Towards Integrating Emotion Management Strategies in Intelligent Tutoring System Used by Children

Mehdi Malekzadeh(✉), Siti Salwah Salim, and Mumtaz Begum Mustafa

Multimodal Interaction Research Lab,
Faculty of Computer Science and Information Technology,
University of Malaya, Kuala Lumpur, Malaysia
malekzadeh@siswa.um.edu.my,
{salwa,mumtaz}@um.edu.my

Abstract. Computerised learning much like classic learning is subject to a host of adverse emotions such as boredom, frustration and anxiety. These emotions can cause serious negative impacts on memory and attention, which in turn affect learning achievement. Thus, many researchers strongly agree that intelligent tutoring systems (ITSs) would significantly improve performance if they can adapt to the affective state (emotional state) of the learners. This idea has spawned an important trend in the development of ITSs, which are systems with the ability to regulate a learner's adverse emotions. In the present study, we review six dominant researches that have implemented different emotion management strategies such as coping strategies and emotion regulation strategies in an intelligent tutoring system. Then, we concisely discuss the results of the best practice that applies emotion regulation strategies to schoolchildren, without using an ITS. The results show that applying emotion management strategies during computerised or non-computerised learning produces more optimistic emotions as well as better learning gain.

Keywords: Emotion · Emotion regulation · Emotion management strategies · Emotion regulation strategy · Emotion coping strategy · Learning · Intelligent tutoring system · Children

1 Introduction

Recent research proves that emotions or feelings are very important in the everyday life of human beings; they affect our attitudes, our perceptions, our performance and our relationships with others [1]. In addition, based on the theories of achievement and motivation, emotions are central to learning because they affect the cognitive function as well as motivation and engagement [2]. Emotions governed by proper attention, self-regulation and motivational strategies can result in positive effects on learning and lead to better achievement [3]. In a traditional learning environment, a teacher maintains a sympathetic relationship with learners to facilitate the development of positive emotions. For instance, students who feel happy generally perform better than students who

P. Cipresso et al. (Eds.): MindCare 2014, LNICST 100, pp. 41–50, 2014.
DOI: 10.1007/978-3-319-11564-1_5

feel sad, angry, or scared [4]. This relationship also exists in a computerised learning environment.

Intelligent tutoring system (ITS) is a type of computer-based educational system that provides individualised instructions like a human tutor. A traditional ITS decides how and what to teach a student based on the learner's pedagogical state in order to enhance learning. However, it has been demonstrated that an experienced human tutor manages the emotional state (besides the pedagogical state) of a learner to motivate him or her and to improve the learning process. Therefore, the learner model structure needs to be augmented in ITSs to provide the ability of interpretation about the emotional state of learners in order to offer learners a tolerable response from a pedagogical and more specifically emotional point of view [5].

A number of researches have investigated embedding of emotional state reasoning into ITSs and intelligent learning environments. The main objective of this area of research is to study the effects of emotions on learning. The scope includes the development of algorithms to enhance the accuracy of a learner's emotional state recognition while learning and how to respond and manage negative emotions to enhance the student's attitude towards learning and academic achievement [6].

The matter of emotion regulation has attracted much interest from researchers in multiple fields such as neuroscience, psychology, education, and computer science. Emotion regulation concerns the ability to reduce high levels of emotional arousal and the capacity to change our feelings [7]. Although several researches have studied methods of emotion recognition during learning with ITSs, there is a lack of research on to how respond effectively to learners' negative emotional states by considering emotion management strategies while they are working with an emotion-sensitive ITS (EITS). This paper focuses mainly on regulating negative emotions arising during computerised learning. We have conducted a review on the efforts that have been taken related to managing negative emotions during users' learning process with EITSs. Additionally, we discuss a prominent research that has been carried out on testing of emotion regulation strategies on children learning in a laboratory environment without using an educational learning system. Based on their results, children with poorer emotion regulation ability may benefit from the design of an emotion-sensitive intelligent tutor system that instructs emotion regulation strategies.

