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THE USE OF EMOTIONS IN STUDENT ASSESSMENT IN A VIRTUAL LEARNING ENVIRONMENT

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This article presents a project on integration of software that recognizes human emotions with a Virtual Learning Environment (VLE) of a higher education institution (HEI) in Brazil. The software analyzes some features of the human face andd infers the emotional state of the user. Both softwares are the result of research projects developed in HEI mentioned earlier. After integration, the VLE will be able to monitor and infer the emotional state of the student during their interaction. This environment already has two pedagogical agents with the ability to express emotions, although the main goal of the research is to understand the emotional state of student adapting content and form of learning objects from the VLE. At the end, we will evaluate if a virtual learning environment that considers the emotion of the student is able to bring improvements in the learning process.

Keywords: Evaluation in virtual learning environments, emotional pedagogical agents, inference of emotions in virtual learning environments.

1 Introduction

In distance learning, teachers and students communicate and interact via a Virtual Learning Environment (VLE). So, knowing the emotions of the student while he or she accesses the VLE may support improvements in the quality of interaction. For the learning process of the human being, there is a relationship between cognition and emotion (LONGHI et al, 2007), (Piaget, 1983), (Duran et al, 2004). Therefore, it is possible to highlight the importance of studies on the interactions, considering affection and emotion of the participants in the process of interaction in a virtual learning environment, or a way that it is possible to establish some kind of interaction in this direction.

Considering this relationship between cognition and emotion, there is a need for change in educational environments and the way those distance education courses occur. In this sense, the evaluations of students may help to guide this change, because the evaluation process is directly related to improving the quality of teaching. Starting from the results of an assessment, it is possible to think about changes in the environment to promote improvements in the learning process.

Therefore, this article presents a study that aims to determine if a virtual learning environment that infers the student's basic emotions as joy, sadness, fear, anger, surprise, disgust and beyond these emotions it expresses the emotions of attention and expectation, it may be adapted according to the inferred emotion, providing a more efficient learning. For that, some objectives must be achieved during the work, such as: inferring the emotion of the student during interaction with the VLE by analyzing their facial expressions; adapting the environment according to the inferred emotion seeking to promote improvements in student learning and evaluate the results.

This article is divided into the following sections: section 2 analyzes the theoretical research about the affective computing and the inference of emotions in virtual learning environments; section 3 describes the research method used in the work, explaining the study objectives; section 4 presents the partial conclusions and outcomes.

2 Theoretical Framework

In the context of affective computing and moods or emotions in students during interaction with virtual learning environments were developed several related researches. In the next sections, the concepts on the subject will be described, as well as models of emotion and inference methods of emotion through facial expressions along with some related works.

2.1 Affective Computing

The affective computing studies the emotions in computing. As it may be seen in Figure 1, the study is divided into two areas: Emotions in Human-Computer Interaction, which studies the recognition of the user's emotions and the expression of emotions by machine, and the Synthesis of Emotions studying the simulation of emotions in machine.

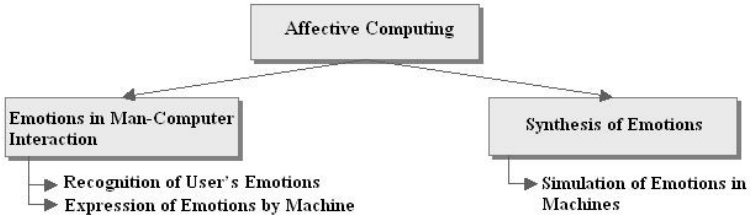

Figure 1: Representation of affective computing and its branches of research. Source: Jaques & Vicari, 2007.

The recognition of user's emotions is the focus of this work, and when computational tools may infer users' emotions in applications such as virtual learning environments, for example, it is possible to say that those tools promote affective computing. In this sense, they are valuable tools for the areas of psychology, education and affective computing (NUNES, 2012).
This work is focused on recognition of user's emotions in order to recognize somehow the emotion of the student at the time of interaction with the virtual learning environment.

