

Impact of Technology

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INTRODUCTION

Technology plays a critical role in modern society. Everyone is touched by the power of technology in some way, large or small, good or bad, every day (MacKenzie & Wajcman, 1999). While few people would argue the importance of technology in our society, there is a great deal of debate about whether technology has had a profound impact in the fields of education and training. That debate is made even more confused by the great difficulty in separating the effects of any technology from the societal, political, technical, and economic contexts in which the technology is developed and used (Pool, 1997; Tiles & Oberdiek, 1995). Another key issue confusing the debate is the problem of fairly and accurately assessing the impact of technology, especially in educational settings. On a more philosophical level, there is debate about the very nature of technology, the extent to which technology is under human control, and, ultimately, whether technology has a positive or negative impact on human society.

BACKGROUND

Prior to discussing how technology impacts modern society, in general, and education, specifically, it is important to discuss what is meant by the terms *technology* and *impact*. Technology can be defined narrowly or broadly. In narrow terms, technology can be defined as any thing or tool employed for a practical use. A saw, a hammer, or even a rock are examples of simple technological tools. A broader definition of technology would include the associated technical and social systems in which a technological tool is used (Hughes, 1996). For example, an automobile is, in itself, a tool, but to fully understand the function and impact of the automobile, one must understand all of the social, economic, political, and industrial systems that influence how automobiles are developed, used, and valued. An even broader definition of technology would emphasize the importance of science and

systemic knowledge to the development and use of technological tools and systems (Cardwell, 1995). Returning to the automobile example, the broadest definition of technology would include the scientific, industrial, and managerial theories and practices needed to design, build, distribute, sell, drive, park, maintain, and dispose of automobiles. To summarize this point, a narrow view of technology would limit discussion to specific technological artifacts while a broad view of technology would include a discussion of the socio-technical systems in which the artifacts exist, as well as the theoretical and applied knowledge needed to develop and use the artifacts.

Impact is not a simple term with one universally accepted meaning. Like technology, the term impact can be defined narrowly or broadly. Viewed narrowly, technology's impact on learning can be defined as increased test scores or improved attendance rates. Viewed more broadly, impact can be defined as a transfer of learning into improved behavior (Kirkpatrick, 2005). This type of impact is harder to determine. The broadest type of impact, and still harder to determine, can be defined as technology playing a pivotal role in school reform and, ultimately, societal improvement.

Difficulty in assessing impact. It is extremely difficult to adequately measure the impact of any technology, even if we define impact very narrowly. One cause for this is the inherently complex and interconnected nature of technology. It is often impossible to separate a single technology from the many other technologies, systems, and theories associated with that technology. This separation problem is especially prevalent when assessing the impact of learning technologies. For example, school improvement initiatives often include the use of new technologies in conjunction with changes in administrative practices, new teaching techniques, modified curricula and schedules, improved community partnerships, and other changes (McNabb, Hawkes, & Rouk, 1999).

Another difficulty in assessing the impact of technology in learning is the interaction between instructional methods and media. As Westra (2004) writes, "edu-

cational innovation is a diverse and complicated field of action . . . it concerns a mix of new developments in pedagogy and technology” (p. 502). Determining how much of the impact of an innovative learning technology is the result of the technology itself and how much is the result of the underlying pedagogical method is a daunting task. There is a heated debate in the educational literature about whether different media technologies possess certain unique attributes that enable them to impact learning in unique ways or whether the media are merely vehicles by which instructional methods are conveyed (Hastings & Tracey, 2005; Surry & Ensminger, 2001).

A final difficulty in adequately assessing the impact of technology is the lack of well-designed, long-term research studies reported in the literature. This problem is especially prevalent in the area of research related to the impact of learning technologies. Reeves (1995) writes that much of the research in this area is fundamentally flawed due to a variety of problems including specification error, superficial treatments, small sample sizes, and other issues.

IMPACT OF LEARNING TECHNOLOGIES

While it is a complicated task to adequately assess the impact of learning technologies for all the reasons discussed in the previous section, it is possible to draw some tentative conclusions. The literature is filled with reports detailing the impact of learning technologies in a wide variety of areas. Some of those studies, representing an impossibly small fraction of the literature, will be discussed in this section.

Has technology had a major impact on the field of education? There is no agreement on the proper answer to that important question. For example, Guthrie (2003) writes that “electronic technologies have not yet had a profound effect on formal education” (p. 57), while Culp, Honey, and Mandinach (2005) point to “past successes, often unheralded, where technology has had a significant impact” (p. 303). Peck, Cuban, and Kirkpatrick (2002) take something of a middle ground reporting that technology has had a profound impact on a small minority of students while having little or no impact on others.

For the purpose of this discussion, we will use a broad view of technology when discussing the

impact of learning technologies. The term learning technologies, when used here, will refer to the tools used to develop and deliver instruction as well as the sociotechnical systems in which the technologies are used, and the knowledge necessary to effectively use the technologies. Learning technologies are designed, developed, and used in a complicated sociotechnical system and require a considerable amount of theoretical and practical knowledge in order to be used effectively. It is inappropriate to view the impact of learning technologies in simplistic or isolated terms. The impact of technology on learning can be viewed in pedagogical, political, practical, financial, organizational, and individual ways. Given the complexity of learning systems and the highly contextualized nature of education, no single study can definitively prove the impact of technology on the learning process. In this section, the tangible and intangible impacts of learning technologies will be discussed.

Tangible impact. The tangible impacts of technology are those that result in specific, measurable outcomes. Learning technologies appear to impact the field of education and training in a number of tangible ways. Perhaps the most commonly discussed type of impact on learning is student achievement. Wenglinsky (2006) calls student achievement the “bottom line” by which the success of technology must be measured (p. 30).

Schacter (1999) reviewed the findings of six large-scale studies into the impact of educational technology on student achievement. The studies in his review reported largely positive impacts of various types of technology on student achievement. Among the major positive findings reported in the review were increased achievement for both regular and special education students, increased scores on standardized tests, and achievement gains in all subject areas (Schacter, 1999). Technology use has also been found to positively affect student achievement in mathematics and history (Wenglinsky, 1998, 2006).

Numerous other studies have found that technology had a positive effect on student achievement in various learner groups and content areas. For example, technology has been found to have a positive impact on the learning of students with special needs and for learners with limited proficiency in English (Svedkauskaite, 2004). A national survey of classroom teachers (Rother, 2005) found that most teachers believed computers were an effective tool for teaching both language

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