Affective Tutoring Systems: Enhancing e-Learning with the Emotional Awareness of a Human Tutor

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ABSTRACT

This paper introduces the field of affective computing, and the benefits that can be realized by enhancing e-learning applications with the ability to detect and respond to emotions experienced by the learner. Affective computing has potential benefits for all areas of computing where the computer replaces or mediates face to face communication. The particular relevance of affective computing to e-learning, due to the complex interplay between emotions and the learning process, is considered along with the need for new theories of learning that incorporate affect. Some of the potential means for inferring users’ affective state are also reviewed. 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 particular 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 or physiological state. The paper concludes with a review of prominent affective tutoring systems and promotes future directions for e-learning that capitalize on the strengths of affective computing.

Keywords: Affective Computing, Affective Tutoring System, Cognitive-Affective Theory, E-Learning, Intelligent Tutoring System, Learner Emotions

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 enabling the communication of the user’s emotional state. While research in human-computer interaction 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). An important future step in interface design is to incorporate the findings for the body of affective computing research into 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

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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 dominant 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.

**Cognitive Basis for Learning**

The past few decades have seen the rise of the personal computer to fill many varied roles as organizer, communicator, entertainer and of course, educator. Research in the area of learning has predominantly taken a cognitive view in which the mental processes are considered as they are involved in learning. Cognitive theory is a learning theory of psychology that attempts to explain human behavior by understanding the thought processes. Cognitive theory is based on the assumption that human beings are logical and will make rational choices.

The field of cognitive psychology provides explanations for many of the underlying mental processes that occur during learning. Prominent in this field is the three stage information processing model (Atkinson & Shiffrin, 1968) shown in Figure 1. This multi-store model of memory proposes that incoming information from the environment is briefly captured in sensory memory, and that information that is interesting is more likely to go on from sensory memory to short term memory. If a particular piece of information needs to be retained, the learner then makes a conscious decision to work with it and to continue to process it. Information that the learner has deemed important is
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