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Emotions as an Element that Maximizes the Effectiveness of a Pedagogical Agent

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Abstract. In order to create a credible emotional agent, it needs to be designed with a behavior that corresponds to the emotional state. In this paper, an effective agent is described as an agent whose intervention is *ad hoc* to what is expected of it by the user; in order to be able to develop skills and abilities. As a result we propose basing the actions of the agent on an emotional structure linked to the teaching-learning process. Which it is assumed will maximize the effectiveness of the agent.

Key words: affective computing, pedagogical agent, emotional theory.

1 Introduction

A very new area exists in Artificial Intelligence (AI) known as affective computing, which explains the importance of emotions in human cognition (the decision-making process, perception, human interaction, intelligence). As a result, applying this focus to intelligent tutor agents is essential in order to maximize the effectiveness of said agent. Among emotional theories, the theory of Ortony, Clore & Collins (1996), known as the OCC theory, specifies a cognitive structure of emotions according to personal and interpersonal descriptions of situations arising from the environment. Furthermore, they lay the foundations for an emotion model that can be operated by computers. In other words, it attempts to create a cognitive model of emotions that can be used in AI systems and to link it to the reasoning system in order to maximize its performance.

The following article is composed of the following sections: *section two* describes the teaching-learning process; *section three* briefly explains the different theories of emotion; *section four* details the OCC theory on which the emotional structure linked to the teaching-learning process will be based; *section five* briefly describes papers relating to the proposal of this paper which are also based on the OCC theory and compares them with our proposal; *section six* explains the proposal of our project and the methodology to be used, followed by conclusions and references.

2 The Teaching-Learning Process and Intelligent Teaching Systems

Research in the area of ITS's has focused on different aspects, from the inspection of each of their modules to the preparation of generic architectures, as well as automatic learning and the construction of help for designing teaching systems (Laureano-Cruces, 2000).

Intelligent teaching systems (ITS) approach the learning process as the collaboration between the intelligent system and the student. Based on the perception of the cognitive state of the student, at any given time the tutor decides on the appropriate strategy. These strategies shall be selected based on the measurement of a series of parameters including: errors made, learning style, knowledge dominated, affective-motivational state, etc. (Laureano-Cruces & de Arriaga, 2000 and Mora-Torres, 2007).

At the end of the 90's, a new area was created in computer sciences in the field of artificial intelligence called affective computing (Picard, 1995) and, since then, emotions have acquired more and more importance in the production of interfaces that make users more comfortable when interacting with systems (Partala & Surakka, 2004).

In turn, the so-called instructional objectives (IO) represent the cognitive sub-skills and abilities that the tutor wants to transmit to the student (Laureano-Cruces & de Arriaga, 2000; Laureano-Cruces, Terán-Gilmore & Rodríguez-Aguilar, 2005; Laureano-Cruces, Sánchez-Guerrero, Mora-Torres & Ramírez-Rodríguez, 2008) in such a way that the student interacts with the system (by means of explanations, comments, graphic examples, etc.) and provides continuity within the instructional session. Continuity is provided by ITS interventions through an interface which could be a pedagogical agent (Lester & Stone, 1997; Lester, Callaway, Grégoire, Stelling, Towns & Zettlemoyer, 2001; Laureano-Cruces, 2004; Laureano-Cruces, et al, 2005; Velasco-Santos, Laureano-Cruces, Mora-Torres, Sánchez-Guerrero, 2008).

3 Emotional Theories

The history of emotion theories dates back to the Ancient Greeks such as Plato and his debate regarding emotion-cognition (the tripartite soul: cognition, emotion, motivation). Descartes followed later with the body-mind debate, as well as Darwin with the biology *versus* culture debate, describing the expression of emotion in men and animals and finally, as part of ancient history, we have James and the central-peripheral debate (parts of the body), which envisages an emotional state resulting from internal events (thoughts, memory and sensations) or external events (actions of others, a change in situation) Scherer (2000).

