AnimA-K: recognizing student’s mood during the learning process

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Abstract: This article discusses the introduction of affectivity studies in virtual learning environments (VLE). The idea is to identify the mood of the student in order to encourage more appropriate teaching strategies. A historical and theoretical review on the importance of the affective dimension in human subjectivity is shown. Also, the challenges of using computational models for recognition and representation of mood into ROODA VLE are discussed. The prototype AnimA-K is presented to check this possibility.

Keywords: Affectivity, mood, affective computing, virtual learning environment

1. Introduction

A new form of social interaction is enabled by the new technologies. This interaction is under continuous transformation, supported by changes concerning the concepts of time and space. This new concept of living in different times and spaces changes all the relationships among individuals, involving modifications concerning the educational field.

Teaching and learning directions are based on the relations and actions taken among teachers, students, the environment, and the object of knowledge. Pedagogical practices are increasingly based on technology, which, in its turn, implies the rethinking of the teaching act. It is through the assessment of learning that the achievement of the goals in relation to the student’s construction of knowledge is verified. However, this assessment should not be limited to cognitive aspects, but also take into consideration affect and the student’s affective attributes, once they interfere deeply with mental processes such as memorization, reasoning, attention, motivation, etc [1][2][3][4].
This leads to a new approach to virtual learning environments (VLE) constituted by a technological infrastructure (graphic interface, synchronous/asynchronous communication, and other functionalities) and by all the relations (affective, cognitive, symbolic, among others) established by the participants [5]. Such relations are established from the strategy applied by the teacher, according to a determined Pedagogical Model1. In this sense, the functionalities of the VLE represent important sources for the search of affective aspects of the students, which are not always perceived by the teacher during the process.

On the other hand, Affective Computing2 applied to Education has been contributing to the development of “virtual tutors”, “virtual learning companions” or other virtual assistants, which perceive the student’s affective reactions and modify their own behavior to support the learning. These artificial agents integrate the Intelligent Tutoring System (ITS)3, developed for a specific educational domain, being visible by means of a character or invisible, being only its activity observed.

Studies [8][9][10] demonstrate that the recognition of the affective aspects and their application in computing systems result in adaptative and functionally more effective systems. In VLE, where the participants act simultaneously in a linear and nonlinear form, of cooperation and collaboration [5], little attention is paid to the study of affectivity in the interactions that are established. Researches on the applicability of affectivity in VLE are still in exploratory stages.

However, there is lack of clarity in the definitions of the terms related to affectivity such as: emotion, mood, motivation, feeling, passion, personality, temper, and many others. The challenge is to unite the concepts used in the several areas dedicated to affective phenomena (Psychology, Philosophy, Sociology, Medicine, Biology, and Computing) so as to homogenize and characterize the definitions, which could lead to the construction of more solid and formalized categories.

The term affectivity, in this paper, is employed in the sense of the identification of a group of psychic and physical phenomena that include the control of the emotions themselves, the feelings of the emotions, the sensitive experiences and, mainly, the ability to get in touch with sensations (p. 59)[8].

This study proposes the recognition of mood states in VLE through student-student, student-teacher, and student-object of knowledge interactions. In the following section, the discussion about the dichotomy affectivity and cognition is

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1 A Pedagogical Model can be defined as a system of theoretical premises that represents, explains and guides the way how the curriculum is approached, which is reflected in pedagogical practices as well as in the interactions professor-student-object of knowledge [6].

2 The term Affective computing was created by Rosalind Picard [7].

3 The ITS are based on the instructional contend models (“what to teach”) and teaching strategies according to the student’s model (“how to teach”).
presented. In section 3, the most widely used theories in computational models are highlighted. In the same section, state-of-the-art approaches concerning the recognition of affective phenomena are reported. In section 4, ROODA VLE\textsuperscript{4} is presented, and the challenges regarding the recognition of the student’s moods are discussed. In section 5, final considerations are made.

2. Affectivity and Cognition: a Brief History

The landmark of modern scientific research on the nature of emotions is the publication of the book *The Expression of the Emotions in Man and Animals* by Darwin \[11\] in 1897. This text defended that emotional expressions (facial expressions, for example) constitute inherited remains and are, thus, innate. However, affective expressions could also be learned, inaugurating, this way, the study of behavioral aspects.