2 Background

Throughout the last decade, several ITSs (e.g. [6, 8]) have been developed to incorporate the assessments of learners' emotions into intelligent tutoring systems to address the emotional aspect of learning. An emotion-sensitive ITS (EITS) is generally divided into two main components. The first component is automatic identification of a student's emotional states. This component processes the data from a learner's facial expression, speech, conversational text or biological sensors. The second module is in charge of responding to a user's actions by adapting a teaching strategy based on pedagogical state (e.g. knowledge level, learning speed) and emotional state of the learner. Teaching strategy should be chosen in such a way that it is able to manage negative emotions of learners and increase learning performance. Generally, the

teaching strategy is involved with emotion management strategies that are domain dependent (e.g. providing hints and definition related to the course content) and domain independent (e.g. providing empathy or encouragement). The main focus of this paper is to review the methods used in EITS to respond to learners' negative emotional states while working with these systems, specifically the strategies that have been applied for regulating the negative emotional states of the users. The architecture of an emotion-sensitive ITS is depicted in Fig. 1.

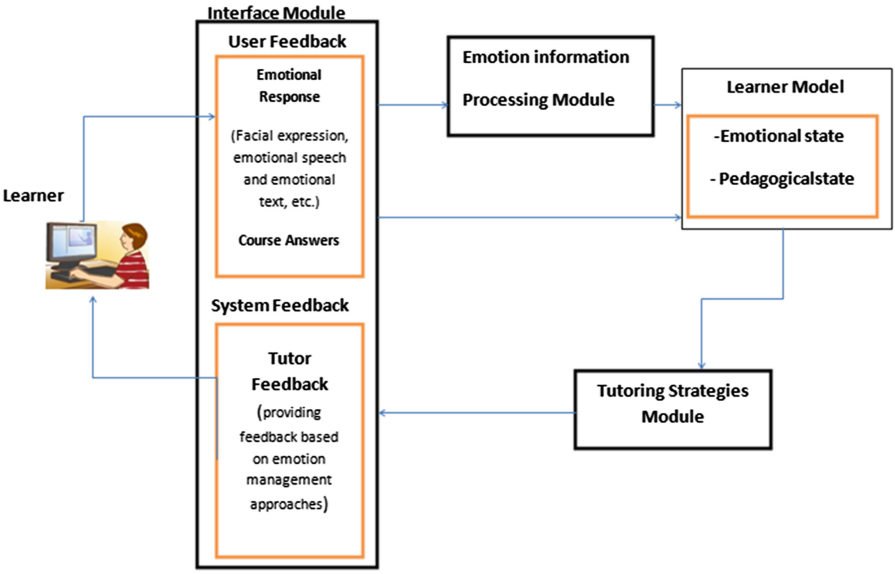

Fig. 1. The system architecture of EITS

In psychology, the concepts of emotion coping and emotion regulation are addressed to manage user emotional states. The emotion coping expends conscious effort to solve personal and interpersonal problems such as stress and conflict, and seeks to master, minimise or tolerate them [9]. Based on the work of Gross [7], emotion regulation concerns the ability to reduce high levels of emotion arousal and the capacity to change our feelings. Although the definition of emotion coping and emotion regulation are in essence very much similar, emotion coping principally focuses on decreasing negative emotion experience, whereas emotion regulation addresses increasing and decreasing both positive and negative emotions [7]. Therefore, emotion can be regulated by using emotion coping strategies as well as emotion regulation strategies by focusing on reducing negative emotion experience. Lazarus [10] classified emotion coping strategies in two different categories:

- Problem-focused coping strategy: Refers to solving of the problem that causes the emotional situation. (For example, providing definitions and examples related to the course content to learner during context of learning.)

- Emotion-focused coping strategy: Refers to reduction and management of the intensity of negative emotions caused by a stressful situation rather than the problematic situation itself. (For example, tutor provides encouraging statements during learning.)

2.1 Gross's Emotion Regulation Strategies

Gross divides the emotion regulation strategies into two categories: antecedent-focused and response-focused [7]. Antecedent-focused strategies (i.e. situation selection, situation modification, attentional deployment, and cognitive change) occur before an emotional response is fully generated in order to influence an emotional state. Response-focused strategies (i.e. response modulation) occur after an emotional response is fully generated. The following statements describe these strategies [7].

