RECOGNIZING STUDENT EMOTIONS USING AN AGENT-BASED EMOTION ENGINE

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ABSTRACT

We investigate the significance of emotions in agent-based systems that support student-lecturer performance evaluation. Emotions are defined as discrete and consistent responding processes that are changed by internal or external events and stimulus. We begin the research by conducting questionnaires on the student-lecturer domain, from which the emotions of stakeholders in the domain are studied. We then implement an agent-based emotion engine to compute student's emotions while evaluating lecturers. The emotion engine outputs are fed into an agent's analysis function for making recommendations to the lecturer and the administrative officer, which include teaching strengths and weaknesses from students' perspectives, with suggestions for areas of improvement. The paper concludes with a discussion on the effective use of emotions in the domain to uphold the performance of the lecturers.

Keywords: Emotion, Agent-Based Emotion, Lecturer Performance Evaluation System, Emotional Questionnaire, Intensity

1. INTRODUCTION

In recent years, many academic institutions explored the development of agent-based applications with the ability to generate or recognize the emotions of students and lecturers. However, the researchers are still facing difficulties in recognizing and measuring emotion and its intensity. Emotions are defined as discrete and consistent responding processes that are changed by internal or external events or stimulus, with reaction to the environment and can include verbal, physiological, behavioral, and neural mechanisms (Fox & Elaine, 2008). In most academic

institutions, the effective use of student emotions that spans across academic settings present a major challenge. While lecturers perform tasks in different ways, they need to work effectively and in an efficient way to achieve shared academic institution goals. The ability to recognize student emotions that are implicitly developed in an academic setting, presents a common goal that requires smooth and effective coordination.

We investigate the application of software agent for recognizing student emotional states towards their lecturers in the performance evaluation system. Our purpose in this investigation comes from ineffective and inefficient traditional systems in used nowadays in most academic institutions and universities, as they do not reflect the right internal states of student emotions towards their lecturers' performance in teaching during classes. Conventional lecturer evaluation systems are usually questionnaire-based techniques to solicit students' opinions or satisfaction toward lecturers' performance in teaching during classes (Yusoff et al., 2012).

Students' emotional states toward their lecturers are one of the most important components of the modern tertiary education system in academic institutions (Yusoff et al., 2012). Due to the strong influence of emotions in communication and expressing feedback (Rahaman et al., 2010), we conduct an effective and efficient way through the use of a questionnaire survey on students to measure their emotions by some factors that trigger emotions during class lessons. We implement an agent-based emotion engine to compute students' emotions while evaluating their lecturers. The emotion engine outputs are fed into an agent's analysis functions for making recommendations to the lecturer and the administrative officer, which include teaching strengths and weaknesses from students' perspectives, with suggestions for areas of improvement. The outcomes or findings from the evaluation systems are used in making strategic decisions like tenure, external quality care, and curriculum development. Lecturers are recommended to take appropriate steps to improve their teaching performance as recommended by the findings.

The application of software agent technology supports task automation (using agent's autonomy), such as emotion's recognition and computation, analysis assembling and rapid delivery of the evaluation report, swift computation of students' responses to the questionnaire and improvement of human-computer interaction. We set three hypotheses for this work as follows: (1) The proposed system can support students to express their experienced emotions effortlessly and systematically, (2) The proposed system can motivate lecturers to develop their competences effectively and improve their efforts and performance in teaching, (3) The proposed system can facilitate the institution's administration to make an effective decision towards its lecturers. The main objective of this study is to investigate and discuss the significance of embedding emotions in an agent-based system that supports students' evaluation towards the overall performance of their lecturers.

