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The influence of using affective tutoring system in accounting remedial instruction on learning performance and usability

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ABSTRACT

Current research on computerized learning has steered toward combining personalized e-learning with an affective tutoring system (ATS) to enable assisted teaching and strengthen students' learning effectiveness. This study develops a novel ATS which includes four modules: affective recognition (combines facial emotion recognition and semantic emotion recognition), tutor agent, content, and instruction strategies for examining the influence of ATS in Accounting remedial instruction on learning effectiveness and usability. Triangulation research methods—quantitative data (questionnaire survey and score) and qualitative data (participant observation and interview) have adopted in this study to evaluate the students' learning performance and system usability. This study recruited 80 students (40 students for traditional teaching group, 40 students for ATS group) from a technology university in Southern Taiwan who attained low academic achievements in Accounting and possess business backgrounds. The research results revealed that the benefits of using the ATS for Account remedial curriculum are good usability of system and high learning performance. Finally, we proposed several prospects for future study.

1. Introduction

Presently, the number of students accepted in universities or colleges is rapidly increasing in Taiwan, yielding an acceptance rate of more than 90%. This phenomenon indicates that enrolling into a university is no longer a challenge. Consequently, students are gradually becoming confused about their purpose in studying, which renders a low willingness to learn among them, resulting in poor learning achievements. In addition, the backgrounds of enrolled students vary immensely, which gradually degrades universities' student quality and generates a sense of disorder and disorganization within the university. Therefore, how students' learning effectiveness and a university's education quality can be improved is a focal concern worldwide. To assist students who demonstrate low learning performance, various colleges and universities have planned and formulated multiple policies and measures, such as cultivating teaching assistants or tutors, allocating office hours for teachers to provide student counseling, and developing online remedial instruction programs.

Learning necessitates not only motivation and an effective method, but also a mechanism whereby learning can be maintained. Emotions may be the key factor that affects learning, as well as the driving factor that promotes learning. Therefore, investigation of emotions based on scientific evidences and perspective is an emerging research trend of academic research (Wu, Tzeng, & Huang, 2014; Wu, Tzeng, Kuo, & Tzeng, 2014). Humans must activate the cognitive system of their brains to engage in learning; however, when negative emotions arise, brain resources are used to process these negative feelings. Thus, when a brain simultaneously processes learning and emotions under limited brain resources, the brain may allocate most of its resources to processing the emotions, which concurrently decreases the individual's learning power.

Affective tutoring systems, ATS, is an intelligent tutoring system incorporating affecting computing, which refers to the process of learning where the emotional status of the student is monitored and the feedback and reactions are given when appropriate so to correct individual's state of emotion during learning (Mao & Li, 2010). ATF is hoped aimed to adapt to the student's the emotional status effectively by imitating a real human scenario (Sarrafzadeh, Chao, Dadgostar, Alexander, & Messom, 2004; Vicente, 2003), so as to spark the learners' motives to learn. In ATS, which is a type of intelligent tutoring systems (ITSs) in interactive learning environments (ILEs) is able to support individual student's learning performance by proving context sensitive hints and feedback

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(Adams et al., 2014; Bernacki, Aleven, & Nokes-Malach, 2014; Jou & Wang, 2013; Vaessen, Prins, & Jeuring, 2014).

Accounting is an extremely complex and challenging subject. Even though students may learn Accounting by themselves, they generally demonstrate unsatisfactory learning efficiency. In addition, based on the Accounting results of students in a science and technology university, students have exhibited poor learning performance in Accounting, which is potentially the reason that discourages students to learn. In recent years, increasing number of studies on emotions and learning have leveraged advanced computer technology to develop human–machine interface systems that enable humans to interact and communicate with computers. These studies have adopted relevant systems to identify and conceptualize emotions that influence learning and devised a computer model that provides immediate feedback. This model was then applied in Accounting remedial instruction to enhance learners' learning effectiveness.

In summary, this study endeavored to use the ATS in Accounting remedial instruction, forming a humanized interactive mechanism whereby virtual agents recognize and adapt their behavior to learners' emotions and provide appropriate feedback for these emotions. Subsequently, students are motivated to learn during their interactions with the system. In addition, suitable Accounting materials were provided to evaluate the usability and improvement of the learning effectiveness of students in the Accounting remedial course.