- Situation selection: Avoids or approaches an emotionally relevant situation.
- Situation modification: Modifies a situation to change its emotional impact.
- Attentional deployment: Distracts one's attention away from an emotional situation.
- Cognitive change (Reappraisal): Reinterprets the meaning of an event.
- Response modulation: Involves attempts to directly influence experiential, behavioural, and physiological response systems (e.g. drug use or exercise to down-regulate effects of negative emotions).

3 Review of Related Works

We have reviewed six prominent research studies in the area of intelligent tutoring systems. The selection criteria was based on the ITSs that consider emotion management strategies such as coping strategies and emotion regulation strategies in their intervention. Table 1 shows the comparison among these studies mainly based on emotion regulation strategies that were used as well as their results. It is worth noting that in earlier studies, researchers did not specifically name the strategies used in designing the feedback component for managing user negative emotions in the proposed systems. However, these strategies can be placed under emotion regulation strategies and coping strategies.

D'Mello and his colleagues [11] proposed a version of an emotion-sensitive ITS called AutoTutor, which provides feedback based on reactions to the emotional states of boredom, frustration, and confusion. The agent action to students' negative emotions were derived from two sources, which are theoretical foundation (attribution theory and cognitive disequilibrium during learning [12]) and recommendation by pedagogical experts. The attribution theory can address boredom and frustration by using empathetic responses from the tutor. The cognitive disequilibrium theory is also applied to address confusion. Cognitive disequilibrium happens once a learner enters a state of confusion due to the content he or she is learning. Staying in a state of cognitive disequilibrium for too long is not recommended and the tutor should display empathy to acknowledge the learner's attempts and lead him or her out of the state of confusion.

Providing empathy and encouragement for students are types of emotion-focus coping strategies. In their evaluation, they predicted that their improved AutoTutor would enhance learning gains and a learner's impressions.

In the Wayang intelligent tutor system proposed by Woolf and collegues [8], a variety of heuristic policies to respond to a learner's emotions (providing text messages, mirroring student actions) was used. They investigated five independent emotional variables, including frustration, motivation, self-confidence, boredom and fatigue. The tutor responded to these emotional states by providing empathetic responses, agent change voice and gesture, presenting graphs and hints, giving encouragement, attributing failure to external factors, and changing the scenario. These types of responses are considered as problem-focus coping strategy (providing graphs and hints) or emotional-focus coping strategy (empathy messages) and emotion regulation strategies like situation modification (change the scenario) and cognitive reappraisal (attribute failure to external factors). They measured interventions in relation to their impact on a student's affect, behaviour and learning.

Chaffar, Derbali and Frasson [13] developed an experiment in which they recognised a learner's emotional responses after some tutoring action in data structure web course. They simulated two situations for the users. In the first situation, the tutor used problem-focused actions (using an example or a definition to change the situation that causes negative emotion) and emotion-focused actions (helping participants to change their way of sensing the situation. For example, by encouraging them to make an effort to understand the course alone) to alleviate the effects of any negative emotion produced in this situation. In the second situation, after providing evaluation marks to students, the tutor used three emotion-focused actions, including *encouragement, recommendation* and *congratulation* as a way to encourage students to improve their marks and their knowledge in the future. The results of the ANOVA test showed learners needed help in understanding during comprehension activity instead of encouragement when they did not understand the course. Hence, using a problem-focused action during learning was suggested. The results revealed that *recommendation* and *encouragement* actions have positive effects on the emotional states of weak learners after receiving their marks.

Strain and D'Mello [14] have performed an experiment to analyse the effects of cognitive reappraisal (an emotion regulation strategy) on learners' emotional states and comprehension scores during a reading comprehension task. First, they tried to inject some negative emotions into participants by putting them in an ambiguous situation. Next, they tried to manage their negative emotions by using two forms of cognitive reappraisal (deep and shallow reappraisal conditions) to regulate negative emotions. Subsequently, in a web-based learning session, participants were asked to learn about the U.S. Constitution and Bill of Rights and then answer questions about what they had learnt. They also reported their affective states at multiple points. Their results show that the utilisation of cognitive reappraisal as an emotion regulation strategy can lead to more positive activating emotions (i.e. positive valence and high arousal) and better reading comprehension score compared with using no reappraisal strategy.