2. RELATED WORKS

Until recently, the concept of "emotion" is still controversial to many different individuals, scientists, and professionals. This notion began when William Jamess tried to offer a suitable definition in 1884, but ended up with a continuing debate without reasonable definition (Scherer,

2005). However, he inspired others like Niedenthal et al. (2005) to pursue this notion further. In addition, the number of scientific definitions proposed has been growing quickly. Kleinginna (1981) reviewed more than one hundred in 1981. Scherer (2005) described emotions as "an episode of interrelated, synchronized changes in the states of all or most of the five organisms' subsystems in response to the evaluation of an external or internal stimulus event as relevant to major concern of the organism." Componential theories of emotion are quite widespread today and the notion of emotions, as component processes seem to gain increasing acceptance.

In Chatzara et al. (2010), the researchers investigated the effect and the significance of this emotional interaction that could occur in many domains. Human-computer interaction researchers discover the development of interactive systems that could accommodate an experienced emotional state. Exploiting this tendency, interaction designers sometimes include embodied computer agents as part of the human-computer interface, and making computer capable of accommodating human-like behavior. Related literature includes a large number of similar efforts in teaching and e-learning domain. Maldonado's and his colleagues (2005) created a virtual classmate agent that cooperates and advises learners by emotionally corresponding with them. Burleson and Picard (2006) used an agent that acts as a learning companion through graphical representation.

2.1. Theories of Emotions

There are many theories of emotions, and a certain theory deliberates on the interconnection between emotions and cognition, in which the cognitive operations are affected by our emotional state. Emotional theories are classified into three types (i) categorical (ii) dimensional (iii) procedural theories (Masuch et al., 2006).

2.1.1. Categorical Theories

These theories define emotions as discrete sets of a fundamental or primary kind (e.g., anger, contempt, disgust, fear, joy, sadness, and surprise). Darwin's pioneering work links emotion's discussion of the analysis of expressions in the human face. Ekman's studies (1993) revealed that some emotions were not culturally determined. They could be universally expressed and recognized across ages, cultures, and even species. In Darwin's tradition, Ekman considered them as evolutionary, whereas Ortony and Turner (1990) suggested interpreting them as emotional prototypes. Moreover, Ekman claims that all other (secondary) emotions result from blending original emotions. However, there is neither an accepted set of primary emotions nor empirical validations of the blending assumptions (Ortony&Turner, 1990).

2.1.2. Dimensional Theories

Emotions can be expressed at different levels of intensity, and some of them are expressed in opposites. In the tradition of Wundt (1999), these similarities or oppositions are represented within basic vectors. Points or spaces within a multi-dimensional emotional vector space represent individual emotions. Their distance from the origin is equivalent to their intensity. Wundt proposed

a three-dimensional model with valence or evaluation (i.e., pleasure vs. displeasure of an emotional state), arousal or activity (i.e., degree of activation associated with an emotional reaction), and tension (in opposite to release). Other researchers proposed additional dimensions such as power, dominance or control (i.e., dominant versus submissive). By restricting the dimensionality to two, emotion is represented as an alignment of base vectors onto the horizontal and vertical axes and a normalization of intensities in the range between -1 and 1. Schlosberg introduced a circular representation. Cir-complex models were applied to facial expressions, emotions, and emotional words. All these models successfully measured similarities and oppositions between emotional entities (Masuch et al., 2006).

2.1.3. Procedural Theories

The appraisal theory proposed by Ortony et al. (1990) focused their research on extracting the eliciting conditions of emotions, according to which subjective interpretations of stimuli raise emotions. In their OCC-theory, stimulus is evaluated with respect to the goals or intentions of actors, to norms or standards, and to tastes or attitudes. According to this theory, emotions can be derived from the cognitive appraisal of the existing situation consisting of events, agents, and objects. The OCC theory defines 22 different emotions and expresses the cognitive appraisal process when there is one active goal. However, this theory does not deal with multiple goals.

