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Virtual Learning Environments with Emotional Pedagogical Agents for Training in Organizations

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Abstract

Learning process is an important activity for the humans. Thus, the use of new technologies in this process, such as affective computing, is promising. In affective computing, the areas as psychology and cognitive science are closed. It is possible to study how computer systems can detect, classify and respond to human emotions. This paper presents the development of an animated pedagogical agent, expressing emotions (tutor agent), embedded in a virtual learning environment, to interact with users in organizations. Doris tutor agent has a role like a guide, identifying the characteristics of user learning. Piaget's clinical method was used for the validation of the methodology utilized by the virtual learning environment. The present study developed in the perspective of a pedagogical practice for qualification purposes in organizations, with the aim to qualify the learning process via Distance Learning. The advantage of using emotional pedagogical agents lies in the pursuit of an improvement to the interaction processes with the users. With an eye toward the continuous globalization and expansion process, organizations require innovation in their segments, while the market is getting ever more specialized, and the concern with qualifying professionals has been rising among organizations. More and more people are submitted to training programs, courses and specializations with the aim to boost the value of the organization. It is believed that the process of organizational learning can assist in organizational sustainability through environments that provide organizational learning that are fundamental to promote the process of sensitization, awareness and training to change behaviour.

Keywords: cooperative/collaborative learning; interactive learning environment;, teaching/learning strategies.

1 Introduction

With an eye toward the continuous globalization and expansion process, organizations require innovation in their segments, while the market is getting ever more specialized, and the concern with qualifying professionals has been rising among organizations. More and more people are submitted to training programs, courses and specializations with the aim to boost the value of the organization.

Therefore, the target is to maximize time and resources, while maintaining efficient and quality results. Nowadays, organizations frequently offer refresher and other qualifying courses to their employees, but to provide them during a definite period of time might prove to be a difficult task, resulting into absenteeism from / or lack of interest in these courses. Factors that account for this may include a priority task to be performed at the moment or the impossibility to attend the course, among others.

To this end, the goal of this research work was to develop a pedagogical approach to qualification in the organizations with the use of virtual learning environments, comprised by intelligent agents with emotional expressions, in order to impart motivation and enthusiasm in the learning processes and provide challenging activities.

The article is split into the following sections: section 2 describes the importance of distance learning in the companies, stressing the use of virtual learning environments, their benefits and characteristics, the importance of pedagogical agents resorting to the use of emotions; section 3 describes the research method used in the case study, justifying the objectives of the work; section 4 presents clear and concise results, demonstrating through the application of Piaget's clinical method the importance of emotion as

an interaction factor of the agent with the user, imparting more motivation and enthusiasm in the virtual learning processes; finally, the conclusions.

2 Theoretical Basis

For some years now, the learning process has stopped being the exclusive concern of the academic environment and moved onto the agenda of the organizations. These are huge teams that constantly improve their capacity to create, and real learning, according to Senge (1990, p.22), "is intimately related to what it means to be human". Therefore, great teams are organizations that learn how to develop new skills and capacities, leading to new perceptions and sensitivities, which, in turn, revolutionize beliefs and opinions.

As a process to stimulate even further the search for knowledge by their professionals, the organizations count on support from DL (Distance Learning), where the difference lies in the flexibility of space and time that is provided (Vieira et al, 2007).

This attests to the importance of qualifications in organizations, which are now being pursued by DL (Distance Learning), in line with what is pointed out by Litto and Formiga (2009), improved training presupposes enhancing the results assessment mechanisms and returns on capital invested in personnel qualification and, within this context, technology offers several learning measurement and control devices.

And one of the manners to provide for an appropriate distance environment for capacity building purposes consists in resorting to Virtual Learning Environments, since they can be used as useful tools in managing and training human resources, whilst imparting agility, speed and a real reduction in costs, along with routine training and personal improvement.

Therefore, a VLE (Virtual Learning Environment) consists of a technological infrastructure (graphical interface, synchrone/asynchrone communication and other functionalities) and of all relations (affective, cognitive, symbolic, among others) established by the participants, where learning is the main focus (Behar, el al., 2010).