At the present time, there are various theories in the field of emotion psychology, the fundamental differences of which are linked to the definition of emotion and its conceptualization. Nevertheless, it should be noted that the elements of the definition of emotion demonstrate a certain similarity between the different theoreticians. The classification of emotion theories according to Scherer (2000) highlights the common principles of the respective focus. Each type of model responds to a focus of the emotional process. These models are described briefly below.

Dimensional

In *dimensional* models, the emotional state is obtained by approach-avoidance to emotional dimensions such as valence and activation. *One-dimensional* models only focus on either valence or activation. In the case of *multi-dimensional* models, the nature of the emotional state is established by the position in relation to various independent dimensions, as described in the Wundt model, which is three dimensional: pleasantness-unpleasantness, rest-activation and relaxation-attention.

Discrete

Discrete emotional models focus on motor expression or adaptive behavior patterns. They obtain the emotional state through the typical situations or stimulus configurations. Discrete models include so-called *circuit models*. The emotional focus of the latter models is similar to that of the neuropsychological system, i.e. the number of

fundamental emotions and their differentiation are determined by means of neuronal circuits created developmentally (Cannon, 1927; Papez, 1937; Arnold, 1960; Panksepp, 1982 and 1989; Gray, 1990) quoted in (Scherer, 2000).

Meaning-Oriented

Meaning-oriented models focus on verbal descriptions of subjective emotions and obtain the emotional state through patterns of cultural interpretation. Meaning-oriented models include so-called lexic models, the basic principle of which is that linguistic terms used in an emotional state allow us to discover the underlying structure of the psychological phenomenon (Oatley & Johnson-Laird, 1987) quoted in (Scherer, 2000).

Componential

Componential model theoreticians assume that emotions are detected by means of a cognitive evaluation (not necessarily conscious or controlled). These models focus on the relationship between the precedents leading up to the evaluation of an emotion and the different reaction patterns resulting from the evaluation. The evaluation is carried out using universally valid criteria influenced by individual and cultural differences.

The model proposed in the OCC theory is a *componential* model due to the fact that it has evaluation criteria, and includes shared aspects with *meaning-oriented models*. This theory is the one on which we will base the emotional structure linked to the teaching-learning process because it provides us with a cognitive model and evaluation criteria, which is basic for a causal relationship between the emotions and events of the teaching-learning process.

4 The OCC Theory

This theory proposes a general structure in which three main classes of emotions are specified (Figure 1), as a result of focusing on each of the three outstanding aspects of the world: 1) events and their consequences, 2) agents and their actions and 3) pure and simple objects. And are established as evaluation criteria: 1) goals for assessing events, 2) norms for evaluating the action of the agents and 3) attitudes for evaluating the objects. The three main classes of emotions specified are: 1) emotions based on events: the goals relating to the events are specified; 2) attribution emotions: they attribute responsibility to the agents relating to their actions regarding norms and 3) attraction emotions: based on attitudes in relation to objects (Ortony, et al., 1996).



Fig. 1. Proposed emotional structure described by the OCC theory.

5 Proposal and Methodology

Our proposal is to specify the emotional structure (using the OCC theory model) and link it to the teaching-learning process described in Laureano-Cruces, Terán-Gilmore & de Arriaga, (2004) and Laureano-Cruces, Ramírez-Rodríguez, Mora-Torres, de Arriaga & Escarela-Pérez (2008) and taking into account the aspects proposed by Castañeda and Martínez (1999). The above shall be reflected in the cognitive-emotional interventions (instructional strategies) in order to maximize the effectiveness of the agent when interacting with the user. Figure 2 shows the structure proposed in this paper.

The structure of the teaching-learning process with which the emotional structure shall be linked is made up of a series of inter-related elements is linked to a parameter of the cognitive environment of the student. These elements are described in Table 1.

