A Computer Method for Giving Adequate Feedback to Students Current Mood

C. N. Moridis and A. A. Economides

Abstract—**Research community is increasingly acknowledging that emotions play a crucial role in human learning procedures. These observations have led Artificial Intelligence in Education during the last decade to integrate emotional factors into computerized learning systems. If the system can reason about the emotional state of a user from the input that the system receives, appropriate content could be displayed in a way adapted for the emotion or the mood of the user. The aim of this paper is to provide a model for applying individualized feedback to a platform of multiple-choice questions in order to help students improve their knowledge and acquire a positive attitude towards learning. For this purpose, we propose a model so as to provide a measurement for the evaluation of student's mood with respect to each question the student is about to answer, and determine the agent's feedback to the student.**

Index Terms—**affective learning systems, emotional agents, emotion modelling, emotions and learning, individualized feedback.**

I. Introduction

Certain experiments [1] proposed that the rational ability is tightly connected to emotion. Based on these experiments, the objective of the approach followed by many researchers is the creation of a computing system capable of recognizing and expressing emotions. Agents able to simulate or process emotional behaviour are the type of agents that we would call emotional agents.

Faced with frustration, despair, worry, sadness, or shame, people lose access to their own memory, reasoning, and the capacity to make connections [2]. In many cases students' intellectual energies and capacities are weakened by negative emotional states. Integrating emotional agents into computer-aided learning systems in order to recognize student's emotion and respond in a way that will increase positive and decrease negative emotions, could significantly enhance learning.

The student's recognized emotional state should be properly managed from the computer-aided affective learning system, based on pedagogical models, which integrate our knowledge about emotions and learning. The system would assess whether the learning process is developing at a healthy rate. If there is a positive development, the system should help the learner maintain this emotional state. If not, the system should induce the learner to an emotional state beneficial to learning.

We develop a platform of multiple-choice questions about basic computer knowledge. The students, using this platform, will be able to improve their knowledge and acquire a positive attitude towards learning. Students may be more relaxed when interacting with an agent, than when interacting with a teacher, since they can repeat the learning material with their own pace [3]. The purpose of this paper is to propose a model in order to provide a measurement for the evaluation of student's mood with respect to each question the student is about to answer, and determine the agent's feedback to the student.

II. The Role of Emotions in Learning

One of the first researches who proposed that the rational faculty is strongly connected to emotions was [1]. Based on the work described in [1], the objective of the approach of many researchers is the creation of a computing system capable of recognizing and expressing emotions. Other humanistic psychologists and educators [4], [5] have emphasized on the role of emotions in learning. Recent affective neuroscience and psychology have reported that human affect plays a significant and useful role in human learning and decision making, as it influences cognitive processes [2], [6]. However, the extension of cognitive theory to explain and exploit the role of affect in learning is in its infancy [7].

Several theoretical models of learning assumed that learning occurs in the presence of affective states [8]. Henceforth, it is recognized that positive and negative emotional states trigger different types of mental states and this can have an important influence on the learning process. The research community is increasingly acknowledging an intense need for a comprehensive theory of learning that effectively integrates cognitive and affective factors [7].

Emotions can disorder thinking and learning. Research has shown that happiness has a positive effect on learning, memory and social behaviour [9]. Conversely, negative emotional states, such as anger and sadness, have been shown to have a negative impact on learning and motivation [2]. Positive emotions such as joy, acceptance, trust and satisfaction can enhance learning. On the contrary, prolonged emotional distress can cripple the ability to learn. It is well known that learning or remembering something in a state of anxiety, anger or depression can be difficult for any individual [2].

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However, negative affect initially focuses the mind, leading to better concentration [10]. In situations of an urgent threat this is favourable, for it concentrates processing power upon the danger. When creative problem solving is necessary this is unfavourable, for it leads to narrow tunnel vision [11]. Positive affect widens the thought processes, making it easier to be distracted. When the problem involves focusing, positive affect may interfere with the subject's concentration, whereas when the problem is treated through creative thinking then the results are optimal. Similarly, the proper amount of anxiety or fear can help individuals to focus, for the reason that anxiety focuses the mind, reducing distractions. It is when the negative affect is too strong that learning tasks are inhibited [12].

