of using learning technologies to teach and learn science. I invite further correspondence regarding the promises and issues raised in this issue.

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