The study by Zakharove and his fellow workers [6] used an agent in their intelligent tutor system in order to respond to their students' actions. Agent's response is managed by a set of rules made in relation to the students' cognitive state (from the session

history) and the students' emotional states. Each rule determines the agent's verbal response as well as change in the agent's emotional appearance. For example, when a learner has submitted a wrong answer several times, the agent's verbal response consists of a list of errors, together with an emotional facial expression—the agent's face looks sad as if the agent is empathising with the learner. Making the student conscious of their negative states may distract them from their negative feelings and move them towards their goal. These researchers used emotion coping strategies and regulation in designing feedback to reduce the negative emotions of learners. In order to evaluate the effectiveness of using the emotional agent in EITS, they performed an experiment in an introductory database course. The experimental group used the emotion-aware version of the agent, while the control group had the emotion-unaware version of the agent. Therefore, the agent did not provide emotional facial expression or verbal feedback, but always remained neutral. Since the learning sessions with ITSs were short, they did not expect to observe significant difference in learning performance measures between experimental and control group. The comparison among different conditions was made based on the questionnaire responses. In general, the findings supported the presence of emotional educational agents, with the emotion aware agent having advantages over its non-emotional counterpart.

Mao and Li [15] proposed an intelligent e-learning system with an emotion agent tutor. The agent tutor "Alice" was capable of recognising emotional states of a learner through facial expression, speech and text. At the same time, the tutor could adapt to emotional states of the learner with facial expression generation (providing empathy), emotional speech synthesis and text produced by the Artificial Intelligence Markup Language (AIML) Retrieval Mechanism. In order to come up with a list of different actions that should be provided to a learner by the agent tutor in different situations, they asked for human teachers' point of view through presenting several scenarios of tutoring, and asking them to offer the suitable educational and emotional actions for each scenario. The authors believed that emotional-aware agents incorporated in an intelligent tutoring system with planning capacity might optimise the learner behaviour towards learners' enjoyment of the learning situation. They did not report the result of any type of evaluation on their proposed ITS system. However, they have conducted a pilot study in a separate research [16] by asking 100 students to use their proposed system to investigate the critical factors that impact learners' satisfaction from using EITSs. The results revealed that the agent tutor's pedagogical action and the agent tutor's expressiveness of the emotion expression (facial expression or emotional speech generation) are two of the significant factors in learners' satisfaction from EITSs.

4 Emotion Regulation in Children

Emotion regulation has become a central concern in investigations of children's emotional development [17]. For example, in educational environments, when a child feels sad, he or she may be engaged with unconstructive thoughts and as the result, attention is likely to be directed towards emotionally relevant information. Therefore, it is difficult to get his or her attention back to neutral emotional state resulting in loss of potentially important educational information. If the educational information is not

Table 1. Using emotion management strategies in ITSs

Citation	Application	Regulation strategy	Results
Strain and D'Mello 2011	Web-based learning system	Applying cognitive reappraisal (deep and shallow reappraisal) as emotion regulation strategies	Cognitive reappraisal strategy leads to more positive emotions and better reading comprehension score
Chaffar et al. 2009	A virtual tutor that teaches data structure	Problem-focused actions (providing an example or a definition) and emotion-focused actions (change its way of perceiving the situation)	Problem-focused action leads to inducing positive emotion during the comprehension task. Recommendation and encouragement actions have positive effects on the learners' emotions after receiving their marks
Woolf et al. 2009	Wayang Intelligent Tutor (teaching mathematic)	Emotion-focused coping strategies (providing empathetic responses, agent change voice and gesture and encouragement). Problem-focused coping strategies (present graphs & hints) and Emotion regulation strategies (attribute failure to external, change the scenario)	The interventions are measured in relation to their impact on student emotion, behaviour and learning
D'Mello et al., 2008	AutoTutor	Give feedback based on Attribution theory, Cognitive disequilibrium and experts recommendation	Authors predicted enhanced learning gain and learner's impression with emotion sensitive-AutoTutor
Zakharov et al., 2008	Intelligent Tutor system (teaching database design skill)	Problem-focused coping strategies (presenting the list of learner errors) and Emotional-focused coping strategies (change in the agent's emotional appearance to empathise with the learner)	Based on learner's opinions, ITS equipped with emotion-aware version of the agent has advantage over its non-emotional counterpart. However, there is no expectation for observing significant difference in learning performance measures because of short learning session
Mao and Li, 2009	Intelligent e-learning system (Teaching concept of affective computing	Emotional-focused coping strategies (adapt to emotional state of learner with facial expression generation (providing empathy), emotional speech synthesis)	Emotional-aware agent in ITS may influence the mood states of the learner, or create positive impression. Agent tutor's pedagogical action and agent tutor's expressiveness are two important factors in learner satisfaction from using EITSs