Figure 1 features the essential elements of a VLE. The control and maintenance tools point to some indicators like reports, activity records and user attendance. The integrating tools see to a variety of communication, information and interaction needs, either synchrone (Chat, Tutor On-line, internal ICQ), or asynchrone (Forum, Discussion List, Noticeboard, Virtual Library), among others. And, finally, the tools for editing didactic material make it possible to provide the professor with this material.

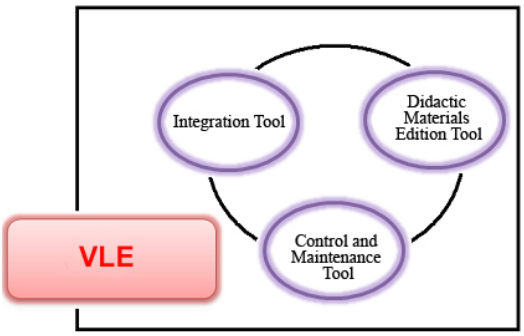

Figure 1: Basic composition of a VLE

Source: adapted from (Fernandes, 2006)

For this reason, we can deduce that a VLE goes beyond the idea of a set of educational pages on the Web, but is a virtual learning environment where the social space consists of cognitive-social interactions about, or on the knowledge object, which could be considered as the subject or theme of study.

The actions of a teacher within the VLEs could unfold in the same manner the VLE is supposed to act, in other words, stimulate the construction in the social and personal sense of knowledge through

interactions and interventions whenever deemed necessary, so as to control, or even evaluate the chronogram of the content and learning activities, and could be understood by some of its characteristics, according to Dallfovo; Vicenzi and Domingues (2005):

- Time: refers to time during which the learning activity occurs.
- Location: refers to the physical location for the learning activity.
- Space: refers to the set of materials and resources available to the student.
- Technology: refers to the set of tools utilized in the distribution of learning materials and in the ease of communication between the participants.
- Interaction: refers to the degree of contact and educational exchange between the students and between students and instructors.
- Control: refers to what extent the student is able to control the pace of the learning activities.

As the development of these environments unfolds, the use of Pedagogical agents, who have been qualified for educational purposes, with the goal to help the students with their teaching-learning process, providing the environments with improved interaction and dynamism, has gained momentum as a manner to help and motivate the users.

The pedagogical agents, according to Frozza (2001), possess some basic attributes as intelligent agents, like autonomy, social capacity (interactions and communication), and adaptability to the environment. Besides these attributes, pedagogical agents should be able to learn, since they possess teaching strategies to be used and, in most cases, they can be represented by a character.

According to dictionary Wilkens (2008), emotion is the act of moving (morally), a disturbance or variation of the spirit stemming from situations and which expresses itself in the form of happiness, sadness, and so on. It could also be a moral shock, commotion, or an intense and brief reaction of the organism to an unexpected event, which is followed by an affective state of painful or pleasant connotation.

But, according to Berch & Vicari (2000), emotion in computation implies in different aspects in the systems, from the control and personalization of the interfaces, from the simulation of systems with emotions to the representation of emotions, from the study of the emotions through systems and even research works that involve emotions in the Man-Machine interactions, which leads us to the concept of emotional agents, that is to say, intelligent agents who possess affectivity characteristics, without losing the capacity to perform purely intellectual reasoning. These characteristics lead to the concept of Affective systems, which are systems developed with some of the capacities to recognize, express, possess or develop emotions.

In the words of Gerald el al (2005), the role of the emotions has been examined in studies of decision-making processes, moral judgment and team guidance. This is what Damásio also studies, famous Neuroscience researcher, who maintains that emotions play a preponderant role in decision-making processes, even exerting an unconscious influence.

Within this context, several educational systems have tried to consider the emotions of the student/user through inference, as well as giving an emotional response to him/her, through the generation of emotion. The evaluation of the teaching and learning process should go beyond the goals mentioned in the content.

One of the most utilized models in Artificial Intelligence, since it is easily instanced in computers through a knowledge basis, is known as OCC, which was developed in 1988 by authors whom the model is named after (Andrew Ortony, Gerald Clore e Allen Collins) which, according to Lino, Tedesco and Rousy (2006), is based on the cognitive structure of the emotions. This model comprises 22 emotions that describe the cognitive evaluation processes responsible for triggering an emotion. Emotions are split into three categories, depending on the stimulus: Events (objectives or consequences; for example, fear), Agents (self or others; for example, pride), Objects (can be appreciated or not; for example, to like).