2.2 Model of Emotions

The emotions, along with the feelings, motivation and mood represent the affectivity, and these states of mind are characterized as: global, constant and long-term (LONGHI et al, 2008) and (JAQUES and VICARI, 2005).
It was used the OCC model to model the emotions. This model was proposed by Andrew Ortony, Gerald L. Clore and Allan Collins, it represents the emotion based on the cognitive approach of emotion, where emotion arises from the perception and evaluation of three aspects: Events, Agents and Objects. (LINO et al, 2006).
That model is widely used because it allows the synthesis of emotions that can lead to cognition, targeting the computational aspect. It is based on the cognitive theory of emotions. Furthermore, that model can be easily implemented computationally (JAQUES, 2004).
In earlier work, realized in the same Virtual Learning Environment which will be done this work, the authors (Borin et al, 2012) used that model to represent a variety of emotions such as: happiness, sadness, surprise, expectation and other emotions in pedagogical animated agents such as Agent Doris, which may be seen in figure 2 and figure 3. In the image in Figure 2, the agent proposes an exercise to the student, and when the student accepts, the agent Doris expresses the emotion of joy.
The agent always expresses emotions during interaction with the student within the VLE. The emotion of joy, for example, is expressed whenever the student shows interest in the course.

Figure 2: Agent proposing an exercise to the student.

Figure 3: Agent expressing happiness because the student performed the exercise.

Pedagogical agents, like Doris, are represented as animated characters, capable of representing emotions in order to provoke a positive action on the student, motivating him/her and improving his/her learning.
This work will add functionality to the virtual learning environment already has developed as a research project, making it capable of inferring the emotion of the student and adapt its teaching materials and pedagogical tactics, in addition to supporting information for the intelligent agent Doris interacts with the student in order to promote an improvement in his/her learning. More detailed information about the environment will be presented in section 2.4.

2.3 Inference of Emotion Through Facial Expressions

Emotions can be easily identified using the model of FACS (Facial Action Coding System) proposed to classify human facial expressions, based on the human anatomy. This model is able to classify facial expression through the movement of facial muscles, which humans can take six primary expressions: anger, joy, sadness, fear, disgust and surprise (EKMAN et al, 2002). These expressions may be seen in Figure 4.

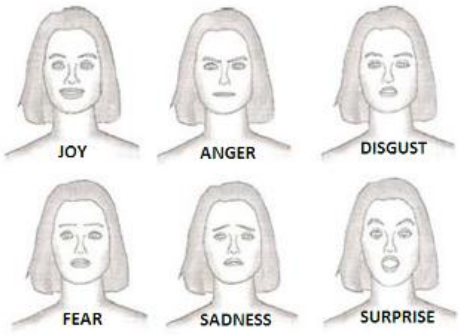

Figure 4: Basic facial expressions. Source: Adapted (FAUSTINO, 2006)

That system of facial coding describes facial expressions divided into Units of Action (UA). These units define changes in the facial muscles and when combined they determine a type of expression (FRIEDLANDER and RAHMILEVITZ, 2010).

Some related works using as method of inference of emotion the analysis of facial expressions of the user may be seen in Table 2. These works are related according to some criteria such as: the name of the authors of the research and the tools used or software developed.

Table 2: Related works that infer emotion through facial expressions.

Authors	What was done
(Frielander and Rahmilevitz, 2010)	They developed software for analysis from the user's photo.
(Oliveira and Jaques, 2008)	They developed software that analyzes image captured by the webcam.
(Leão, 2010)	He developed software that analyzes image captured by webcam.
(Santos et al, 2011)	They developed the system SENSUS that captures the image of the client while he/she looks at a windowshop in a mall and classifies his/her emotion.

Source: Author

The works presented as inference method to analyze the user's facial expressions make the use of computer vision and image processing methods to analyze images or videos captured through devices like webcams or digital cameras.

In the next section, it will be described the method that it will be used to infer the student's emotion in this work, as well as the environment in which this work will be done.

2.4 Inference method of emotion and VLE used at work

To infer the emotion of the student in the Virtual Learning Environment, it will be use software that was developed by (Böhm, 2011). This software captures the user's facial expressions through a webcam and ranked according to the corresponding emotion. In the following figures, it may be observed the performance of the software inferring emotions: joy (figure 5) and sadness (figure 6).

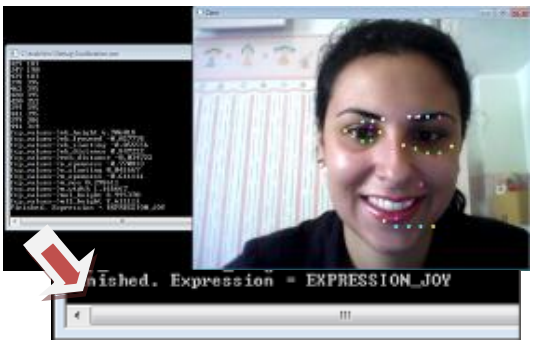

Figure 5: Expression of joy.