2. Background and related work

2.1. Emotions and learning

Emotions are sudden responses to internal or external incidents that are significant to an individual. Emotions are momentary yet strong psychological responses that comprise a coordinated set of responses, which entail verbal, physiological, behavioral, and neural mechanisms (Fox, 2008). Psychological responses induced during a student's learning process are referred to as academic emotions (Pekrun, 1988). Prior study reported that deducing from a learner's mental state is either by activation or deactivation; from the research of their positive and negative emotions, they constructed four dimensions for exploring academic emotions in students' self-regulated learning and achievement (Pekrun, Goetz, Titz, & Perry, 2002): (a) Positive activating emotions (e.g., enjoyment, fun, hope, and happiness) are triggered by positive emotions and are beneficial for inducing strong learning motivations in students to continue learning. (b) Positive deactivating emotions (e.g., relief and relaxation) are typically stimulated after the cessation of a negative event, causing learners to relax temporarily during their learning process. Nevertheless, such emotions are conducive to their learning behavior when a certain amount of time has elapsed after the incident. (c) Negative activating emotions include anxiety and shame; students with such emotions are characterized by a high level of control, which motivates them to solve problems encountered during learning or devote additional effort to avoid failure. (d) Negative deactivating emotions (e.g., boredom and hopelessness) are generated when learning activities or results possess demands that are beyond learners' capabilities or tolerance, or when leaners are not willing to overcome the challenges encountered during learning. In addition, learners with negative deactivating emotions are characterized by a lack of subjective control.

Based on the aforementioned assertions, emotions are not only the primary factor hindering learning processes, but are also the driving factor that promotes learning. Examining emotions from a scientific perspective is a key topic of contemporary research. Emotions influence learning achievements to a certain extent. Past studies have indicated that positive emotions can enhance, promote, and sustain active and continual learning behaviors, whereas negative emotions are detrimental to a person's daily living and learning activities, which thereby influences learning efficiency and progress (Wu, Tzeng, & Huang, 2014; Wu, Tzeng, Kuo, et al., 2014).

2.2. Affective computing

Affective computing is the study of interactions between human affects and computers; it primarily considers computers that recognize emotions, express emotions, have emotions, and have emotional intelligence. Affective computing is based on the ability to recognize emotions and correctly interpret emotional states according to emotional expressions and the inferences made from the generated emotional state. Multiple studies have focused on emotion recognition (Picard, 1997; Vesterinen, 2001). Moreover, numerous scholars worldwide have explored emotion recognition or affective computing using various technologies. Emotions exert a critical influence on the learning behaviors of humans (Vesterinen, 2001). In addition, computers must be equipped with the ability to recognize and express emotions to understand, intelligently respond to, and effectively utilize human emotions (Picard, 1997). Therefore, detecting and recognizing learners' emotions are pivotal to the ATS used in teaching processes because such a system can improve the learning motivation and effectiveness of learners.

An effective, intelligent digital learning system based on the technique of "affective computing" has been proposed for identifying and analyzing students' status of emotion using 3D models and to provide a virtual instructor with appropriate teaching style according to the student's personal trait (Duo & Song, 2012). They built a learning environment on the system similar to a conventional face-to-face teaching.

2.3. Intelligent and affective tutoring systems

Recent, the major issue in computerized learning has shifted from content delivery towards personalized online learning with intelligent tutoring systems (ITS) (Adams et al., 2014; Latham, Crockett, & McLean, 2014). Recent, the rapid growth of wireless sensor networks technologies derives the ITS toward to the ubiquitous (or mobile) tutoring system (Jou & Wang, 2013). The intelligent tutoring system provides students with personalized instruction or messages of direct feedback by means of computing and analysis. ITS does not employ a teacher in the flesh; instead, it can mimic one to carry out diverse teaching tasks, and provide the students with suitable teaching methods when needed according to the characteristic of the individual student. ITS began development in late 1970s and became widely used after 1990s. It consists of the User interface model, the Domain model, the Student model and the Tutoring model (Ben Ammar, Neji, Alimi, & Gouardères, 2010; Koedinger & Corbett, 2006; Nkambou, Mizoguchi, & Bourdeau, 2010; Nwana, 1990; Vos, 1995).

An ITS is a computer teaching system based on learning and several artificial intelligence technologies such as Bayesian decision theory, neutral network theory, natural language process, or cognitive psychology (Bernacki et al., 2014) that designed to provide individual and adaptive instruction (Bernacki et al., 2014; Latham et al., 2014; Vos, 1995). An ITS has benefits to solve and deal with students' problems and provides instruction to improve seeking strategies, the speed of learning and learning performance (Bernacki et al., 2014; Curilem, Barbosa, & de Azevedo, 2007; Latham et al., 2014; Vaessen et al., 2014). Students can ask for hints or messages to find the right steps for correcting wrong