Because the OCC model specifies, according to (Morgado, 2005), a concrete set of appreciation criteria subject to being expressed under the guise of formal rules, directly implementable in computer models, has turned into a major support to emotion modeling in intellectual agents, since the 1990s.

This leads us to conclude that the entry of external information and perception acts like a filter subject to be influenced by several factors, such as attitudes, self-esteem, social standards, motivation, cultural aspects and, of course, emotion.

For this reason, the pedagogical agents are represented as animated characters, able to represent a variety of emotions like: happiness, sadness, surprise, expectation, and others. But there is a need to identify the most appropriate behavior intended to arouse a positive action in the student, so as to provide improved learning.

Picard (1997), explains that Affective Computation is a computer area linked to aspects that exert an influence on the emotions and this field of Artificial Intelligence is split into two branches, as illustrated in figure 2: one, in which mechanisms for the recognition of emotions in machine are studied through man-computer interaction and, in the other, where the synthesis of emotions is conducted through the simulation of emotions in machine, so as to discover more about human emotions.

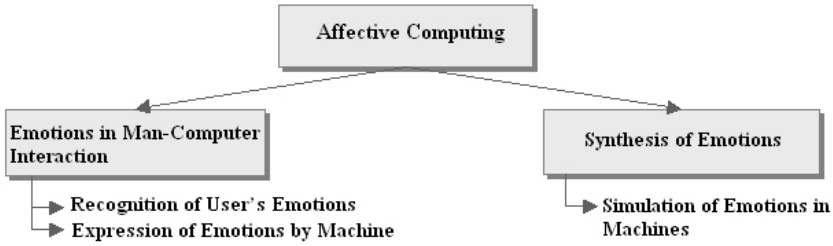

Figure 2: Branches of affective computing

Source: Jaques & Vicari, 2007

Therefore, as demonstrated by figure 2, Jaques and Vicari (2007) also explain that the study on the recognition of human emotions and the expression of emotions by machines is commonly used in the area of Informatics in Education, studying the recognition of the emotions by the student and expressing emotions through agents.

3 Methodology

The research referred to an exploratory and experimental research. According to Gil (2002), the goal of an exploratory research is to provide higher familiarity with the problem and a better knowledge for the researcher regarding the subject, to give him/her a chance to formulate problems more precisely or create hypotheses that could be examined in later research works. And experimental research, when the object of a study is established, defines the manners to control and observe the effects generated by the research work.

Just like what happens with the history of humanity, where society and economy transformations have also acted as innovation propelling factors, all areas of knowledge attest to the fact that a part of these transformations represent a pursuit of personal growth, through quality of life and work. Within this context, technologies can be viewed as effort joining components within organizations, facilitating, among other things, information and knowledge, because, according to Drucker (1999; p.83), "information has turned into the production organizing principle".

This justifies the importance of devising a pedagogical practice geared toward entrepreneurial qualification through a virtual learning environment, which adjusts to the profile of every company user, motivating them at every expression demonstrated by the pedagogical agent towards interacting with the system.

The proposed research required the definition of a working methodology, as shown in figure 3, involving the following steps, in the following sequence:

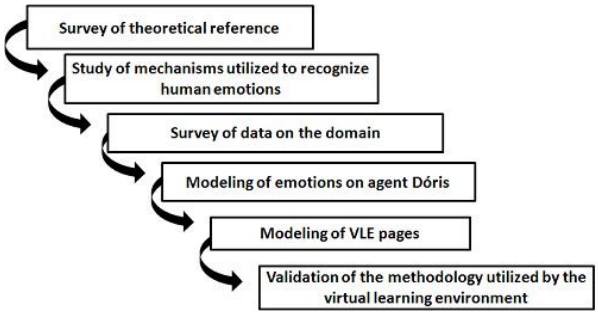

Figure 3: Work Methodology

1st Study of work-related subjects: a survey of the theoretical reference was conducted, in order to expand the research in question, attesting to the importance and contributions that research works in this area provide for new improvement ideas, scientific and practical enhancements.

