IIAI Open Conference Publication Series
IIAI Letters on Informatics and Interdisciplinary Research
Vol. 004, LIIR156
DOI: https://doi.org/10.52731/liir.v004.156

Development and Implementation of a Game-based Learning System with Real-time Facial Emotion Recognition Technology

Yi-Chen Li [*], Kai-Hsiang Yang [*], Chih-Han Chang [*]

Abstract

This study aims to design and implement an innovative game-based learning system based on real-time facial emotion recognition technology to enhance learners' motivation and engagement. This paper will discuss the background, objectives, methodology, and experimental results related to the system development.

Keywords: Emotion recognition, Game-based learning, Real-time facial emotion recognition.

1 Introduction

Emotion management has become an integral part of modern society. People often need to master emotion management skills to cope with different situations in their lives, especially in work and study settings. Researchers have shown that positive emotions and interpersonal relationships have a significant positive impact on job satisfaction (Chen et al., 2015), and some scholars believe that learning in positive emotions also has a positive impact on learning effectiveness (Schutz & Lanehart, 2002).

Several researchers have emphasized that positive emotions can indeed enhance students' interest and motivation in learning (Mary E. Pritchard Gregory S. Wilson, Vaughn, 2003), and in recent years educators have been trying to find the most effective ways to enable students to learn in a positive emotional state. With the advancement and popularity of technology, digital game-based learning has received much attention in academic circles and has become a topic of research for many scholars (Chen et al., 2020).

However, most contemporary game-based learning systems can only detect users' actions or choices without directly assessing their emotional states. Studies have shown that negative emotions can weaken the learning process, while positive emotions can contribute to learning effectiveness and help thinking and problem solving (Coles, 1998). In addition, positive emotions do enhance students' interest and motivation to learn (Mary E. Pritchard Gregory S. Wilson, Vaughn, 2003). Emotions evidently play a vital role in learning.

This study proposes that incorporating real-time facial emotion recognition technology into digital game learning systems will allow for the accurate identification of users' emotional states. By generating real-time feedback messages corresponding to detected emotions, the system aims

[*] Department of Mathematics and Information Education, National Taipei University of Education, Taipei, Taiwan

to enhance learners' engagement, improve learning effectiveness, and ultimately elevate their overall learning experience.

In this study, there are three research questions: Can our system enhance learners' engagement? Can our system improve learning effectiveness? Can our system elevate learners' overall learning experience?

2 Literature Review

2.1 Game-based Learning

Digital game-based learning is a digital learning model that has been widely used in teaching and learning in recent years and has been the subject of many scholars' research (Chen et al., 2020). Its rapid growth can be attributed to engaging and motivating games that enhance learners' cognitive performance (Connolly et al., 2012), and achieve educational outcomes through their entertaining nature (Bellotti et al., 2013). Many studies have shown that when young people play digital games, the learning activities they spend time on are more complex and challenging than those in formal schooling (Gee, 2003). Many studies have shown that digital game-based learning has a positive impact on learners' motivation and attitudes (Tapingkae et al., 2020; Yang et al., 2020). The most effective way to learn is to enable learners to take the initiative in learning, not only by teaching students the content, but also by focusing on learner communication and interaction and generating intrinsic motivation to create a new learning culture (Prensky, 2001). The use of information technology in teaching and learning, the use of multiple assessments, or the integration of games in teaching activities can arouse students' interest in learning and create a relaxed and lively learning atmosphere (Huang et al., 2002). Some studies point out that digital game-based learning is the close integration of teaching contents with teaching materials and digital games, which can also be regarded as all educational games on digital carriers (Prensky, 2003). Digital game-based learning is advocated to combine games and learning to achieve the effect of teaching with fun and increasing learners' immersion in learning, which allows learners to participate more actively in learning than traditional teaching in the past. The use of information in problem solving not only transcends time and space constraints, but also reduces problem solving errors and improves attitudes toward learning mathematics (Wu & Meng, 2005). Therefore, with the booming of digital technology, digital game learning will become the main learning method in the 21st century (Prensky, 2001). In addition, many studies suggest that appropriate teaching strategies must be integrated into digital game-based learning to effectively improve learners' learning outcomes and problem-solving abilities (Hsu & Wang, 2018).

2.2 Emotion Recognition Technology

Emotion are human attitudinal experiences of objective things and corresponding behavioral responses, including facial expressions, postural expressions, and speech intonation expressions (Ekman, P., 2004). Moreover, some researchers found that people can capture the emotions of others and perceive the mood states of people around them (Darwin, 1965), so human beings can recognize emotions, which can be said to be an innate instinct, and some researchers believe that the brain is a selector with a rule-based mechanism that can turn on emotions to deal with various problems (Minsky, 2006). Thus, emotions play a very important role in different aspects of decision-making process, perception, and learning (Ammar et al., 2010).

3 System Design and Development

3.1 System design

The framework adopted in this experiment is the combination of emotion recognition module, game design module, and learning content module. As shown in the figure 1.