Later, James and Lange developed, independently, the first physiological theory at the end of the XIX century. They affirmed that the behavior of the body (heartbeat, flushing, etc.) triggered by any emotional event (stressing, pleasurable or sad situation, etc.) would produce the feeling of emotion, and not the opposite. Thus, emotions would be the product of the mental perception of certain physiological modifications \[12\]. Cannon-Bard’s theory contested James-Lange’s, proposing that emotional experience and the behavior of the body constitute parallel processes. At this time, philosophical and scientific movements dedicated to debates on thought, knowledge, behavior, reason, reasoning, and intellect. Affectivity was not discussed very often.

With the advent of computers and Artificial Intelligence (AI), scientists from the most diverse areas of knowledge created the hypothesis that the mind is an information processing mechanism. In the 1960’s, Simon \[13\], one of the precursors of AI, influenced by James, would recognize the importance of providing the cognitive theories of information processing with aspects of motivation and emotion. In parallel, the consolidation of great psychological theories – gestalt, psychoanalysis, behaviorism, genetic epistemology, cultural and socio-historical psychology –, took place. Affectivity in cognitive processes is specially emphasized in these theories.

Since then, psychogenetic approaches, through the Piagetian and Vygotskian perspectives, have been highlighting the role of affectivity in cognition. Piaget recognized that affectivity is the motivating agent of cognitive activity \[2\]. The author paid special attention to the social dimensions in the cognitive (and affective) development affirming that, besides cognition, a moral or ethical component, a social component and an affective component are present in the

\textsuperscript{4} The name ROODA comes from Rede cOOperativa De Aprendizagem, which means Cooperative Learning Network. It is available on-line at <http://www.ead.ufrgs.br/rooda>
intellectual development [14]. Vygotski conceived language and social interaction as fundamental elements for consciousness and learning [3]. The subject gains consciousness and learns not only in his/her relation with himself (intrapersonal level), but also at the social level (interpersonal level). Vygotski contested the dualism between the affective and cognitive dimensions in the way how traditional psychology separated intellectual aspects from affective and volitive aspects [15].

In the last three decades, Neuroscience has been establishing the relation between cognition and affect. It holds strong evidence regarding the inseparability of cognitive and affective processes. That is, the set of affective phenomena exerts influence on the mental processes; and, in its turn, brain systems destined to affectivity are intrinsically connected to those destined to cognition [1][18].

Among many researchers of the cognitive sciences, Ortony et alii [19] and Scherer [20] agree that: a) believes and desires influence actions; b) the interaction with others and with the environment may originate new beliefs; and c) new needs provoke new desires. This way, beliefs, desires and intentions influences cognitive processes, which, in their turn, activate affective phenomena in subjects (and vice-versa).

3. How to recognize and represent the affective dimension

One of the presuppositions of Affective Computing [7] is that computers have the capacity of recognizing and inferring affective aspects as if they were third-person observers. In a real environment, affective communication is captured by means of the senses or by means of mediating instruments (paper, telephone, video, etc.). It may be visible or presupposed. In many of the cases, affective communication takes place by means of an information patterns that may be represented in the computer. Thus, the recognition of affective states constitutes an issue related to pattern recognition [7].

Affective patterns can be recognized by the application of one of the inference methods present in literature [21]: prognostic inference (a top-down perspective), diagnostic inference (a bottom-up perspective) or hybrid inference (combination of prognostic and diagnostic). In the first case, the recognition of the affective aspects is based on factors that influence or cause the affective state. This approach is supported by psychological theories [19][20]. In the second approach, diagnostic inference, the recognition is made through behavioral and physiological measurements collected by sensors that capture affective patterns [9][22]. The two methods (prognostic and diagnostic) can be combined, originating the hybrid approach, whose result is a more precise affective inference [21][23].

