Work in Progress - Towards an Emotional Learning Model for Intelligent Gaming

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Abstract - **Recent research defines achievement emotions as emotions that are strongly related to learning and achievement contexts, where behaviors and outcomes arise during activities. Game-based learning environments reward the mastering of skills and abilities. This paper is focused on a qualitative and quantitative approach to recognizing the learner's achievement emotions. Learners' emotions are inferred from two sources: from observable behavior and from answers to questions in a game dialogue. The analysis and design involved in the creation of this affective student model are the central focus here. *PlayPhysics*, an emotional games learning environment, is being implemented for teaching Physics at undergraduate level. When our results are finalized our affective student model will be incorporated into *PlayPhysics*. To ensure accuracy of the recognition method, a preliminary prototyping study has been conducted. The results from this prototyping phase are presented and discussed.**

Index Terms - affective student model, emotions, game-based learning environments, intelligent tutoring systems, PlayPhysics.

INTRODUCTION

Emotions can influence learning and performance [1]. Intelligent Tutoring Systems (ITSs) have focused on the problem of identifying the learner's motivation [2] or emotion [3] and responding accordingly. Until today, there is no system capable of accurately identifying the emotions that take place in a learning context and there is no consensus about what emotions must be recognized. According to the Control-Value theory of Achievement Emotions [1], control and value appraisals have been signaled as the most important when determining these emotions. Game-based learning environments effectively engage the learner's attention, offering immediate feedback to the learner's actions [4].

This work focuses on a qualitative and quantitative approach to identifying the learner's achievement emotions. The analysis, design and results from the preliminary evaluation of this affective student model are discussed here. The affective model will be included in *PlayPhysics*, which will be tailored to provide feedback to meet the learner's needs.

RELATED WORK

Predicting emotion from its origin is an approach that reasons about its probable antecedents [3]. Often, the Ortony, Clore and Collins (OCC) model [5] is used. This approach is limited in that it requires awareness of the learner's beliefs and needs adapting to the learning context.

Recent research has shown that emotion, cognition and motivation are deeply intertwined [1]. Mapping observable behavior to infer the learner's motivation using a qualitative and quantitative approach has proven effective in [2]. Self-efficacy has been shown to predict the learner's disposition and has been used in [6] to construct a student model. Recognizing the learners' emotion constitutes a challenge, since the factors that can influence an emotion or its expression vary from person to person. Until now, there is no student model which can reason accurately about the learner's emotions using both motivational and cognitive variables. Our research is focused on achieving this goal.

EMOTIONAL LEARNING MODEL

The approach explored here reasons about the learner's emotion through analyzing qualitatively and quantitatively the learner's observable behavior. The affective student model is based on the "Control-Value Theory of Achievement Emotions", which assumes that appraisals of control and value are the most relevant to determine academic emotions [1]. *Control* is determined by the learner's beliefs and skills related to the goals of an activity where a desired outcome can be achieved. *Value* is related to the importance of the activity per se, or to its desired outcomes. Three classes of achievement emotions are defined according to their focus and time frame: *prospective-outcome, activity and retrospective-outcome* emotions. The theory has proven effective at assessing the learners' emotions through self-report in the Physics domain using the Achievement Emotions Questionnaire (AEQ).

Uncertainty is involved when identifying the learner's emotion. To handle it, Dynamic Bayesian Networks (DBNs) and a Probabilistic Relational Models (PRMs) approach, described in [7], were used. Three DBNs were derived. The "outcome-prospective emotions" DBN is shown in Figure 1.

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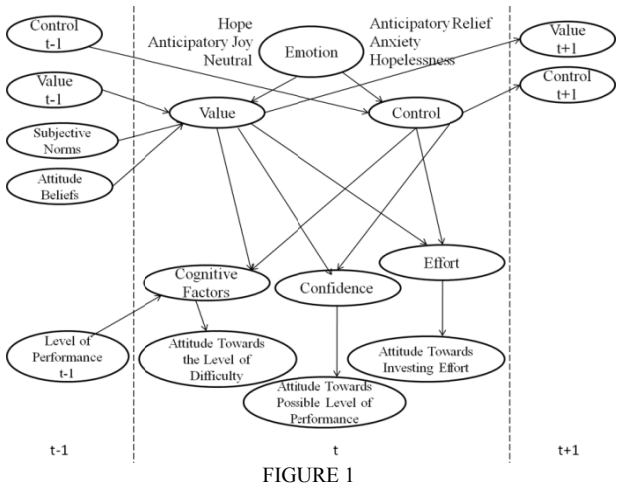

FIGURE 1
OUTCOME-PROSPECTIVE EMOTIONS DBN

The motivational and cognitive variables comprising these DBNs were selected from the AEQ questionnaire [1]. Some observable variables and dependencies between variables were incorporated into the model using as a basis the work in [2, 6]. For example, a statement in the AEQ related to the emotion anxiety states "I worry whether I will be able to understand the material". From this statement it was inferred that the student's beliefs in respect of the level of difficulty are indicators of value and control. The Conditional Probability Tables (CPTs) values were set using common sense. To determine the learner's beliefs and attitudes, the theory of planned behavior [8] was employed to design questions adapted to the game-dialogue of *PlayPhysics*.

PLAYPHYSICS DESIGN

Physics' students often find it difficult to understand underlying principles [9]. *PlayPhysics*' design requirements were identified from an online survey applied to lecturers and students of Physics at Trinity College Dublin and Tecnológico de Monterrey, Mexico City. The most difficult topics were identified and *PlayPhysics* focuses on teaching these topics. *PlayPhysics*' utilizes the *Olympia* architecture, which has proven effective for building online game-based learning environments and teaching Physics [9]. In this research, *Olympia* is being adapted to recognize the learners' emotions. *PlayPhysics* employs a space adventure game, where learners apply their knowledge of Physics.

PRELIMINARY EVALUATION OF THE EMOTIONAL LEARNING MODEL

A preliminary evaluation of the prototyping material and the outcome-prospective emotions DBN was conducted with 7 postgraduate students. The students undertook a pre-test in selected Physics topics. Once the students were aware of their results, they proceeded to answer the questions in the game dialogue. Finally, the students reported the emotion that they felt before starting to play the game. This emotion was compared with the emotion reported by the affective student model. Preliminary results in Figure 2 show an accuracy of 57.14%.

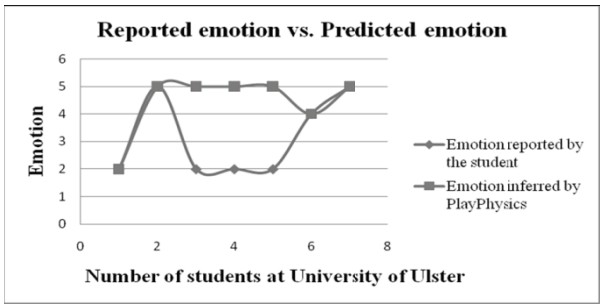

FIGURE 2
RESULTS OF THE PRELIMINARY EVALUATION OF THE OUTCOME-PROSPECTIVE DBN

It was noted that some students did not know how to report the emotion that they felt. Examples of these emotions will be included in an updated version of *PlayPhysics*. The nature of the results may be due to the probabilities set in the CPTs, which may require some adjustment. To ensure the accuracy of the identification of the affective model further tests will be conducted on a larger population of students. When the affective student model produces reliable results it will be incorporated into *PlayPhysics*.

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