III. Towards Computer Aided Affective Learning Systems

Accurately identifying a learner's cognitive-emotional state is a critical mentoring skill. Although computers perform as well as or better than people in selected domains, they have not yet risen to human levels of mentoring. Even if the presence of technology is very obvious in computerized learning environments, it does not, however, take into consideration the affective reactions experienced while using such learning environments. These observations have led Artificial Intelligence in Education during the last decade to integrate emotional factors to computerized learning systems. An essential condition for the suitable management of emotions by a computerized affective learning system is the valid and convenient diagnosis of these emotions.

People's behaviour while undertaking a task may be affected by several factors such as personality, age, experience, general educational background etc. For example, experienced computer users may be less frustrated than novice users. Similarly, older people may have different approaches in interacting with computers, as compared to younger people [13]. Thus, for the purpose of analyzing the results of an empirical study, it would be preferable if users were categorized into several groups, in order to take into account important characteristics of each user in the form of stereotypes. For example, it is suggested [14], [15], that the integration of stereotypes in emotion-recognition systems improves the system's accuracy. Stereotype-based interpretation takes an initial impression of the user and utilizes this to build a user model based on default assumptions [16]. Stereotypes offer supplementary evidence supporting whether the assessment of a user's feelings is correct or incorrect.

The diversity among individuals shows that the same circumstances may be regarded as stressful by one individual, but not stressful by another. This is a key issue, because it points that it is an individual's view and interpretation of demands placed upon them that provokes malfunction to the individual, not the demands themselves [17]. We can help the individual to handle negative expectations when interacting with a computer system by providing adequate feedback. Positive feedback can influence and improve low self-esteem students in believing that they can accomplish and learn from the subject material that they feared the most [18].

Last years we observe a serious effort in order to create agents with dialogic behaviours that are based on social rules and lead to the achievement of communication objectives. These characters, in which is inherent the significance of emotion and personality, are also known as embodied conversational agents [19]. Due to the emergence of believable and social agents, a number of computational models of emotions have been proposed within the agent's community. The goal is to have emotional agents who will be able to recognize user's emotion and respond in a way that will increase positive and decrease negative emotions, according to the objectives of each application.

IV. Emotional Agents in Computerized Learning Environments

The recognition of user's emotional condition may play a vital role to the amelioration of the effectiveness of e-learning. The lack of recognition of emotions has been considered as one of the main limits of traditional tools of e-learning. While experienced teachers can modify their teaching style according to the stimuli that they receive from their students, the platforms of e-learning in general are not capable of receiving feedback from the students, and as a result they become inadequate for learning. Although the presence of technology is very obvious in web-based learning environments, it is not, however, taking into account the affective reactions experienced while using such learning environments.

Actual computerized learning environments, whether web based or not, usually include a combination of carefully structured hypertext, animations and test based feedback in a well-organised educational environment. In addition, current research aims to provide these systems with the ability to recognize a learner's emotional state and activate an appropriately tailored response. Providing individualised feedback according to student's cognitive and affective state has been neglected until recently where its value has become more apparent [20].

Results from conversational agents showed that anthropomorphism does not constitute an advantage, unless it is combined with sufficient expressive faculties of discussion and interaction [19]. Concisely we can say that a "learning agent" is supposed to:

(1) Recognise the running emotional state of the user

(2) Recognise when to intervene, in order to change the user's emotional state

(3) Produce the most optimal emotional state for learning.

Emotional agent systems consist of four components: a method for interpreting stimuli (input) whether internal or external, a computational model of emotions that regulates how emotions are generated and managed, a mode to direct agent behaviour and actions informed by emotional state, and a process for displaying emotional state to the world (output) [21].

There is a variety of human expressions in computer applications, however these are limited in symbolic gestures, as a meaning of hand that would mean greeting and in expressions that would declare emotion, as is a grin. Thus, in the planning of emotional agents, there is an effort to develop gestures and

expressive characteristics in connection to the speech, so as to give naturalness to discussions with the users.

V. Our Method

A person's emotions could be predictable if their goals and perception of relevant events were known [22]. According to the OCC model, joy and distress emotions arise when a person focuses on the desirability of an event in relation to his goals. The OCC model defines joy as a person pleased with a desirable event, and distress as a person displeased with an undesirable event. Implemented in a computational model this can be achieved by using agents, artificial intelligence techniques, reasoning on goals, situations, and preferences [23]. For example, if the system can reason about the emotional state of a user from the input that the system receives, appropriate content could be displayed in a way adapted for the emotion or the mood of the user.

