

## Observing the users of digital educational technologies—theories, methods and analytical approaches

Digital technologies are used in a variety of educational settings, ranging from K-12 (primary and secondary) schools, colleges and universities, to home education, libraries, museums, zoos, art galleries, and other contexts. They include web sites, multimedia objects, digital libraries and repositories, wikis, blogs, games, and authoring tools, and they are accessed on devices varying in size from handheld PDAs to desktop computers. They are used synchronously and asynchronously to support individuals and groups, such as students, teachers, parents, curriculum developers, administrators, and others. Digital technologies are used to reinforce face-to-face instruction, individual student learning, educator professional development, distance learning, and many other educational activities.

There is ongoing debate as to the effectiveness of digital educational technologies. Journals and conferences report many cases of the successful use of digital tools in educational settings. This success can be qualified: Waxman *et al.* (2003) for instance reviewed 42 studies covering 7,000 students and reported “a modest, positive effect of teaching and learning with technology on student outcomes”, while a recent report to the US Congress (Dynarski *et al.* 2007) on the effectiveness of reading and mathematics software, which looked at 33 districts, 132 schools, 439 teachers and 9,424 students using 16 different software products, found that “test scores were not significantly higher in classrooms using selected reading and mathematics software products”.

These varying conclusions on the effectiveness of educational technologies are reminiscent of the so-called “productivity paradox” of office computerization in the 1980s and 1990s, which claimed that large-scale investment in office technological infrastructure was failing to increase productivity (Brynjolfsson 1993). More recent research has indicated that computerization did indeed support office productivity gains, although these gains were not as high as hoped for, and occurred only after new practices had been learned, and complex long-term social and organizational changes had worked themselves out (Brynjolfsson and Hitt 1998). As Brown and Duguid (2000) put it, the changes that follow the introduction of a new technology “proceed in a series of feedback loops along with developments in the technology . . . [This is] a matter not of society ‘catching up’ with a technology, but of society adjusting technology to its needs”. The implementation of technologies (digital educational technologies included) involves not so much learning how

to use a new technology “out of the box”, but rather users adopting, shaping and fitting new technologies into their existing daily practices, practices which are also simultaneously shaping and adapting to the shifting forms of that new technology (Kling 1999).

The point of drawing this parallel between office computerization in the 1980s and digital educational technology use in the 2000s is two-fold. First, as argued above, if digital educational technologies are indeed in the relatively early stages of adoption, then this is one reasonable explanation of why it is possible to identify individual instances of success, while at the same time evidence of some of the wider institutional and systemic gains has yet to emerge. Pflaum (2004), for example, describes the on-the-ground implementation of computers in American schools as “a mosaic of computer use, misuse, and nonuse”, a process that depends critically on the consideration given to the use of new technologies in the context of existing complex practices and habits, and which (as his cases show) can easily be derailed by a host of organizational, technical and other unexpected obstacles. Second, and consequently, the parallel suggests the need for research that investigates the longitudinal dimensions of digital educational technology implementation and use in real world settings. A significant challenge here is that as digital educational technologies vary widely in form and function, the process of implementation is often theoretically under-determined: that is, we lack detailed accounts of all the variables associated with digital educational technology use that would allow us to isolate and study the impact of the technologies themselves. One theoretical and methodological response here is to approach digital educational technologies as sociotechnical *systems* - that is, as networks of people, practices, institutions, technologies and other variables related in emergent ways (Van House *et al.* 2003) - which require, in turn, *multifaceted* evaluation approaches that combine and triangulate a mix of quantitative and qualitative methods (Marchionini *et al.* 2003). Such systemic and multifaceted approaches move from considering summative evaluation questions, such as “did it work?” to examine more formative evaluation questions, such as “how is it working and how might it be improved?”

The call for this special issue therefore requested qualitative and mixed method studies that considered digital educational technologies as complex mixtures of people, practices and technologies, embedded in a range of institutional, technological and social contexts: in other words, case studies which considered digital educational technologies and their users “in the wild”. The accepted papers describe a wide range of technologies and contexts, and emphasize:

*longitudinal studies* that followed users for weeks or months;  
*mixed methods approaches* that combined and triangulated data from observations, interviews, surveys, analyses of communication, webmetrics and data logs, and analyses of artifacts produced by users;  
*grounded theory approaches* that built up analyses from iterative reviews and codings of data;  
*integration of research into cyclical and iterative development*, with the research

producing recommendations for future iterations of the systems under consideration.