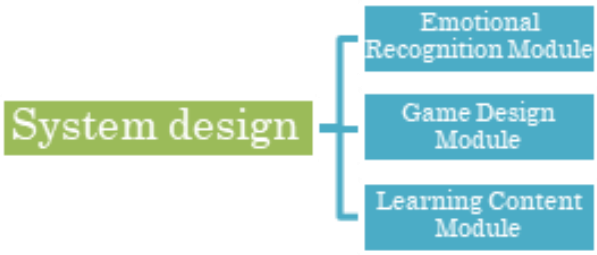

Figure 1: System Design

3.2 Emotional Recognition Module

The face emotion detection system uses the DeepFace package in Python language and a video camera as a tool to capture faces. The accuracy rate is 97% , Data training by FaceBook AI group on 2015. Before the game starts, the pre-made real-time face emotion recognition program will be opened, the program will export the judgment result into a text file, and then read it with the script program inside the game, and change the variables in the game to guide the game content to make customer-oriented changes. As shown in the figure 2 and 3. If it is positive emotion, learners will be encouraged to spend some time reading the myths; if it is negative emotion, emotional support will be provided so that learners can change their negative emotion.

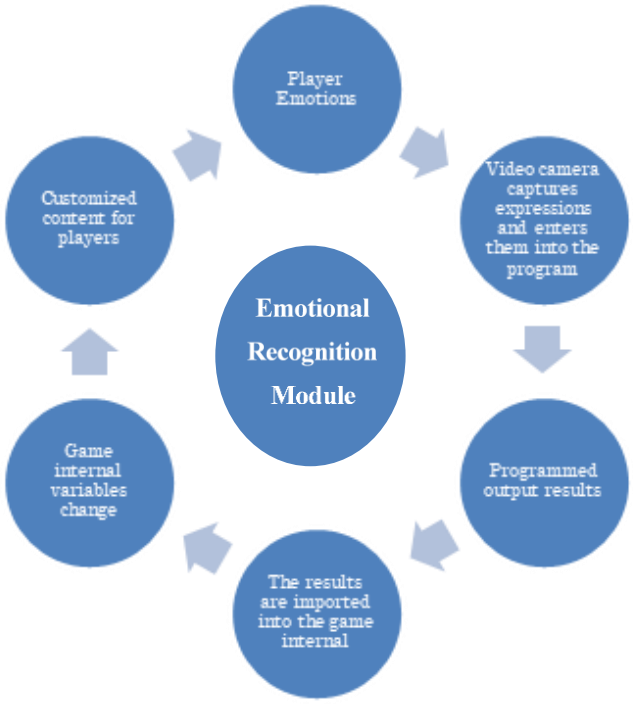

Figure 2: Emotional Recognition Module

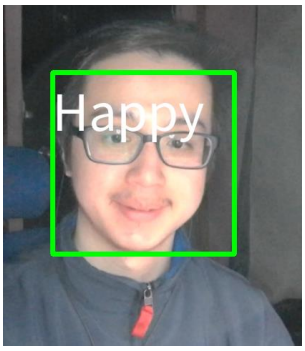

Figure 3: System Emotion Recognition

3.3 Game Design Module

The tool used in this study is: "RPG Maker VX ACE", which is a production tool for RPG-type games published by Enterbrain Japan. "VX" is the abbreviation of "VANGUARD EXPERIENCE" in the version code. "Ace" is the tenth game in the RPG Maker PC series, which is a follow-up and enhanced version. Compared with its predecessor, the editing function of the software is more user-friendly, using RGSS3 as the game engine and RUBY as the programming language for writing the in-game scripts, which is a relatively intuitive and easy-to-use programming language. The games designed by this software can be run completely and smoothly in today's information classroom computer equipment in China, which does not require high hardware requirements. References

3.4 Learning Content Module

In the role-playing type of digital learning games, the teaching materials are integrated into the game in the form of secrets or dialogues, so that learners can learn mathematical concepts while playing the game, which increases learners' knowledge without causing too much anxiety to learn mathematics. In addition, the game system is combined with a real-time facial emotion detection system to provide appropriate feedback messages according to the learner's current mood, which helps learners to correct their myths on the one hand and encourages them to spend time reading the feedback messages on the other.

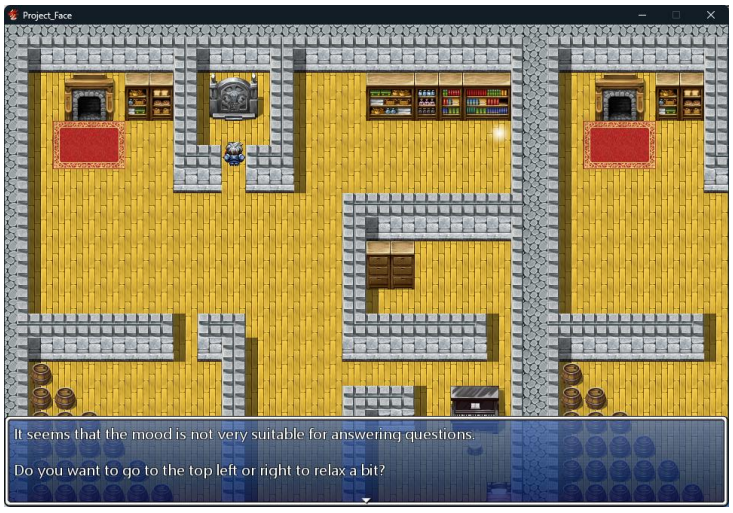

Figure 4: Game Play Scene

4 Experimental Design & Expected Results

This experiment adopts a quasi-experimental research method to investigate the impact of digital game-based learning mode combined with real-time face emotion recognition technology on middle school mathematics learning. We prepared three questionnaires to measure learner engagement, effectiveness, and learning experience.