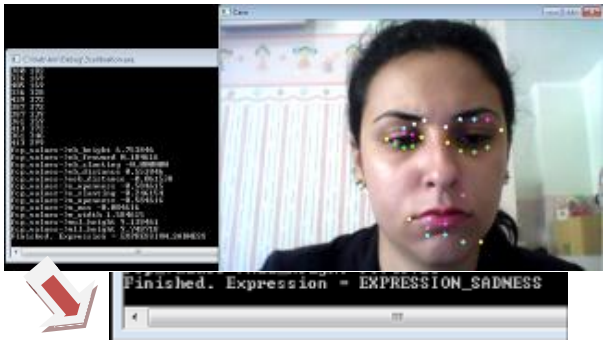

Figure 6: Expression of sadness.

It may be observed that the lower left corner, the software shows the result of emotion inferred. Where it is found the results EXPRESSION_JOY (Joy) in Figure 5, and EXPRESSION_SADNESS (sad) in Figure 6.

By capturing the image of the user's face via webcam, the system uses algorithms that identify the main points to be analyzed on the face and constitute the AUs. The explanation on the functioning of AUs or units of action is found in section 2.3. The face is then analyzed and ranked as one of basic expressions: happiness, sadness, fear, disgust, anger, or surprise.

In order to make the virtual learning environment capable of considering the emotion of the student, and adapt according to the emotion of the student, looking to its integration with the software that makes the inference of emotion.

Figure 7 shows the virtual learning environment where the research work will be done. Right now, the content that is being studied is the Selective Collection of Waste, and it is also possible to view the presence of intelligent tutors agents: Doris and Dimi (frames of the left and right respectively).

Figure 7: Screen VLE from UNISC during the execution of one of its courses.. Source: (FROZZA et al, 2011)

This environment is an ITS (Intelligent Tutoring System) which was developed by a research group, where according to Santos (2001), the initial work has been carried out since 1998. Currently, many researches in the field of affective computing and distance education are being made in this environment. Many results have been achieved with researches that have as main objective to provide better learning of their students. Thus, the environment has been adding features over the years. Some of those works may be found in Santos et al (2001), Frozza et al (2009), Silva et al (2010), Schreiber et al (2010), Frozza et al (2011), Borin et al (2012) among others. Table 3 shows the evolution of the features of this environment over the years.

Analyzing the data from the table, it appears that the project started with only one agent in 2000, this agent was Doris, she expressed three emotions, her role was to guide the student into the environment and she was drawn in 2D. The other agent called Dimi came in 2002 and his purpose was to act like a classmate. The two agents had knowledge of the general area. In

2005 and 2007, the environment began to use Bayesian networks and Ross tests to collect information and student profile. In 2010 the agents began to look like in 3D and in 2012 it was established a protocol for communication between agents, when was modeled and standardized communication between them. (GRIESANG, 2013).

Table 3: Evolution of the Virtual Learning Environment from UNISC

Feature	2000	2002	2005	2007	2009	2010	2011	2012/2013
Agent Doris	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Agent Dimi		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Guide the student	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Collect Information		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bayesian Network			Yes	Yes	Yes	Yes	Yes	Yes
Test Ross				Yes	Yes	Yes	Yes	Yes
Emotions Doris	3	3	3	3	7	7	7	7
Emotions Dimi		fixed	fixed	fixed	fixed	2	2	2
Domain Knowledge Doris	General	General	General	General	General	General	General and specific	General and specific
Domain Knowledge Dimi		General	General	General	General	General	General	General
Appearance Doris	2D	2D	2D	2D	3D	3D	3D	3D
Appearance Dimi		2D	2D	2D	2D	3D	3D	3D
Interaction between pedagogical agentes								Yes
Consideration of Affection student								Focus of this project.

Source: Adapted from (GRIESANG, 2013).

Based on the data of Table 3, we find that the VLE developed and researched in our HEI is in constant process of development and the next step is to allow this environment to be able to consider the emotions of the student, in other words, to make this environment become an affective environment.