2nd Study of the mechanisms utilized to recognize human emotions: in this case, talks were also conducted with researchers that act directly in this area (researchers in Psychology and Education Informatics), besides theoretical reference. Papers already concluded were analyzed to lend support to the proposal developed.

3rd A survey of data on the domain that was addressed as case study in this research: the survey of data on the domain, which refers to selective collection and composting, carried out at Unisc (University of Santa Cruz do Sul).

4th Modeling of emotions at agent Dóris was enriched with the emotions model as methodology to improve the individualized interaction process of the environment with the users. As addressed in section 2, on the importance of emotions in the learning process, and after studies on emotions, the choice was for the development of seven emotions for modeling on the tutor agent, according to table 1. These emotions were chosen based on model OCC and on the theory of the book, "The Body Speaks" (Tompakow, 2008) and by author Ekmann (1999), since emotions are not only represented by the face, but also by the body. For example, in the indignation emotion, the hands are clasped at the waist.

Table 1: Characteristics of the agent's expressions

Expression	Description
Happiness	Relaxed eyebrows; mouth open and sides of the mouth upturned; shiny eyes.
Sadness	Inner side of the eyebrows (near the nose) upturned; eyes slightly closed; relaxed mouth, and sides downturned.
Expectation	Attentive eyes to the front; mouth (tight lip smile); hands: clasped in front of mouth or under chin; upturned eyebrows (distension of orbicular muscle plus frontal contraction).
Anger	Eyebrows and eyelids closer together and eyes slightly closed; upper lip asymmetrically upturned forming a tiny curve; hands on waist.
Surprise	Upturned eyebrows; upper eyelids wide open and lower eyelids relaxed; open mouth and downturned lower jawbone.
Attention	Elbows on the table, with one hand resting against the face and the other, with the fingers in the mouth; attentive eyes focused forward; (distension of orbicular muscle plus frontal contraction).
Doubt	Upward eyes; one hand over the head.

Source: Based on EKMANN, P. Basic Emotions, 1999. Available at: http://www.paulekmann.com/pdfs/basic_emotions.pdf; e WEIL, Pierre; TOMPAKOW, Rolland. *The body speaks. 64th edition. Petrópolis: Vozes, 2008.* PICARD, *R. Affective Computing*. Cambridge: MIT Press, 1997.

The OCC model contributed towards defining the behavior of agent Dóris in the expression of every emotion, depending on the stimulus received by the action of the environment user. The emotions, according to this model, are split into three categories that induce types of emotions, depending on the stimulus:

- Events – Objectives or consequences (for example: fear).
- Agents – Standards or actions (for example: pride).
- Objects – Attitudes or aspects (for example: to like).

Many expressions are able to translate emotions and feelings without using words, and the face is seen as the main element of expressions, that is to say, the main elements in human education. Therefore, Ekmann (1999) stresses that facial animation requires a certain knowledge of facial anatomy, especially the muscle structure, since its objective is to represent facial expressions in a manner that make them continue being recognized as familiar to human beings.

As they are characterized as one of the non-verbal communication manners, facial expressions are essential for perceiving and interpreting the emotions and behavior among humans. To this end, we used a simple muscle structure, as it can be observed in the description of table 1. Universal facial expressions of Ekmann (1999) were also observed, like in figure 4, where (a) represents sadness, (b) (hatred), (c) happiness, (d) fear, (e) disgust and (f) surprise.

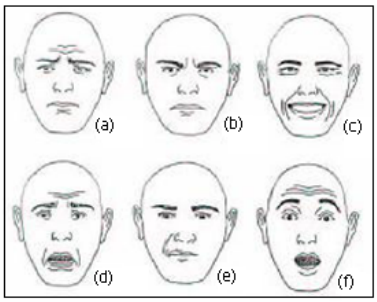

Figure 4: Universal Expressions

Source: (Ekmann, 1999)

Kendall and Creary (1995) also state that facial movements are strongly influenced by three areas: eyebrows, eyes and the mouth.

The emotions, shown in table 1, happiness, sadness, expectation, indignation, surprise, attention and doubt, have their description related to the expression on the face of pedagogical agent Dóris. These emotions are expressed by the agent in the interacting environment with the student.

What follows is some modeled expression.