Let us assume that students emotional state when interacting with the system is dependant on their success when answering a set of predefined questions. If a student fails to give correct answers to a large number of questions there is a high possibility to be exhausted from negative feelings. On the other hand, if the student gives correct answers to almost every question, there is a high possibility to be positively aroused. We provide a measurement for the evaluation of the student's mood with respect to each question the student is about to answer, using the following formula:

$$M(q, r, w) = (r - w)q, \tag{1}$$

where M is student's mood, r is the number of correctly answered questions, w is the number of questions for which the student gives wrong answers, and q is the total number of questions up to the current point.

If the number of correctly answered questions r, is greater than the number of wrongly answered questions w, then M, i.e., student's mood, is a positive number, as it is derived from (1), and this indicates that the student is in a positive mood. On the other hand, if the number of wrong answers is greater than the number of correct ones, M has a negative value. In this case the student is in a negative mood. When the two numbers r and w have equal values, M equals zero, which implies a neutral student's mood.

It is remarkable in (1) that the quantity (r-w) is multiplied by the parameter q. In this way we take into account the fact that student's mood depends also on the number of the given questions. For example, the student feels small pressure when he has answered the first 3 questions wrongly, and proceeds to answer the next question given that the total number of questions is 100. On the contrary, if the same student had answered 80 questions wrongly and he was about to answer the 92nd one out of 100 questions, then the emotional pressure would be much higher. The opposite would have happened if the student was about to answer question 92 being aware of the fact that he had already given 80 correct answers. In this case the student would certainly be more relaxed. Therefore, multiplying by q, we try to add the adequate emotional gravity to the good or bad record of the student, in proportion to the number of questions the student has already answered.

The maximum value that M can take into the system according to (1) is:

$$\max M = q^2, \tag{2}$$

while the minimum value that M can take according to (1) is:

$$\min M = -(q^2), \tag{3}$$

Since, according to (2) and (3) we know the maximum and minimum values of M, we can use a set of discrete values in order to approximate the real value of M. In this way, each discrete value of input M is mapped to a discrete output value which corresponds to a set of certain actions the agent will perform as a feedback to the student. Thus, we can calculate the agent's feedback to the student using the formula shown bellow:

$$feedback(M, L) = A, \tag{4}$$

where L is the discrete level to which M is assigned, and A is the action triggered from the M, L pair. In order to provide the agent with a much richer and varying behaviour, we can attach more than one possible action to each M, L pair. These actions could be triggered randomly or based on the frequency of their appearance. It would be preferable, if the agent wouldn't repeat the same action for the same M, L pair.

VI. Conclusions

Emotions have a great influence on learning procedures. Therefore, computer-aided learning systems designed to enhance users' learning experience should take into consideration affective factors as well. Towards this direction it is important to develop intelligent systems, which will integrate affect recognition and emotional expression.

We aim to develop a platform of multiple-choice questions about basic computer knowledge, in order to help students improve their knowledge and acquire a positive attitude towards learning. Based on previous research, we assume that students emotional state when interacting with the system has to do with their success or failure when answering the questions. We as well take into account the fact that students mood depends also on the number of the given questions. If the student fails to answer too many questions there is a high possibility to be exhausted from negative feelings. On the other hand, if the student answers almost every question right, there is a high possibility to be positively aroused. We propose a model in order to provide a measurement for the evaluation of student's mood with respect to each question the student is about to answer, and determine the agent's feedback to the student. More specifically, the approach consists in giving an adequate feedback to the student's current mood. This yields a method that is more efficient than just applying a non individualized emotional feedback as was done in previous research.

REFERENCES

[1] A. R. Damassio, Descartes' error: emotion, reason and the human, New York: Putnam, 1993.

[2] D. Goleman, Emotional Intelligence, New York Bantam Books, 1995.

[3] L. Fryer, and R. Carpenter, "Emerging technologies: BOTS as language learning tools," Language Learning & Technology, vol. 10, no. 3, pp. 8-14, 2006.