This study hopes to enhance the learning effectiveness of digital game learning system, improve users' learning experience, reduce learners' learning anxiety, and further expand the application of digital game learning system through the application of emotion recognition technology. In addition, this study can also be used as a reference for educational institutions and educators to raise their awareness of the importance of emotional factors in the learning process.

5 Conclusion

This study developed a game system based on artificial intelligence emotion recognition technology, which can automatically recognize the player's emotional state and adjust the game content according to his emotion, further improving the game experience. In the future, the game system developed in this study will be further optimized to improve its stability and playability. Meanwhile, we will also explore how to better apply emotion recognition technology and artificial intelligence technology to create a more intelligent and interesting game experience.

Acknowledgement

This study is supported in part by the National Science and Technology Council of the Republic of China under contract numbers MOST 110-2511-H-152 -002 -MY3.

References

[1] Chen, Yen-Yu, Lu, Boyu, and Chuang, K.-S. (2015). The effects of interpersonal relationships and positive emotions on job satisfaction and promotion opportunities. Data Analysis, 10(6), pp. 191-215.

[2] Schutz, P.A., & Lanehart, S. L. (2002). Introduction: Emotions in education. Educational Psychologist, 37(2), pp. 67-68.

[3] Chen, X., Zou, D., Cheng, G., & Xie, H. (2020). Detecting latent topics and trends in educational technologies over four decades using structural topic modeling: A retrospective of all volumes of Computers & Education. Computers & Education, pp. 151.

[4] Coles, G. (1998). Reading lessons: The debate over literacy. Macmilan.

[5] Mary E. Pritchard, Gregory S. Wilson, Vaughn (2003)., Using Emotional and Social Factors to Predict Student Success, Journal of College Student Development.

[6] Connolly, T. M., Boyle, E. A., MacArthur, E., Hainey, T., & Boyle, J. M. (2012). A systematic literature review of empirical evidence on computer games and serious games.

Computers & Education, 59(2), pp. 661-686.

[7] Bellotti, F., Kapralos, B., Lee, K., Moreno-Ger, P., & Berta, R. (2013). Assessment in and of serious games: an overview. Advances in human-computer interaction, 2013.

[8] Gee, J. P. (2003). What Video Games Have to Teach Us About Learning and Literacy? ACM Computers in Entertainment, 1(1), pp. 1-4.

[9] Tapingkae, P., Panjaburee, P., Hwang, G.-J., & Srisawasdi, N. (2020). Effects of a formative assessment-based contextual gaming approach on students' digitalcitizenship behaviours, learning motivations, and perceptions. Computers & Education, pp. 159.

[10] Prensky, M. (2001). Fun, play and games: What makes games engaging. Digital game-based learning, 5(1), pp. 5-31.

[11] Huang, K.H. and Liu, C.T. (2002). The joyful mathematics classroom: The practice of innovative teaching and learning of factor mathematics materials. Science Education Research and Development Quarterly.

[12] Prensky, M. (2003). Digital game-based learning. Computers in Entertainment (CIE),1(1), pp. 21-21.

[13] Wu, Y. K., and Meng, E. R. (2005). A study on the effectiveness of information-integrated problem solving strategies on multiplication and division word solving for elementary school students with learning disabilities. Journal of Special Education, 21, pp. 103-128.

[14] Prensky, M. (2001). Digital Game-Based Learning.

[15] Hsu, C.-C., & Wang, T.-I. (2018). Applying game mechanics and student-generated questions to an online puzzle-based game learning system to promote algorithmic thinking skills. Computers & Education, 121, pp. 73-88.

[16] Ekman, P. (2004). Emotions Revealed: Understanding Faces and Feelings: Phoenix. 84 Elizabeth Molloy, Francesc Borrell-Carrió, Ron Epstein (2012). Feedback in Higher and Professional Education, The impact of emotions in feedback, 1st Edition, pp. 22.

[17] Darwin, C. (1965). The expression of the emotions in man and animals. Chicago: University of Chicago Press.

[18] Minsky, Marvin Lee (2006). The Emotion Machine: Commonsense Thinking, Artificial Intelligence, and the Future of the Human Mind. New York: Simon & Schuster.

[19] Ammar, M. B., Neji, M., Alimi, A. M., & Gouardères, G. (2010). The affective tutoring system. Expert Systems with Applications, 37(4), pp. 3013-3023.