

Chapter 3.25

Tangible User Interfaces as Mediating Tools within Adaptive Educational Environments

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ABSTRACT

This chapter proposes that, as approaches to human computer interaction (HCI), tangible user interfaces (TUIs) can scaffold rich classroom experiences if they are coupled and generated within multi-pedagogical frameworks that adopt concepts such as Multimodality, Multisensoriality, and Multiliteracies. It overviews some necessary conditions for these tools to be effective, arguing that tangible user interfaces and multi-pedagogies are efficient when they are conceptualized as part of adaptive educational environments—teaching and learning ecologies where learners and teachers are seen as co-creators of content and of new ways of interacting with such content.

INTRODUCTION

Information and communications technologies (ICTs) enable types of learning experiences

involving HCI that other means do not easily achieve (Simon, 1987; Underwood & Underwood, 1990). While digital spaces are traditionally manipulated via simple input devices (e.g., keyboard and mouse) that are used to manipulate representations displayed on output devices (e.g., monitors), *tangible user interfaces* remove this input-output distinction and connect physical and digital worlds using physical objects as interfaces to digital information (Ullmer & Ishii, 1997).

This chapter discusses the potential role of *tangible user interfaces* in scaffolding rich HCI classroom experiences and some necessary conditions for such tools to be effective. I argue that these interfaces can have a key role in contemporary teaching and learning environments if they are coupled and generated within multi-pedagogical frameworks that adopt concepts such as Multimodality (Kress & Van Leeuwen, 2001), Multisensoriality (Ceppi & Zini, 1998), and Multiliteracies (Cope, Kalantzis, & New London Group, 2000).

Tangible user interfaces and *multi-pedagogies* are, however, effective when they are conceptualized as part of *adaptive educational environments* (Loi & Dillon, 2006)—teaching and learning ecologies where learners and teachers are seen as *co-creators* of content and of new ways of interacting with such content.

This chapter is divided into four sections. In the first part I overview why and how *tangible user interfaces* can enrich classroom experiences, while in the second I outline the importance of coupling them with multi-pedagogical frameworks. The third section overviews the notions of adaptive educational environments and proposes that *tangible user interfaces* can be conceptualized as mediating tools enabling a shift of such environments to become creative spaces. In the last section I offer a number of concluding remarks, highlighting future implications and the need for new ways of conceptualizing contemporary learning environments.

One of the key objectives of this chapter is to highlight the importance of designing *tangible user interfaces* for teaching and learning by considering them part of larger ecological HCI frameworks where pedagogy, people, and context play a crucial role.

TANGIBLE USER INTERFACES AND LEARNING ENVIRONMENTS

Ullmer and Ishii (1997) point out that while *graphical user interfaces* (GUIs) have proven to be “a successful and durable model for human computer interaction,” the GUI approach to HCI “falls short in many respects, particularly in embracing the rich interface modalities between people and the physical environments they inhabit” (p. 1). Within this context, a range of alternatives has been explored, from ubiquitous computing to augmented reality. However, these attempts often rely on exporting the GUIs paradigm to world-situated devices, failing in capturing the

richness of physical-space interactions they want to enhance (Ullmer & Ishii, 1997).

This understanding was the basis on which the notion of *tangible user interfaces*—user interfaces that adopt surfaces, instruments, physical objects, and spaces as physical interfaces to digital information—was constructed through initial explorations by Fitzmaurice, Ishii, and Buxton (1995) and the original work of Ullmer and Ishii (1997). Tangible interfaces put emphasis on touch and physicality in both input and output and are often coupled to physical representations of actual objects (O’Malley & Stanton Fraser, 2004). Examples of *tangible user interfaces* include rehabilitation tools (Edmans, Gladman, Walker, Sunderland, Porter, & Stanton Fraser, 2004), drawing and designing tools (Ryokai, Marti, & Ishii, 2004), collaborative and management tools, browsers and exploratory tools (Piper, Ratti, & Ishii, 2002), multimodal interactive tools (Raffle, Joachim, & Tichenor, 2002), music creation and performance (Patten, Recht, & Ishii, 2002; Weinberg & Gan, 2001), and toys/educational tools (Mazalek, Wood, & Ishii, 2001; Vaucelle & Jehan, 2002).

O’Malley and Stanton Fraser (2004) stress the beneficial role of *physical manipulatives* in learning environments by highlighting that:

- physical action and concrete objects are important in learning;
- physical materials trigger mental images that inform future problem solving in the absence of physical materials;
- learners can abstract symbolic relations from a variety of concrete instances; and
- familiar physical objects are more easily understood by children if compared with more symbolic entities.

This suggests that children are capable of demonstrating their knowledge via physical actions (e.g., gestures) and can solve problems by working with given concrete materials even if they cannot

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