Chapter 7
The Application of Affective Computing Technology to E-Learning

Nik Thompson
Murdoch University, Australia

Tanya Jane McGill
Murdoch University, Australia

ABSTRACT
This chapter discusses the domain of affective computing and reviews the area of affective tutoring systems: e-learning applications that possess the ability to detect and appropriately respond to the affective state of the learner. A significant proportion of human communication is non-verbal or implicit, and the communication of affective state provides valuable context and insights. Computers are for all intents and purposes blind to this form of communication, creating what has been described as an “affective gap.” Affective computing aims to eliminate this gap and to foster the development of a new generation of computer interfaces that emulate a more natural human-human interaction paradigm. The domain of learning is considered to be of particular note due to the complex interplay between emotions and learning. This is discussed in this chapter along with the need for new theories of learning that incorporate affect. Next, the more commonly applicable means for inferring affective state are identified and discussed. These can be broadly categorized into methods that involve the user’s input and methods that acquire the information independent of any user input. This latter category is of interest as these approaches have the potential for more natural and unobtrusive implementation, and it includes techniques such as analysis of vocal patterns, facial expressions, and physiological state. The chapter concludes with a review of prominent affective tutoring systems in current research and promotes future directions for e-learning that capitalize on the strengths of affective computing.

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INTRODUCTION

Affective computing is defined as ‘computing that relates to, arises from, or deliberately influences emotions’ (Picard, 1997, p. 3). Affective computer interfaces improve human-computer interaction by focusing on the development of technology that can appropriately detect and respond to the user’s emotional state. While research in human-computer interaction (HCI) in the past had been dominated by cognitive theories, the importance of users’ affective response is gaining attention (e.g. Beale & Peter, 2008; Gratch & Marsella, in press; Scherer, Banziger, & Roesch, 2010). As a branch of the broader domain of HCI, affective computing incorporates knowledge of users’ feelings, moods or emotions as feedback into the interface to yield more natural and intuitive applications. The incorporation of the body of affective computing research into HCI is an important step as it may yield interaction environments that enhance both cognitive performance and personal comfort by providing the needed emotional context (Maxwell, 2002). This is even more relevant given the shift from the desktop paradigm toward ubiquitous computing. As the computing environment is steadily becoming more tightly integrated with the day to day physical world, developments in this area are applicable to a vast array of situations such as embedded applications, information appliances, vehicles and so forth.

There is evidence that emotion has an impact on the speed at which information is processed (Öhman, 2001) and whether it is attended to (Anderson, 2001; Vuilleumier, 2001). Emotion also has a relation to motivation in that evaluations or feelings regarding the current situation will largely determine the action that is taken in response. Therefore, emotions are often precursors of motivations (e.g. Oatley, 1992). Memory is also impacted by emotional state, and again there are many mechanisms by which this can occur. The Processing Efficiency theory (Eysenck & Calvo, 1992) suggests that emotions can utilize cognitive resources that would otherwise be used for processing new information; for example in the case of anxiety, intrusive thoughts may compete with the cognitive task and result in a decrease in performance. Thus, an area which can benefit greatly from affective computing is education. The fact that interaction with computers is a fundamental part of study in most disciplines, coupled with the cognitive and emotional journey that all learners experience makes e-learning an ideal candidate for affective computing developments.

Intelligent tutoring systems attempt to emulate a human tutor by providing customized feedback or instruction to students. Whilst intelligent tutoring systems remain an active area of research, they have failed to achieve widespread uptake. A reason for this is the technical difficulty inherent in building cognitive models of learners and facilitating human-like communications (Reeves, 1998). The difference in learning performance between ideal one-to-one tutoring conditions and other methods is known as the 2 Sigma problem (Bloom, 1984). Research on expert human tutors indicates that ‘expert human tutors devote at least as much time and attention to the achievement of affective and emotional goals in tutoring, as they do to the achievement of the sorts of cognitive and informational goals that dominate and characterize traditional computer based tutors’ (Lepper & Chabay, 1988, p. 242). Given the apparent link between cognition and affect, it may be argued that for an intelligent tutoring system to emulate a human tutor successfully there should be some consideration of affective processes during learning. The inability of current intelligent tutoring systems to cater for the role of emotion in learning may to some extent explain the 2 Sigma problem in the context of computer based learning. It is hoped that the incorporation of affective components into e-learning development may therefore lead directly to improved pedagogical outcomes. Providing this vital form of affective feedback into intelligent tutoring and other applications should greatly improve their success.
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