

Responding to Student Affect and Efficacy through Empathetic Companion Agents in Interactive Learning Environments

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Abstract

Because many students experience frustration during learning, it is important to develop affective strategies to support students' coping with frustration in interactive learning environments. First, we must devise affect recognition models to detect student affect. Second, we need to determine when to intervene; these conditions are likely to be different for each student. To determine how much frustration a student can persist through, we should utilize models of student self-efficacy to predict a student's frustration threshold. Third, we should devise techniques for responding empathetically before the student reaches her threshold of frustration. We propose an approach to support students' coping with frustration in intelligent tutoring systems that utilizes induced models of affect, self-efficacy and empathetic behavior to effectively reason about precisely when and how to intervene in frustration-ridden learning situations.

Introduction

Affect has begun to play an increasingly important role in intelligent tutoring systems (ITSs). Recent years have seen the emergence of work on student affect modeling (Conati and Maclare, 2005), detecting frustration and stress (Burleson and Picard, 2004; Predinger and Ishizuka, 2005), modeling agents' emotional states (Gratch and Marsella, 2004), devising affectively informed models of social interaction (Paiva et al., 2005), and detecting student motivation (de Vicente and Pain, 2002). This work seeks to increase the fidelity with which affective and motivational processes are modeled and utilized in ITSs in an effort to increase the effectiveness of tutorial interactions and, ultimately, learning.

Anxious, highly frustrated students have difficulty with discovery learning situations in which they receive little guidance. Because it is believed that many that students who have a high frustration tolerance may make better learners, ITSs should provide support that helps students cope with emotions such as anxiety and frustration and

increase their tolerance for such learning situations. But how can we gauge how much frustration to allow a student to experience before it becomes excessive and in fact diminishes learning? Self-efficacy, which is one's beliefs in one's abilities to perform (Bandura, 1997), influences student persistence. Thus, models of student self-efficacy should support the detection and monitoring of student frustration tolerance and thresholds. Using human tutoring as a model, our intelligent tutors, whether they are companion agents, virtual peers, or pedagogical agents, should respond similarly to typical human empathetic behavior. We propose an approach to supporting students coping with frustration during learning utilizing empathetic companion agents.

Background

Frustration occurs when something or someone impedes a student's progression towards a particular goal. As an emotional response, frustration is not dramatically different from another negative affective response common to a variety of situations, anxiety. Anxiety is often more than merely an emotional response; it also consists of behavioral, cognitive, and physiological responses (Seligman et al., 2001). However, because we focus on interactive task-oriented learning environments, where the construction and achievement of goals is critical to learning episodes, we broaden our scope beyond anxiety to include frustration.

Self-efficacy influences students' reasoning, their level of effort, their persistence, and how they feel; it shapes how they make choices, how much resilience they exhibit when confronted with failure, and what level of success they are likely to achieve (Bandura, 1997). While it has not been conclusively demonstrated, many conjecture that given two students of equal abilities, the one with higher self-efficacy is more likely to perform better than the other over time. Self-efficacy is intimately related to motivation, which controls the effort and persistence with which a student approaches a task. Effort and persistence are themselves influenced by the belief the

student has that she will be able to achieve a desired outcome (Bandura, 1997).

Modeling Student Affect

To model student affect we first collect training data from student interactions in the learning environment. We monitor observable attributes in the learning environment in addition to student physiological response. The observable attributes consist of representations of all student actions including temporal and locational features, such as where the student is currently located, where the student has and has not visited, how long the student has occupied particular locations, what the student's current goal is, and how long she has been pursuing it. The observable attributes also contain intentional features that represent student progression towards learning objectives and goals. Affect information is obtained from several sources. To date, we have investigated using physiological response such as heart rate and skin conductivity and self-reports in which students assess their own affective states. In the future, we hope to further incorporate annotations with information obtained from student video recording analysis of facial expressions and body posture. In runtime learning environments, we use models of affect to monitor the same attributes observed during the training phase to recognize student affective states. Construction of affect recognition models, self-efficacy diagnosis models, and models for empathetic behavior control have utilized naïve Bayes and decision tree techniques to date. Our current work investigates the use of support vector machines and *n*-gram models for such tasks.

Research Agenda

The research plan will be conducted in four stages. The first stage is concerned with investigating affect modeling in ITSs (McQuiggan and Lester 2006a, 2006b). This includes the development of frameworks for modelling four key psychological constructs: empathy, self-efficacy, anxiety, and frustration. The second stage investigates the relationship between student efficacy with student frustration thresholds and tolerance levels. This stage will see the development of a study that induces student frustration and anxiety in learning environments, discovers thresholds (i.e., how much frustration the student can bear before electing to quit or move on) all while monitoring student self-efficacy through self-reports, biofeedback and expert diagnosis. The third stage will integrate the first two stages and examine strategies from the educational psychology literature that can be deployed in our learning environment to help facilitate successful coping with anxiety and frustration and guide students to effective emotional states for learning. This will involve another experiment to analyze the significance of implemented facilitating strategies for coping and learning. This experiment will also investigate the embodiment and role

of the other agents in the learning environment, assessing the merit of deploying companions vs. peers vs. tutors and exploring how each can create different learning experiences. The fourth stage will culminate in a comprehensive experiment investigating the effectiveness of the proposed approach to affect modeling on the student's learning experience. It will utilize measures of learning effectiveness, transfer, and student engagement.

Summary

The research proposed here is concerned with the development of strategies to support students' coping with anxiety or frustration. As students approach their frustration threshold, empathy models are used to guide tutorial control of virtual agents (companion, peer, tutoring, and teaching agents) to deliver appropriate tutorial feedback customized for the student's affective state. We propose to utilize probabilistic modeling techniques for tasks such as affect recognition, self-efficacy diagnosis, and empathetic behavior control.

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