2.2. Emotional Agents

Studies have shown that emotions are always involved in every aspect of the teaching and learning process. Therefore, an understanding of the nature of emotions, its eliciting conditions, and emotional experienced within the academic environment and setting context are essential. From the literature, "Sophia" is an emotional agent developed in SeDICT (ICT Applications in Special-Education Laboratory). It can express emotions and can portray facial expressions and body movements (See Figure 1). Sophia can represent 36 different emotions, and she can perceive the same number of emotions from users. The aim of this application is to teach first-year universitystudents, and the agent behaves accordingly to user's behavior and emotional state. Students have given positive perceptions of the use of emotional agent in the application. However, the sample size was limited, and most of the students indicated that they preferred to interact with the pedagogical agent (Chatzara et al., 2010).

**Figure-1.** Sophia Agent in the E-learning Environment (Chatzara et al., 2010)

Karthi and Debbie (2005) created an Agent-Cocktail Party World emotions project for studying intelligence by modeling emotions in autonomous agents. The results show the ability of agents displaying emotions within the constraints of a virtual environment. Their experimental software portrays the importance of emotion in human-like intelligence in agents. This project aims at exploring the aspect of artificial display to agents of an emotion-based intelligent component, which made a statistically significant difference to the experimental condition by creating a more realistic environment. The project merely adopts the traditional BDI agent structure, which is not easy to express emotion and make emotional reasoning.

Paolo and Robert (2006) claimed that the encounter between emotion research and agent-based technology is multifaceted. On one hand, results from emotion research serve as a role model from nature, providing inspirations for technical design criteria for individual agents on the micro level and agent groups and societies at the macro level as well as the sophisticated linkages between them. On the other hand, they are of immediate impacts to human-agent interaction and effective social cooperation between humans resulting from different areas of emotion in conversational interfaces. In a broad survey, they offer an interesting selection of research, but did not consider how to establish the structure of emotional agent.

3.   THE PROPOSED SYSTEM

We propose a system in which emotions play an important role in human intelligence, decision-making, social interaction, perception, and learning. Emotional communication also plays an important role for students and lecturers and can help them overcome learning problems (Lee et al., 2007). To do so, we incorporate a graphical representation of an agent to act as a medium, as an emotion's translator and communicator between the users and the system. Since software agents have been introduced to improve interaction, in this work, agents interact with students via questionnaire survey and are perceived as believable, helpful, and concerned. The proposed system embeds emotions in the conventional parts within the system that contains the three basic cooperating elements: Administrator, Student, and Lecturer. We represent these elements as software agents that can provide the system with more adaptability, autonomous ability and improved interactivity (Figure 2).

Figure-2. The System Overview
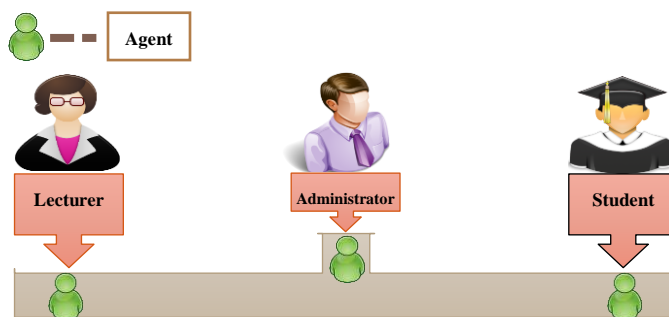
Embodying software agents with emotions makes the proposed system more interactive, natural, and engaging. The benefits of the outcomes of this system are expressed in Table 1. The students play the major role to make this system effective and significant (Beale et al., 2009).

Table-1. The Benefits of Embedded Emotions in Lecturer Evaluation System

Elements	Benefits
Lecturer: The results of student evaluation can be used to:	• Help lecturers to improve their teaching. • Improve classroom instruction. • Improve students learning. • Foster professional growth of lecturers. • Help lecturers to evaluate themselves.
Administrator: The results of student evaluation can be used for:	• Making an administration decision. • Recommending Promotion of lecturers. • Revising salary increment or decrement for lecturers. • Awarding the best lecturers in the faculty.