- *Expression of happiness*

Figure 5: Stages in the expression of happiness of the agent modeled for the virtual learning environment

Figure 5 presents the expression of happiness, as described in table 1. The image of the first picture expresses a kind of sympathy, which could change as the user continues acting; in the second picture the eyebrows are relaxed, the mouth is half-open and the sides slightly upturned, the eyes are shiny and smaller. According to the explanation by Kendall and Creary (1995), the facial movements are strongly

influenced by the eyes, eyebrows and mouth, illustrated in the last picture, fully demonstrating the expression of happiness.

This expression is used in the environment whenever the user demonstrates interest, fondness, for example, at the moment the user accesses the complementary material and carries out the suggested random exercises (Figure 6), and gets them right (Figure 7).

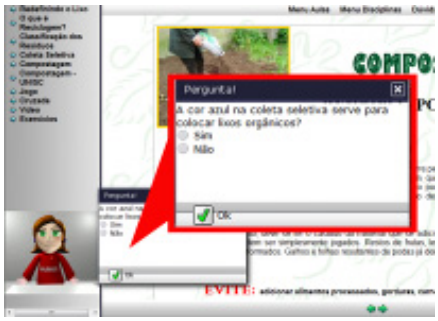

Figure 6: Agent proposing random exercise

Figure 7: Agent expressing happiness at the accomplishment of the random exercise by the user

- *Expression of attention*

Figure 8: Stages in the expression of attention of the agent modeled for the virtual learning environment

This expression is always used in moments the agent presents some activity to the user, like, for example, when he presents him random exercises, figure 8, exercises that appear randomly in the interaction of the use with the environment, in the dialogue box, when he presents a new strategy upon changing the profile for presenting the user's instructional material. It is possible to observe the upturned eyebrows and attentive eyes with the elbow leaning on the table and hand on mouth, like featured by the fourth picture of figure 9, attentive to user's reply.

Figure 9: Example of an expression of attention in the user-agent interaction

These emotions developed on the agent were a determining factor for students in the area and for the defined objectives regarding the qualification in organizations.

The performance of agent Dóris in the environment is determined by a set of production rules (format: IF <condition> THEN <action>) consisting of conditions/perceptions and reactions/actions. The idea is that,

upon perceiving situations that take place in the environment, the agent reacts with the performance of some action.

5th Modeling of the pages of the virtual learning environment for qualification for the chosen study: creation of the Web pages structure on the domain addressed and its inclusion in the basic knowledge of the environment previously developed by the research team at UNISC Informatics Department (Frozza el al., 2007).

6th Validation of the methodology utilized by the virtual learning environment: practical interaction of the users with the virtual learning environment has been performed, monitoring the actions of the agent with emotions and how this has reflected in learning and interaction with the different users. Piaget's Clinical method was utilized as evaluation tool, seeing that, for Piaget (1971), knowledge results from interactions that are produced half way between the subject and the object, but, in spite of depending on both at the same time, it stems from a complete difference between the subjective and the objective and, therefore, not from interchanges between distinct forms.

To this end, Piaget's clinical method serves as scientific basis for the project, as it suggests what the examiner should always do before the examination, what he should try to do during the examination and the evaluation methods of the answers. Trying to learn the sequence of the subject's thoughts, instead of counting the number of replies predetermined as correct, a system common with existing tests.

This method is a procedure that consists of interviews with the subject, collecting and analyzing data, which follow the subject's thought, with systematic intervention, always devising new questions based on the subject's replies, and evaluating the quality and scope of these answers, as well as to what extent the subject masters his answers in light of counter-arguments.

In spite of the flexibility of the clinical method, Mayer (2005) explains in his book that the examination of any aspect of the intelligence is not done in a totally free manner. It is always guided by the knowledge of both the solution for the specific problem, which constitutes the object of the exam, and by the intelligence development stages.

In other words, the examiner should have a good grasp of the concept of the object of the study, to define the range of questions to be answered by the subject. At this stage, the questions' role is to check the subject's understanding as to his task; or for determining the development stage.

An example of this stage can be observed in the studies by Borin (2009), who utilized Piaget's clinical method to analyze the study context of the subjects before and after the use of a virtual learning environment in the Geography domain. In this analysis, some subjects were interviewed, and the first question was: In what manner do you study?