Markovic *et al.* in *Pervasive learning game: A comparative study*, describe a pervasive game on the subject of digital economies that is played using mobile phones and text message-based games in the real world. Students receive text messages that direct them to various real world locations, where they have to react to the questions and problems posed by the game. In doing so, they also compete against the other student teams. The authors analyze the game using Csikszentmihalyi's (1990) concept of "flow", "the state in which people are so involved in an activity that nothing else seems to matter", deriving and modeling a series of variables that can be used to describe the flow experience, and using these variables to compare the more positive learning experiences of a gaming group with those of a non-gaming control group.

*A study of teachers' use of online learning resources to design classroom activities* by Recker *et al.* addresses the subject of professional development workshops for educators. Adopting a "teaching as design" approach, they use the Design Capacity for Enactment framework of Brown and Edelson (2003) - which posits a continuum of curriculum adoption and use by educators that ranges from straightforward adoption through to free improvisation - to examine how educators integrate digital educational technologies into their existing practices in professional development workshops. Comparing data from surveys, observations, interviews, webmetrics, and content analysis of the projects produced by educators in a series of workshops in which educators used an educational digital library and an educational resource design tool to create their own teaching resources, they show how the knowledge of digital educational technologies acquired by the educators in the workshops contributed positively to their attitudes towards using technology (including volunteering to run their own workshops).

Kerne and Koh (*Representing collections as compositions: visual forms, procedural generation and human manipulability support distributed creative cognition and situated creative learning*) examine the importance of creativity in learning from the point of view of situated learning (Lave and Wenger 1991) and distributed cognition (Hutchins 1995). Integrating these theories with a creative cognition approach (e.g. Finke *et al.* 1992) they develop models of "distributed creative cognition" - ideation processes that occur in distributed environments of participants, artifacts, context and practice - and "situated creative learning" - learning processes in which goals go beyond pre-defined learning skills and methods to develop new creative forms and products. They use these concepts to analyze undergraduate student design teams using the authors' combination tool to search for, represent, and manipulate collections of digital resources in support of their design assignments.

In *Designing for privacy in personal learning spaces*, Narjafian and Iverson examine the privacy and trust dimensions of educational social software. One important need the users of social software tools have is to understand the privacy functions of the tool, in order to manage comfortably the ways they

work and communicate. Users often assume that it will be easy to understand privacy settings and permissions, but in practice this can be a frustrating experience that can reduce engagement with and use of a tool. The authors' study of a group of K12 students using an educational social software tool reveals the complex and situated nature of the users' privacy models; and they warn against the problems that can arise when social sites use a "one-size-fits-all" privacy policy.

In *Collaborative learning in a wiki environment: experiences from a software engineering course*, Minocha and Thomas describe the use of wikis to support an online course in requirements engineering in which students work through a typical requirements engineering cycle. The technological and social design of the wikis was informed by the Salmon (2002, 2004) 5-stage model for teaching and learning through online interaction. An inductive analysis of a series of "reflection assignments" produced by the students as part of their assignments reveals the ways in which the wiki supported the students' distributed collaboration and learning, as well as some of the social and technical barriers to using the wiki. In *REASE: The repository for learning units about the Semantic Web*, Diederich *et al.* report on an evaluation of a repository of digital learning objects on the subject of the semantic web. The authors examined a range of components of the repository using questionnaires, user studies, and transaction log analysis; and they triangulate between these approaches to derive a picture of users and usage that is being used to inform the design of the next iteration of the tool.

Finally, in a technical note *Seekers, sloths and social reference: Homework questions submitted to a question answering community*, Gazan looks at how the members of an online question answering community reacted to students who posted their homework questions to the site. The analysis reveals the emergence over time of community norms and practices that seem able to distinguish between "lazy" students who "just want the answer", and who are generally brushed-off by the community, and other inquirers who seem prepared to make some effort to engage in dialogue and learning, and who were as a result treated in a more friendly and constructive fashion by the community.

The articles in this special issue represent a timely and engaging cross-section of ways of understanding exactly how a wide range of users are engaging with sophisticated digital educational technologies. They illustrate the wide range of tools, contexts and uses that fall under this description, as well as the complexities, opportunities and also sometimes problems that arise when digital educational technologies are integrated into daily life and practice. They also reinforce the importance of carrying out ongoing in-depth mixed method evaluations and assessments of digital educational technologies, as a prerequisite to iterating and improving these tools.

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