In the next section, it will be addressed the relationship between cognition and learning with assessment of learning.

2.5 Relationship between Cognition and Learning and Assessment of Learning

Cognition is a set of mental processes involved in acquiring knowledge (LONGHI et al, 2007). Thus, cognition is directly related to learning.

According to Duran et al (2004), cognition is a process of knowing that involves some aspects such as attention, perception, memory, judgment, reasoning, imagination, thought and speech. And for the student to have an improvement in the learning process, he/she should be motivated to cognitive processes are reached in all aspects.

However, the student evaluation process is directly related to improving the quality of education. Starting from the results of an evaluation, it then may consider changes to improvements in learning.

An evaluation that aims to a change in the learning process, not only aims to measure performance data, but "the continuous observation of the manifestations of learning to do with the educational action" and optimize thus the student learning; and dealing with evaluation of courses, implement programs that benefit the institution or course evaluated (HOFFMANN, 2001).

Until then, it was approached the theoretical about the work will be produced. As part of the research, some studies related to the inference of emotion were found. These studies will be presented in section 2.6.

2.6 Work related to the inference of emotion in students

In the area of affective computing, there are several mechanisms that may be used to infer the emotion on the student. These mechanisms may be through observation or analysis of aspects such as: observable behavior, facial expressions or gestures, written or spoken language and physiological signals such as skin conductivity, heart rate, temperature and others.
In this paper, the facial expressions of the student will be analyzed in order to make recognition of his/her emotion.
But as part of this study, a survey was conducted on work related to other inference methods of emotion beyond the analysis of facial expressions.
Considering the related works that infer the user's emotion using different methods, it is possible to see a comparison in Table 4 in relation to some criteria such as inference methods used, tools used and developed in this work and the emotions inferred.

Table 4: Comparison of related works and inference methods.

Inference Method	Authors	Tools	Emotions
Observable Behavior	(LONGHI et al, 2008)	Behavior within the VLE.	Encouraged, Discouraged and Uninterested.
	(CUNHA and SILVA, 2009)	Building a framework with shape of box in Moodle environment.	Sociability, Communicability, Punctuality, Commitment, Thoroughness and Initiative.
Textual Analysis	(LONGHI et al, 2009)	Creating a model of inference machine using RBs.	Satisfied, Dissatisfied, Lively or Discouraged.
	(LONGHI et al, 2010)	AWM classifier Framework (Affect Word Minig).	Satisfied, Dissatisfied, Lively or Discouraged.
Physiological signals	KAPOOR and PICARD (2005)	Proposing an inference engine of emotion.	Behavior patterns during the learning.

Source: Author

The related works listed in Table 4 are intended to infer the emotion of a student during interaction with VLE. For that, different methods were used as observable behavior, textual analysis and physiological signals. In Table 5, it is possible to observe some studies using more than one method of inference simultaneously.

Table 5: Works that use more than one method of inference of emotion.

Inference Method	Authors	Tools	Emotions
Physiological signals, Facial Expressions and Observable Behavior	KAPOOR and PICARD (2005)	Proposing an inference engine of emotion.	Behavior patterns during the learning.
lysis of Personality and ervable Behavior	(NUNES el al, 2011)	NEO-IPIP and TIPI- Inventory PV1.0 and Kinect.	Personality Capturing the personality of the user.
Facial Expressions and Observable Behavior	AMORIN et al (2010)	Software Emotion Recognition. It analyzes student interaction in an educational game.	Uninterested, Low Interest, Average Interest, High Interest and Neutral.
Observable Behavior, Textual Analysis and Analysis of Personality	(LONGHI et al, 2011)	Construction of RODAafeto tool, it uses among other methods, the tool AWM.	Satisfied, Dissatisfied, Lively or Discouraged.

Source: Author

These studies use more than one method simultaneously to infer the user's emotion. Among the methods used are: physiological signals, observable behavior, facial expressions, textual analysis and analysis of personality. They are also organized by the following criteria: inference methods used, tools used and developed in this work and the emotions inferred.