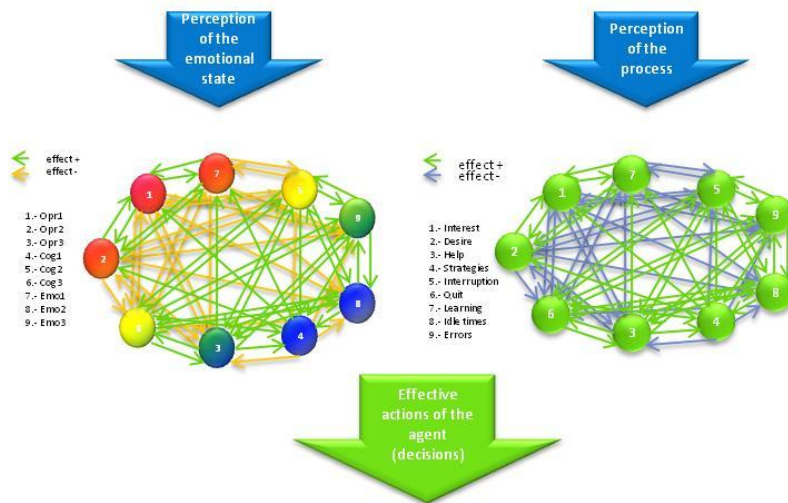


Fig. 2. Emotional model linked to the teaching-learning model.

Elements	Description	Related to	Parameter related to the student's cognitive environment
<i>Interest</i>	Interest in the subject of the proposed task.	Motivation, profile	Predetermined as being present when entering the system and modified by the effect of the rest of the elements.
<i>Desire</i>	Desire to continue carrying out the proposed task.	Motivation, profile	Predetermined as being present when entering the system and modified by the effect of the rest of the elements.
<i>Help</i>	Possibility of requesting help to carry out the proposed task.	Confidence in the tutor/environment	Request for and execution of help.
<i>Cog/op strategies</i>	Application of cognitive and operative strategies according to the state of the rest of the elements.	Motivation by the tutor	Application of cognitive/operative strategies by the tutor.
<i>Interruption</i>	Need to interrupt the proposed task.	Ability to organize, use operative and/or cognitive strategies, to undertake a constructive discussion, to be opportune	Interruption of the task by the system.
<i>Quit</i>	Possibility of leaving the tutorial system before finishing the proposed task.	Latent possibility which could always occur if a student is not interested and/or does not have previous skills.	Exit from the system (ability to save session).

<i>Learning</i>	Develop skills and abilities.	Latent possibility which is always aimed for and which is encouraged based on different strategies.	Inferred by the effect of the rest of the elements.
<i>Idle times</i>	Possibility of no action being carried out for prolonged periods of time depending on level of expertise.	Lack of understanding or interest in the example or concept; distraction, tiredness, frustration, multiple tasks.	Time established by the expert (button to pause/activate time)
<i>Errors</i>	Possibility of making mistakes while carrying out the proposed task.	Level of skill achieved taking into account the different profiles, distraction, lack of interest, tiredness.	Errors made (considering error type)

Table 1. Parameters of the cognitive environment of the student linked to elements from the Teaching – Learning process.

Goals, Norms and Attitudes in the Teaching-Learning Process

The emotional structure according to the OCC theory is developed based on the three criteria already mentioned: goals, norms and attitudes. In our case, the goal is to acquire the skill proposed by the system (for example, to understand the control structures of structured programming). Thus, the aspects which are taken into account are: desirable events (compliance with instructional objectives, understanding of content, etc.) and undesirable events (abandonment, i.e. leaving the system before completing the tasks). With regards norms, these are considered to be those norms that indicate the performance of the user. The above is related to level of commitment to the study: 1) percentage of tasks completed, 2) percentage of attendance, 3) material covered over a specific period of time, among others. As far as attitudes are concerned, we are referring to preferences towards types of tasks or strategies according to learning styles. Based on the above, three types of emotions are specified: 1) **emotions based on events**, 2) **attribution emotions**, and 3) **attraction emotions**.