Most of the researchers adopt one of the first two methods, that is, the ones in which the inference of the affective states are made by prognostic or by diagnostic methods. In the research being conducted at graduate Program in Computer
Education (PGIE) from Federal University of Rio Grande do Sul (UFRGS), the hybrid approach is adopted to recognize the Mood. In the first phase of the project, the intention is to obtain behavioral, self-recorded, and observable measurements. Based on the evidence provided in these three measurements, the probabilistic inference of the student's mood while interacting in the ROODA VLE will be made, which will be described in the next section.

Current computational models to represent the affective dimension are based on the cognitive theories known as Appraisal. According to these formulations, emotional states result from the evaluation process (appraisal) of the subject’s beliefs, desires, and intentions and environmental demands. In the research under development, the theory known as Component Process Model [24] will be adopted. The appraisal model CPM (or Scherer’s model) determines to which group of affective phenomena the emotion belongs, through the result of a sequence of verifications (SEC – Stimulus Evaluation Checks). The evaluation of the events occurs in a hierarchical way in three levels [25]: at the sensory-motor level are verified the innate characteristics (genetically installed, primary emotional responses such as reflexes; at the schematic level are considered the history of learning, the social interactions and the abstract representations of the assimilated emotional patterns; and, at the conceptual level, the individual’s cultural meaning. In each of the levels are identified the four objectives of the appraisal: 1) the relevance of the event; 2) the implications of the event in the well-being and accomplishment of the individual’s goals; 3) the potential of coping; and 4) the meaning of the event, considering the individual’s norms and values.

Scherer’s model is applied especially in systems that analyze the emotional expression at the moment of communication. Thus, it is supposed that such model is consistent for the construction of affective (and communicative) agents that assess states of mood of the participants of the ROODA VLE, once it has resources that favor the synchronous and asynchronous interaction between them.

4. Complexity in the Inference of Moods in VLE

The ROODA VLE⁵ is based on constructivist principles [3][26], having as its goal the change of educational paradigms based on the interaction and cooperation of the users in virtual learning environments. It highlights the process of cooperation,

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⁵ The concept of coping, or the ability to overcome (or minimize), has been defined as “the group of strategies used by people to adapt to adverse or stressing circumstances” [27].

⁶ The ROODA [28] is virtual learning environment developed by NUTED (Center of Digital Technology applied to education), of the School of Education and connected to the CINTEDE Center of Interdisciplinary Studies of New Technologies of UFRGS, supported by CNPq.
and has as a special characteristic the fact that it is a multi-course platform, centered on the student [29].

The convenience of using ROODA is justified for it has resources that tend to support synchronous and asynchronous interaction, cooperation, and the individualization of learning. The tools for synchronous interaction (chat) and asynchronous interaction (forum and log book) support the negotiations, discussions, and coordination that are part of the construction of knowledge through the ROODA [5], enabling the search for and the identification of subsides for the recognition of affective states, in this case, moods. The basis for the study of the moods in the ROODA environment comprehends: the texts produced by the students when using the resources of synchronous (chat) and asynchronous interaction (forum and log book), as they represent the interactions in the virtual environment.

In this context, the prototype AnimA-K [30] is inserted, with the purpose of validating the parameters necessary for the development of an affective agent able to infer the student’s moods. With the aim of designing the prototype, it was decided that the domain construction of computational algorithms (figure 1) would be used as a preliminary experiment. It means de recognizing different moods during an activity that involves the use of adequate methodology to solve computational models, the formulation of solutions, and, finally, the construction of the algorithm.

The prototype AnimA-K considers the following moods, based on Scherer’s definitions [20]: 1) Being cheerful – implies showing a happy behavior, good disposition, motivation, interest, satisfaction to face the challenges of learning, showing demonstrating collaboration, and cooperation; 2) Being upset – implies demonstrating discontentment, sad behavior, lack of disposition, lack of interest, lack of motivation, dissatisfaction, frustration (or even feeling penalized) to continue learning; or still, feeling coerced, for believing that the colleagues' will prevails; and 3) Being indifferent – implies demonstrating apathy, carelessness, negligence, inattention, and lack of motivation for the contents being learned.