3 Methodology

The research objectives were identified according to the definitions of Santos (2001), where the research is exploratory, descriptive and experimental. As for the procedure of data collection, this research is a case study, because it is applied in an existing environment.
The methodological procedures adopted in this study are divided into five steps outlined below:

1. To study the relationship between cognition and emotion through a literature review of both the area of affective computing and psychology. To study also the method of inference of students emotion in VLEs by analyzing their facial expressions, through a literature search on inference methods. And apart from literature searches, to study in practical the software that will make the inference of student emotion by analyzing facial expressions captured via a webcam at the time of his/her interaction with the VLE.
2. After the software is correctly inferring emotions, it will be integrated into the VLE, thus they will be united in a single application. Together, they will constitute a VLE that considers the emotions of the student, since the knowledge of emotion is necessary so that it may interact and propose improvements in the learning process of the student.
3. To infer emotion student will be set a few moments during the interaction with the VLE to be his/her images captured by webcam in order to analyze his/her facial expressions. A literature search will be conducted to properly define these moments.
4. From the inferred emotion, adjustments will be made regarding the outcome. Therefore, at this stage, studies will be conducted on possible adjustments to the VLE according to the emotion of the students in order to seek improvements in their learning.
5. Conduct a process evaluation of learning in VLEs based on emotions: Evaluate the VLE, in order to realize improvements in student learning process. With positive results obtained, it will be possible to prove the hypothesis of the study: that is to verify if VLE is able to infer the emotions of the students and it may bring improvements in their learning process. In the process of learning assessment, tests will be performed with a group of students that will make a course that uses the inference of emotion and other group of students that uses the course without the inference of emotion. For that, the methodology of using will be realized with a pretest and a posttest.

To achieve the objectives proposed in the steps described above, it will be realized the activities listed in Figure 8.

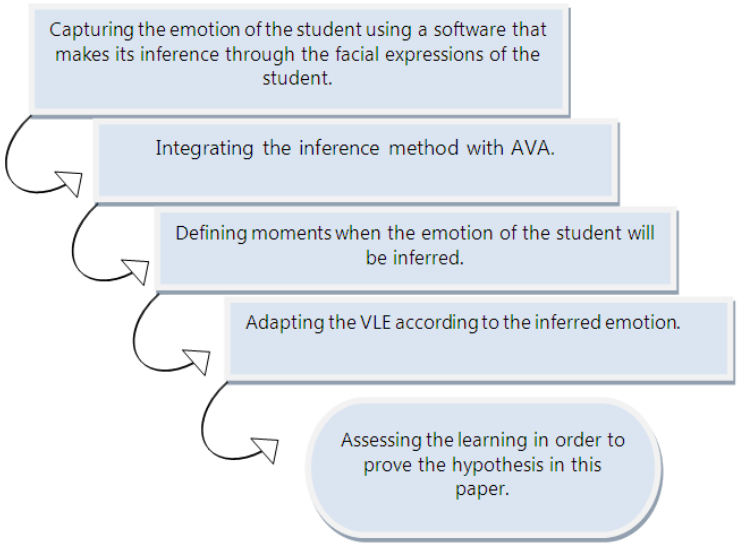

Figure 8: Activities that will be implemented in the work. Source: Author.

At the end of the steps proposed in the research, it aims to achieve the ultimate goal that is to examine the veracity of the hypothesis that a VLE, which may infer emotion students, is possible to bring somehow improvements in their learning process.

4 Conclusion

The mood of a student in the classroom may be observed in many aspects. Through tone of voice which he/she speaks, facial expression, participation in class, for example. During a course, in classroom or distance, there are several factors may contribute or hinder the student learning. These factors could cause the student to feel motivated and get a good learning, or they can make the student to feel unmotivated, disrupting or hindering his/her learning.

In a virtual learning environment, it is very useful to identify the state of mind of the student in a practical and automatic way. In inference through facial expressions, the analysis may be performed by capturing the face image of the student while he/she interacts with the environment.

In possession of inferred emotion, it is possible to check the reason of certain behaviors in the environment and to interact with the student in a more precise and objective way in order to get his/her needs and establish an effective communication. Effective communication may be defined as the ability of VLE interprets the student profile and adapts to it.

In this sense, the research is justified because it intends to detect the emotions expressed by students in their moments of interaction with the VLE and, from there, to analyze the influence of emotional states on a teaching-learning virtual process.

In short: we intend in this research to capture the emotion of the student through a software that makes the analysis of his/her facial expressions; to make this software works in conjunction with the VLE, or being part of it, which it is an integration between both; to adapt VLE to inferred emotion, and to evaluate the student learning to know whether all this process served or not to improve student learning.

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