There are challenges to overcome in this research such as sex differences and individuality. We will overcome these challenges when we develop the whole system using some empirical ways, e.g., multi-level evaluation and weighted values for sex differences, etc., as prescribed by the literature (Marsh, 1987; McKeachie, 1983).

3.1. Building an Emotional Agent-Based System

In this section, we describe the whole system, which uses software agent and incorporates emotion-recognizing techniques that aim to communicate to the users in this domainemotionally. Each user interacts with the computer via a software agent. Each one of these agents has some specific functions that perform effective tasks. These functions are considered as the system core, which are the emotion engine, analysis function, and emotional report function. The emotion engine is responsible for calculating the students' answers and deriving the emotions accurately by using mathematical functions that calculate the values for each answer. The rule-based reasoning compares the values and determines the right emotions. The derived emotions are fed into the analysis function for the administrator and lecturer. The administrator analysis function analyzes the derived emotions and feeds all the student's emotions along with recommendations from the administrator such as recommending him/her to see the lecturer or award him. The lecturer analysis function highlights the strong and weak points of the lecturer's performance in teaching. All these analyzed data are represented in a graphical form (see Figure 3.)

Figure-3. The Conceptual Design of the Proposed System
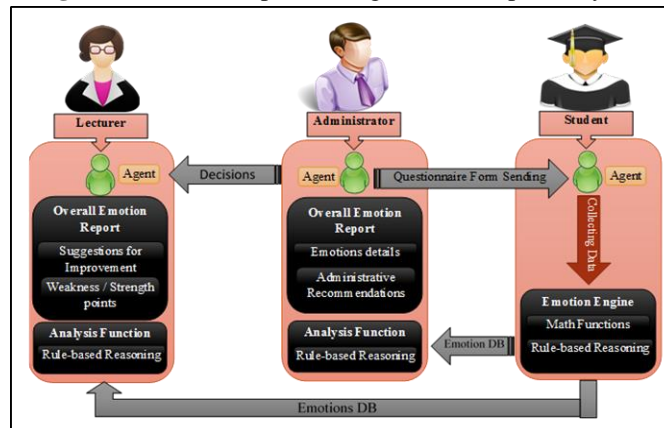
3.2. Designing the Emotional Questionnaire

Accurately measuring student experienced emotions during academic setting towards their lecturers are subjective issues and can only be obtained through self-reporting techniques. Since verbal self-report serves as a good instrument for assessing student emotional states, we conduct an affective questionnaire survey which has the ability to convert self-reported numerical data obtained from student's emotional questionnaire surveys into a graphical interface in the form of facial expressions, emotional words, and value scales (from 0 to 4). The academic environment creates a context for a variety of emotional experiences that have the potential to influence and evaluate teaching and learning processes. We select specific groups of experienced emotion such as enjoyment, boredom, anxiety, and anger. This selection is based on two reasons: it occurs frequently as documented in (Picard, 2003), and it is based on the control-value theory of achievement emotions (Pekrun et al., 2007). Student's emotions might be affected by many factors such as the way the lecturer teaches, the communication between the lecturer and students, and the level of lecturer's knowledge (Almuzaini et al., 2010). Intelligent agents that mediate in e-learning and teaching environments could accommodate the emotional process in order to be believable, and they could act as a medium and as a communicator between the user and the machine in a naturalistic manner (Meyer et al., 2007).

4. CONCLUSION

In this paper, we explored the significance of emotions and software agent technology to propose an agent-based emotion engine that enables the evaluation system to recognize students' emotions towards their lecturer in an effective and efficient way and coordinates to maximize the performance of the lecturers. We believe that the agent-based emotion engine will benefit educational institutions since the proposed system can serve as an assistant to all administrative officers to help in making decisions like promotions, research, and development. This research provides a foundation for future works in the application of recognizing emotions using agent technology in other problems related to student learning.

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