The subject replies: "I take my notebooks and revise alone with music playing loud; I try to memorize the content"; And after some days, do you still remember? "Then I forget"; Then why do you study? "To get good marks at school and pass the year". And do you study at the computer? "Sometimes, I look for the sites contained in the books; sometimes I read and summarize them, and sometimes I only copy them".

In this dialogue, it is easy to observe that the examiner conducts the questions according to the replies, although time is short, since, according to Piaget's clinical-critical methods, some characteristics come as questions that lead to exploration, making new questions surface which will be justified in on-the-subject centered manner, like in the dialogues recorded by Borin (2009).

Another important step, the examiner is supposed to explore during the exam, is to follow the subject's reasoning, paying close attention to what the subject says or does, without automatically correcting the replies given by the subject and without completing what the subject says.

Therefore, through this methodology, the intention was to achieve the objectives regarding the proposal of this paper, joining educational and computational methodologies to adjust and propose improvements to capacity building programs in organizations for different domains.

4 Results

The objectives of the work were achieved, and they are as follows:

- *Pedagogical Practice*: The use of the environment as a didactic resource which brings contributions to the teaching-learning process, turning the subject pleasant and attractive to the user. Conducted with 10 employees at the Campus Coordination sector, of the University of Santa Cruz do Sul, in July 2010.
- *Modeling of the knowledge basis*: Instructional content in the domain of selective collection and composting with different teaching strategies (imagetics, textual, games and exercises).
- *Modeling of expressions*: The use of emotions by the pedagogical agent and the importance of user and agent interaction, in the emotional question.
- *Validation of the Environment*: Application of Piaget's clinical method in the validation process. About which we can state that it works as scientific foundation for the project, as it suggests what the examiner should always do before giving the exam, what he should try to do during the exam and the response evaluating method. In an attempt to understand the sequence of the subject's thoughts, instead of counting the number of answers pre-determined as correct, a common system with the existing tests.
- *Organizational sustainability*: The possibility of use of this environment in order to support for training in organizations. Thus, this proposal can contribute to keep the learning organization, it can be disseminated to the people involved (people management) and contributing to the politics of economic and social sustainability of the organization.

5 Conclusion

The use of educational environments as pedagogical practice for cognitive development has been providing for challenging activities, which arouse more motivation and enthusiasm in the teaching-learning processes.

The present study developed in the perspective of a pedagogical practice for qualification purposes in organizations, with the aim to qualify the learning process via Distance Learning (DL). Within this context, on the grounds of this research, one can conclude that virtual learning through the use of a pedagogical agent expressing emotions is a didactic resource that contributes toward the teaching-learning process, making the subject attractive and pleasant to the user.

To evaluate the pedagogical practice, Piaget's clinical method was utilized, where the essence of the method lies in discerning between the data that have something to do with us from the ones that just confuse us, that is to say, situate every answer within its mental context, just like in Piaget's citation (1926, p.11), "the good experimenter should effectively have two qualities very often incompatible: to be able to observe [...] and, at the same time, know how to go after something precise…"

Analyzing the results of the evaluation through Piaget's clinical method, described in section 3, what is perceived is the importance of the interaction of the agent with the user, in the emotional matter, even in the cases when the subjects answered in the interviews that they did not perceive the expressions performed by agent Dóris, because in observation, which is also a method technique, it was ascertained that they were important in the interaction of the subject with the environment. The inquiries made by the agent captured the attention of the subjects to the context, particularly when the agent questioned them on the subject being presented.

Therefore, a major contribution of this research was the development of emotions in pedagogical agent Dóris, acting in a virtual learning environment, and its evaluation by a group of users. Its purpose was to arouse, through expressions, users' reactions with regard to what she was doing in the environment, like, for example, what happened to a subject, described in section 3, when the agent expressed the doubt emotion, a difference in the understanding to the approached subject.

In the study of pedagogical agents' affectivity, three research lines can be considered: emotion recognition, emotion expression and emotion analysis. The focus of this dissertation was the expression of facial emotions by pedagogical agent Dóris. The justification refers to the analysis of the use of a learning environment, with an emotional agent, as pedagogical practice for the use in capacity building. The advantage of using emotional pedagogical agents lies in the pursuit of an improvement to the interaction processes with the users.

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