attended to and encoded, it cannot be remembered, so negative emotions may interfere with children's memory for educational information [18]. In addition, the findings from many researches (e.g. [19]) prove that effective emotion management gives a wide range of interpersonal, academic, and mental health benefits for children. Therefore, school-based emotion education programs have become an increasingly common component of children's elementary school experience [20].

Recently, a research [18] has been undertaken to examine the effects of reappraisal and rumination (strategies of emotion regulation) on children's memory for educational information. The results of the study show that reappraisal strategies are more effective in reducing children's self-reported negative emotions. In addition, reappraisal improved memory for educational details compared with the control group with no instruction. The authors suggested the utilisation of reappraisal strategy in learning context specifically for children who have poorer emotion regulation skills. For children with poor emotion regulation skill, many researchers (e.g. [21]) have evaluated the ability of emotional regulation among the schoolchildren who stutter (CWS) (type of speech disorder) and children who do not stutter (CWNS). Empirical findings show that young CWS compared with CWNS peers, have comparatively less efficient regulation of emotionality, at least in negative situations. Therefore, instructing them to apply emotion regulation strategies in negative situations will benefit their academic performance as well as their social life.

5 Conclusion and Future Work

Emotion plays an important role in the cognitive processes and particularly in learning tasks. Therefore, emotion-sensitive ITSs have used emotion regulation strategies in their feedback provided to learners. The main concern of these systems is to place learners in pleasant conditions to enhance their learning performance. In this paper, we have reviewed six prominent researches that applied emotion regulation strategies in their feedback. The purpose of this review is to help our future researches, on how we may integrate Emotion Management Strategies in ITS for children during computerised learning. The following statements summarise the main points of these studies:

- Emotion-sensitive ITSs are generally more effective in enhancing learning performance and learners' impressions compared with non-sensitive ones.
- Problem-focus coping strategies have greater positive effects on college students during learning while emotion-focus strategies are effective after learners receive evaluation marks, particularly for weak learners.
- Utilising cognitive reappraisal as emotion regulation strategy can lead to greater positive emotions and better learning scores among college students and child students.

The reviewed researches have some limitations that can be dealt with in future researches. The following are some major limitations of these studies:

- Emotion regulation strategies were mostly embedded and evaluated in the ITSs that have been used by college students. However, the emotion copying and regulation strategies have not been studied for schoolchildren who use computerised learning systems.

- Other methods of emotion regulation strategies should be applied to see which strategies are most effective in the context of computerised learning.
- Most studies did not evaluate and report learning gains properly after applying emotion regulation strategies to the learners. It seems that, there is a lack of specific measures and methods for estimating learning gain in these studies.

Acknowledgments. This research is supported by UM High Impact Research Grant UM-MOHE UM.C/HIR/MOHE/FCSIT/05 from the Ministry of Higher Education Malaysia.