In a preliminary phase of the project AnimA-K, the semi-apparent and assessment indicators are being considered in the identification of the student’s moods. The semi-apparent indicators are obtained from information about the student’s behavior when interacting with the application (for instance: time spent doing an activity, number of times that the student resumed/quit the activity, success or failure doing the activity, and asking for help) and textual expression through key words in the writing and emoticons in the forums, logs, and chat in the ROODA environment. The assessment indicators are obtained through the application of research inventories and questionnaires at five moments: beginning of the course; beginning, during the development and at the end of the activity (figure 2); and at the end of the course. The result of these investigations will

7 The text miner SOBEK [31], which is being studied for possible adaptations, is the device to be used to analyze statistically the affective content of the texts recorded.
assist the development of an affective agent to be incorporated in the ROODA, in order to evaluate the pedagogical and affective activities associated with the student’s behavior during the learning activities.

![Image](image1.png)

Figure 1 The prototype AnimA-K: (a) Construction of computational algorithms activity; (b) The mood assessment indicator by Affective State Wheel.

The prototype will be applied early in the school year 2009 in the Course of Computer Science (presence and distance classes) and the examination results will be in the first half of 2009. After the analysis of the results obtained with the application of experiment AnimA-K, this prototype will be implemented in the ROODA environment and the experiment will be used in other undergraduate and/or graduate courses in order to confirm or redefine the parameters which were initially established.

The greatest challenge in the incorporation of the affective dimension regards the suitability of the computational models (of recognition and representation) to these environments. The recognition models that determine a greater accuracy in the inference are the hybrid ones. Most of them involve, besides observable behavioral measures, the application of physiological sensors to capture the emotional expressions manifested through the movements of the body (facial expressions, gestures, etc.) and speech undulations.

The models of representation of affectivity must be dynamic because the affective dimension is modified along time; for example, the student, at a certain moment, can be excited about developing a task, and, at another, feeling

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8 The affective state wheel is an instrument to measure emotional reactions present in learning processes. It is based on Geneva Emotion Wheel (GEW, see Scherer [20], downloaded from http://www.unige.ch/fapse/emotion/ on DATE) that was developed by Swiss Center of Affective Sciences.
frustrated. Computational models to generate the affective model – the most widely known are BDI (Beliefs, Desires and Intentions) and the Bayesian Networks – have shown to be adequate to treat the dynamic characteristic of affective states and also indicate the situations in which more than one state may be evidenced.

This research adopts the hybrid approach, focusing on the student’s observable behavior in the development of an activity and in the interactions with the colleagues and the teacher. However, the identification of the moods, based on the observable behavior in the ROODA VLE, and the application of inventories may not be enough to determine the accuracy of the valence (positive or negative) of these states, as well as their intensity. For this reason, the inclusion of the treatment of written language, with the aim of identifying more reliable affective patterns in the ROODA VLE, is justified.

The result of these investigations will assist in the development of an affective agent to be incorporated in the ROODA in order to evaluate the pedagogical and affective activities associated with the student’s behavior during learning activities.

5. Final Considerations

VLE offer technological possibilities by means of resources such as Chat, Forum, Log Book, Webfolio, among others, that enable the participants to construct a cooperative work as they interact virtually and socially. Cooperation, for involving sociability and exchange, can transform the student’s way of thinking. In these exchanges, factors such as being motivated or not, being bored or not, being indifferent or not, being frustrated or not, etc. appear, and they should be taken into account in the teaching process.

The teacher, with the support of VLE, is responsible for developing strategies that enable the assistance, systematization, and the construction of new possibilities, intervening whenever necessary in the student’s cognitive development. In this context, the methods to introduce new technological tools, such as computational agents, to recognize affective aspects are discussed. This means developing instruments that enable a more accurate perception of affective aspects and the motivation of students in VLE.

Indeed, the prototype AnimA-K has the purpose of validating the parameters necessary for the development of an affective agent able to infer the student’s moods during an activity to construct a computational algorithm and the records made in the synchronous and asynchronous tools of ROODA. It is important to point out that the recognition of affect aspects favors pedagogical actions, as it helps the teacher to take decisions and interventions, whenever necessary. It aims, broadly, to restructure educational practices and policies in order not to give importance only to cognitive aspects.
References