The first, the so-called **emotions based on events** are related to the *desirability* of the described event, with the *forecast* of results depending on the effort and *wellbeing* they produce. According to the *desirability* of the events such as, for example, *acquiring skills* or *getting right answers*, there will be agreement or disagreement when said events do or do not occur. With regards the *forecasting* of results due to the probability and effort-carrying out of said results, emotions are presented as hope/fear, relief/disappointment, satisfaction/confirmation of fears. For example, when carrying out proposed tasks, it is hoped that skills and abilities will have been developed in the domain. In accordance with this expectation, first of all there is the hope that it will occur or the fear that it will not. Subsequently, when the event occurs, relief can be felt that the fear was not confirmed or disappointment is felt that the expectation was not achieved. Satisfaction may also occur as a result of the achieved expectation or simply confirmation of the fear. Thus, these emotions dominate, based on predictions and form part of the emotions of one's vicissitudes. The emotions of *well-being* are jubilation or anguish. For example, when you get something right, you feel *jubilation* as well-being. However, on the other hand, if you make a mistake, you feel anguish.

The **emotions of attribution**, in turn, are linked to the approval or disapproval of the actions of the agents. In our application, an agent is the tutor or the user. Due to the *plausibility* (approval or disapproval), the user can approve or disapprove the content in their presentation (strategies). According to the *force of the unit* (degree to which the pedagogical agent is in cognitive unity with the user, i.e. the perception of the user towards the system with regards considering it part of a work team), pride/embarrassment, admiration/reproach may be felt. In order to measure this force, the deviation of expectations needs to be taken into consideration. For example, pride or embarrassment is felt due to the correct or incorrect development of proposed tasks in accordance with expectations. In such case, the user qualifies its own performance.

Finally, **attraction emotions** are linked to the affection or displeasure felt by the user in relation to the objects, which in our case are linked to: strategies, content, design of the interface (Velasco-Santos et al, 2008). Due to the *capacity to attract*, love or hate are felt towards the pedagogical agent and the development interface. The above is

based on the extent to which the user finds the help provided by the pedagogical agent effective and the ease of use of the learning environment.

Methodology

We used the procedure proposed by Castañeda y Martínez (1999), Laureano-Cruces (2000) and Laureano-Cruces et al. (2000) which mainly consists of three stages: the *first* covers the analysis of the domain which allows necessary knowledge and skills to be identified. During this stage, tools used for cognitive psychology are required and include: mental models, the cognitive analysis of tasks, genetic graphs, cognitive model of emotions, among others. The *second* stage consists of the modeling of the domain. The level of demand is established, i.e. it is decided whether the system is for beginner or advanced students. Furthermore, the tasks are specified in order to obtain evidence. During the *third* stage, the knowledge base of the domain is constructed. In order to do this, the problem needs to be represented using artificial intelligence representation techniques and, in the study case, using fuzzy cognitive maps. It's worth mentioning that the cognitive model will be enriched by *mental emotional-motivational models* that reflect procedural effectiveness. Within the operating framework proposed as a guideline for the methodology, the following are taken into consideration: 1) the development of the novice-expert transformation, and 2) precision and speed indexes.

Conclusions

As mentioned at the beginning of this paper, emotions play an important role in decision making. The process of making decisions in order to create the best institutional strategy within the teaching-learning process is a crucial point for the user. The development of a cognitive structure of emotions linked to this process is a contribution in the field of affective computing. The purpose of the above is: 1) to simulate and shed light on emotional abilities useful in teaching which should be handled by a human tutor, and 2) make learning-based system interactions more efficient, thus maximizing them. Finally, this cognitive structure of emotions can be assembled in order to produce the behavior of a pedagogical agent which provides more credibility to the tutor system.

Based on the previous paragraph, a cognitive structure of emotions allows us: 1) to highlight the importance of emotions in education and 2) to create a representation of the distributed behavior which allows for the inclusion of emotions, using fuzzy cognitive maps, 3) to generate a dynamic interaction, 4) to choose the personalized, preventive didactic strategy, maximizing the learning status.

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