References

1. Isen, A.M.: Positive affect and decision making. In: Lewis, M., Haviland, J.M. (eds.) Handbook of emotions, pp. 261–277. Guilford Press, New York (1993)
2. Mesquita, B., Walker, R.: Cultural differences in emotions: a context for interpreting emotional experiences. Behav. Res. Ther. **41**, 777–793 (2003)
3. Pekrun, R., Goetz, T., Titz, W., Perry, R.P.: Academic emotions in students' self-regulated learning and achievement: a program of qualitative and quantitative research. Educ. Psychol. **37**(2), 91–105 (2002)
4. Connor, K.M., Davidson, J.R.T.: Development of a new resilience scale: the Connor-Davidson Resilience Scale (CD-RISC). Depression Anxiety **18**, 76–82 (2003)
5. Neji, M., Ben Ammar, M., Alimi, A., Gouardères, G.: Agent-based framework for affective intelligent tutoring systems. In: Woolf, B.P., Aïmeur, E., Nkambou, R., Lajoie, S. (eds.) ITS 2008. LNCS, vol. 5091, pp. 665–667. Springer, Heidelberg (2008)
6. Zakharov, K., Mitrovic, A., Johnston, L.: Towards Emotionally-Intelligent Pedagogical Agents. In: Woolf, B.P., Aïmeur, E., Nkambou, R., Lajoie, S. (eds.) ITS 2008. LNCS, vol. 5091, pp. 19–28. Springer, Heidelberg (2008)
7. Gross, J.J.: The emerging field of emotion regulation: An integrative review. Rev. Gen. Psychol. **2**, 271–299 (1998)
8. Woolf, B., Burleson, W., Arroyo, I., Dragon, T., Cooper, D., Picard, R.: Affect-aware tutors: recognising and responding to student affect. Int. J. Learn. Technol. **4**, 129 (2009)
9. Lazarus, R.S., Folkman, S.: Stress, appraisal, and coping. In: Gellman, M.D., Turner, J.R. (eds.) Encyclopedia of Behavioral Medicine, pp. 1913–1915. Springer, New York (1984)
10. Lazarus, R.S.: Emotion and Adaptation. Oxford University Press, Oxford (1994)
11. D'Mello, S., Jackson, T., Craig, S., Morgan, B., Chipman, P., White, H., Person, N., Kort, B., El Kaliouby, R., Picard, R., Al, E.: AutoTutor detects and responds to learners affective and cognitive states. In: Proceedings of the Workshop on Emotional and Cognitive issues in ITS in conjunction with the 9th International Conference on Intelligent Tutoring Systems, pp. 31–43 (2008)
12. Craig, S., Graesser, A., Sullins, J., Gholson, B.: Affect and learning: An exploratory look into the role of affect in learning with AutoTutor. J. Educ. Media. **29**, 241–250 (2004)
13. Chaffar, S., Derbali, L., Frasson, C.: Inducing positive emotional state in Intelligent Tutoring Systems. AIED **2009**(200), 716–718 (2009)
14. Strain, A.C., D'Mello, S.K.: Emotion Regulation during Learning. In: Biswas, G., Bull, S., Kay, J., Mitrovic, A. (eds.) AIED 2011. LNCS, vol. 6738, pp. 566–568. Springer, Heidelberg (2011)

15. Mao, X., Li, Z.: Implementing emotion-based user-aware e-learning. In: Proceedings of the 27th International Conference Extended Abstracts on Human Factors in Computing Systems - CHI EA '09, pp. 37–87. ACM Press, New York, USA (2009)
16. Mao, X., Li, Z.: Agent based affective tutoring systems: A pilot study. Comput. Educ. **55**, 202–208 (2010)
17. Campos, J.J., Frankel, C.B., Camras, L.: On the nature of emotion regulation. Child Dev. **75**, 377–394 (2004)
18. Davis, E.L., Levine, L.J.: Emotion regulation strategies that promote learning: reappraisal enhances children's memory for educational information. Child Dev. **84**, 361–374 (2013)
19. Saarni, C., Campos, J.J., Camras, L.A., Witherington, D.: Emotional development: action, communication, and understanding. In: Eisenberg, N. (ed.) Handbook of Child Psychology, Vol. 3: Social, Emotional, and Personality Development, pp. 226–299. Wiley, New York (2006)
20. Domitrovich, C.E., Cortes, R.C., Greenberg, M.T.: Improving young children's social and emotional competence: a randomized trial of the preschool "PATHS" curriculum. J. Prim. Prev. **28**, 67–91 (2007)
21. Johnson, K.N., Walden, T.A., Conture, E.G., Karrass, J.: Spontaneous regulation of emotions in preschool children who stutter: preliminary findings. J. Speech Lang. Hear. Res. JSLHR **53**, 1478–1495 (2010)