[4] R. Best, "Struggling with the spiritual in education," in Tenth International Conference Education spirituality and the Whole Child Conference, University of Surrey Roehampton, London, 2003.

[5] M. R M. Leal,"The caring relationship," in Ninth Annual International Conference Education Spirituality and the Whole Child, Roehampton, London, 2002.

[6] A. Bechara, H. Damasio, D. Tranel, and A. Damasio, "Deciding advantageously before knowing the advantageous strategy," Science, vol. 275, no. 5304, pp. 1293 – 1295, 1997.

[7] R. W. Picard, S. Papert, W. Bender, B. Blumberg, C. Breazeal, D. Cavallo, D. Machover, M. Resnick, D. Roy, and C. Strohecker, "Affective learning - a manifesto," BT Technology Journal, vol. 22, no. 4, pp. 253-269, 2004.

[8] S. D. Craig, A. C. Graesser, J. Sullins, and B. Gholson, "Affect and learning: an exploratory look into the role of affect in learning with AutoTutor," Journal of Educational Media, vol. 29, no. 3, pp. 241-250, 2004.

[9] A.M. Isen, "Positive affect as a source of human strength," in Aspinwall LG , Staudinger UM ,editors. A psychology of human strengths: fundamental questions and future directions for a positive psychology. Washington, DC: APA Books, pp. 179-195, 2003.

[10] N. Schwarz, H. Bless, "Happy and mindless, but sad and smart? The impact of affective states on analytic reasoning," in J. P. Forgas (Eds,). Emotion and Social Judgments, New York: Pergamon, pp. 55-720, 1991.

[11] D. A. Norman, "Emotion and design: Attractive things work better," Interactions Magazine, vol. 9, no. 4, pp. 36 – 42, 2002.

[12] G. Bower, "How might emotions affect learning?" in Handbook of Emotion and Memory: Research and Theory, edited by Svenake Christianson, Lawrence Erlbaum, Hilsdale, NJ, 1992.

[13] E. Alepis, and M. Virvou, "Emotional intelligence: Constructing user stereotypes for affective bi-modal interaction," in Proceedings of 10th International Conference on Knowledge-Based Intelligent Information and Engineering Systems, (KES (1) 2006), pp. 435-442, 2006.

[14] T. Moriyama, and S. Ozawa, "Measurement of human vocal emotion using fuzzy control," Systems and Computers in Japan, vol. 32, no. 4, pp. 59 – 68, 2001.

[15] T. Moriyama, H. Saito, and S. Ozawa, "Evaluation of the relation between emotional concepts and emotional parameters in speech," Systems and Computers in Japan, vol. 32, no. 3, pp. 56 -64, 2001.

[16] J. Kay, "Stereotypes, student models and scrutability," in G. Gauthier, C. Frasson and K. VanLehn (eds.): Proceedings of the Fifth International Conference on Intelligent Tutoring Systems, Lecture Notes in Computer Science, Springer-Verlag, Berlin, Heidelberg, Vol. 1839, pp. 19-30, 2000.

[17] S. E. Ross, B. C. Niebling, and T. M. Heckert, "Sources of stress among students," College Student Journal, vol. 33, no. 2, pp. 312–317, 1999.

[18] T. B. Bouchard, "Influence of self-efficacy on performance in a cognitive task," Journal of Social Psychology, vol. 130, pp. 353-363, 1989.

[19] J. Cassell, J. Sullivan, S. Prevost, and E. Churchill, Embodied conversational agents, The MIT Press, Cambridge, MA, USA, 2000.

[20] M. Mavrikis, A. Maciocia, and J. Lee, "Targeting the affective state of students studying mathematics on a web-based ILE," Young Researchers Track of the 11th International Conference on Artificial Intelligence in Education (AIED), 2003.

[21] A. Camurri and A. Coglio , "An architecture for emotional agents," IEEE MultiMedia, vol. 5, no.4, pp. 24-33, 1998.

[22] A. Ortony, G. L. Clore, and A. Collins, The cognitive structure of emotions, Cambridge University Press,Cambridge, UK, 1988.

[23] C. Conati, "Probabilistic assessment of user's emotions in education games," Journal of Applied Artificial Intelligence, vol. 16, no. 7-8, special issue on managing cognition and Affect in HCI, pp. 555-575, 2002.

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