

## Chapter 2

# Sensory Extension as a Tool for Cognitive Learning

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### ABSTRACT

*The practice of educational technology has long been driven by a relatively restricted set of operational metaphors: typically, computers are identified as potential “teachers” or “tutors” of material or (arguably more productively) as “learning tools” for students. Recent developments in technology suggest the advent of another, perhaps still more fruitful metaphor – namely viewing educational technology (not limited to computers) as a means of sensory extension. In this view, technology is seen not as a repository of content, but rather as an extension of scientific instrumentation (telescopes, microscopes, bubble chambers) and prosthetics (eyeglasses, cochlear implants). This chapter is intended as an initial, partly speculative exploration of what it would mean for science and arts education to rethink the role of technology in terms of sensory extension rather than classroom instruction.*

### INTRODUCTION

*Man has, as it were, become a kind of prosthetic God. When he puts on all his auxiliary organs he is truly magnificent, but these organs have not grown onto him and they still give him much trouble at times.... Future ages will bring with them new and probably unimaginably great advances in this field of civilization. (Sigmund Freud, *Civilization and Its Discontents* [1930])*

Educational technology, over the years, has been driven by metaphors. In the early era of computing, when computers were popularly referred to as “giant brains” (as in Berkeley’s (1949) popular title), the recurring image was that of computers as agents of mechanized thought; and when applied to education, that image became one of “computer-assisted instruction” (cf. Suppes, 1966), with the computer patiently presenting individually-customized material to students. By

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the early 1980's, the range of metaphors applied to educational technology had expanded somewhat, as reflected in the title of an excellent summary by Taylor (1980): "The Computer in the School: Tutor, Tool, Tutee". For Taylor, the "tutor" role was exemplified by Suppes' work, with the computer as classroom instructor; the "tool" role was exemplified by the (still relatively new) idea of having children use computers as calculators and word processors, among other possible uses; and the "tutee" role (exemplified in the work of researchers such as Seymour Papert) involved having children "teach" the computer via programming.

The power of these originating metaphors continues to be felt, and productively pursued, in educational technology today. There are still active research projects, not to mention commercial development, in computer-based training and tutoring (see, for example, the proceedings of the Intelligent Tutoring Systems conferences, such as Trausan-Matu *et al.* (2014)); in the use of computers as tools for such tasks as simulation (Wilensky & Rand, in press) and educational gaming (Shaffer, 2006); and for child-friendly programming (Kafai & Burke, 2014). Indeed, none of these venerable metaphors is at all objectionable. At the same time, however, metaphors not only tend to structure and inform the educational technology community; they also channel and constrain that community as well. The associations of the early images of computing – an "artificial mind" sitting in a box on a desk – tend to make us think of the computer as an object and source of activity, profoundly separate from the student. The computer, in this vision, is *something to communicate with*. Even in more current images – students enrolling in MOOCs, or viewing lectures on the Web, or collaborating with other learners via websites or email, or playing multi-person educational games – the computer is fundamentally something set apart from the learner, and it affects the learner only via relatively abstract channels such as typing (for input to the machine) and viewing a screen or listening to speakers (for output from

the machine). The computer – and the community accessible through it – are thus seen as repositories of expertise, and the educational dimension of technology is realized by tapping that expertise.

This essay is a frankly speculative exploration in what it might mean to pursue a rather different metaphor – a metaphor for education suggested by the advent of various new technologies, and likewise suggested by the guiding theme of this collection. Broadly speaking, the idea here is to think of technology as a matter of *sensory extension*, as being a means of extending or augmenting the sensory apparatus of the student or child. Taking this metaphor seriously means devising uses of novel technologies that suggest analogies with certain types of scientific instrumentation: telescopes and microscopes (for extending the range of vision), Geiger counters (for extending sensitivity to phenomena such as radioactive decay), and so forth. In a less rarefied sense, there might be technologies analogous to that of eyeglasses, hearing aids, or walking sticks – prosthetic devices that improve or repair our everyday senses.

The idea of educational technology as sensory extension is one that gives rise to complexity on many fronts. First, it should be emphasized that sensory extension need not be viewed in *opposition* or *contrast* to existing traditions in educational design, but as *complementary* to those traditions; there are obviously many potential areas of overlap and collaboration with these existing traditions, and this chapter will touch on several possibilities. Perhaps more pointedly, the topic of sensory extension involves wading into potentially uncomfortable territory, of "brain-computer interfacing" or body modification. Such subjects raise delicate questions of what it means to alter, extend, customize, or experiment with ourselves as humans; and if these issues are thorny for adults, they are even more anxiety-provoking in the context of education and children's technology. Nonetheless, it will not do to completely ignore the topic of sensory extension merely because, in certain instantiations, it raises uncomfort-

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