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The Dynamic Adjustment Instruction Strategy: by Using Emotion Analysis of Brainwave

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Abstract: Education has always been focus of public attention, and how to cultivate students' abilities is a very important subject for teachers. Students' learning situation is deeply influenced by teachers' instruction strategies. Especially in higher education, how to build up the ability to think independently and solve problems in different ways is a very important thing for students. As time changes and technology evolves, students encounter problems more difficult and complex. how can teachers adjust their instruction strategies? When is the best time to help students? In this paper, we propose the use of electroencephalogram (EEG) to analyze and classify learning emotions. Next, the classification results will be sent to the teacher through the app, who can adjust the course content and methods. In addition, six kinds of instruction strategies were used to analyze the influence of emotion. The results show that students are in a better emotion if educators use these strategies at the right time.

Keywords: EEG, emotional state, instruction strategy

1. Introduction

In recent years, the problems for the world has been increasing of diversity and complexity. Most of the problems depend on cooperation with different fields of specialization, such as environmental change or energy issues. For this situation, we can know that people should cultivate their ability like think independently and solve problems in different ways, so it also emphasizes that higher education should train students to have this ability. In recent years, the role of teachers is no longer an information provider but an advisor, offer help when students encounter difficulties. When students encounter difficulties in autonomous learning, the most obvious reaction is emotion, so we think the brain wave analysis will be useful.

In the field of brain wave research, how to classify emotion is still a very important problem (Gupta, Aingh & Karlekar,2018). However, in most of the literature, emotions are only divided into two types: positive and negative (Murugappan, Nagarajan & Yaacob, 2009; Soleymani, Asghari-Esfeden, Fu & Pantic, 2016). This is due to the uniqueness and specificity of the characteristics of brain waves (Jayarathne, Cohen & Amarakeerthi, 2017). For this reason, we cannot guarantee that emotions will be classified in great detail. Machine learning will become the promised solution for analyzing electroencephalograms (EEGs) (Imah & Widodo, 2017), and most studies which using EEG can use it classify more accurately. In this paper, considering the students' learning emotion is timely data, need to classify as soon as possible. Therefore, we use support vector machine (SVM) algorithm to do classifier. Because as compared with other methods, SVM has a lower computational time.

The types of brain waves can be simply divided into 5 types (alpha (α) wave, beta (β) wave, theta (θ) wave, delta (δ) wave, gamma (γ)wave). Different types of brain waves have their meaning. For example, the bigger electrical potential of the β wave, the more attention is focused (Arai & Mardiyanto, 2013). Although it is not possible to accurately distinguish between emotion changes and brain waves, some of the affected brain waves can be understood by measuring brain waves. For example, when the test score is 100, the α waves and the γ waves will increase (Du, Raja & Lee. 2014). Emotion is a basic feeling that humans have. These emotions can be the simplest, the positive

and the negative emotions. According to some studies (Fredrickson & Branigan, 2005; Isen, 2001; Staw, Sutton & Pelled, 1994), positive emotions can help people improve their intelligence and observe problems in different ways.

The structure of this paper is as follows: The second section will introduce some EEG classification studies, learning and emotional relationship and the adjustment of instruction strategies. The third section is our proposed mechanism and experimental results, using different strategies. Finally, the fourth section is our conclusion.

2. Related work

2.1 Emotions

Emotions are complex and coordinated response of physiology, behavior, and neural mechanisms. (Fox, 2008). At present, the most common and most popular emotions can be grouped into six categories, including happiness, anger, fear, surprise, sadness and disgust. (Ekman, Friesen & Ellsworth, 2013). Some scholars think that emotion is not independent of each other but can be combine. Plutchik, for example, believes that the eight basic emotions (joy, sadness, anger, fear, trust, distrust, expectation, and surprise) are based on the positive and negative states of the four basic emotions. Joy is contrary to sadness, anger is contrary to fear, trust is contrary to distrust, expectation is contrary to surprise. (Plutchik, 2002). In addition, everyone grows in different environment and culture, so the emotions generated by social learning are varied. But most of emotions are made up of basic emotions. For example, the mixture of happiness and trust is love. The basic emotions are closely related to the physiological reactions of the human's body. Therefore, we can analyze these four basic emotions through the brain wave to understand the students' real learning situation.

2.2 Emotion and learning

There is a reciprocal causal relationship between the students' learning situation and emotions. The studies can observe when emotions are happy and positive, learning effects are better than negative emotions. Pekrun studies how emotions affect students' learning and achievement. The study then points out that students' accomplishments usually affect their emotions. For example, success may lead people to increase hope and reduce anxiety (Pekrun, 1992). To explore the impact between motivation and learning, Pekrun and others used the Achievement Emotion Questionnaire (AEQ) to assess students' achievement emotions. The results show that achievement emotions of students are related to academic achievement, learning self-regulation and the use of learning strategies (Pekrun, Goetz, Frenzel, Barchfeld & Perry, 2011). These studies prove that students' learning status can be understood through emotional analysis, and teachers can also find out whether students need help through the analysis results.

2.3 Instruction strategies and learning emotions

From the above we can know that emotion is related to learning effect. Therefore, teachers can adjust instruction strategies through the analysis of students' learning emotions. In addition to the analysis of learning emotion, teachers can also be more aware of students' current learning emotional state according to their attention and adopt different instruction strategies. Such as holding a pop quiz, advance or dumb down the difficulty of instruction, let students take a group discussion, let students take a break and diversion of the students' attention. To take different instruction strategies can be adopted to relax or concentrate the learning emotion of the educated students and advance their learning performance (Hsu, Lin, Lin & Lin, 2014).

3. Proposed mechanism- dynamic adjustment the instruction strategies

In nowadays, people must not only focus on their professional knowledge, but must also have the ability like teamwork, problem solving, imagination, and creativity. For this reason, traditional

instruction methods are not suitable for training this ability. In order to improve educational efficiency, we propose using EEG to analyze learning emotions. In addition, use our development application to collect students' emotional information: concentrate or distraction in class. The feedback from the system developed in this study can help teachers track students' status and help teachers adjust the content of instruction, instead of the traditional instruction mode-modifying after class. Figure 1 is our proposed mechanism flowchart. There are five phases: initial, data collection and analysis, providing information to teachers, modifying decisions, and using strategies to implement suggested mechanisms.

3.1 Analysis the emotion of learning with using EEG

In this paper, the study of emotional analysis can be divided into three section. The first is the definition of learning emotion; in the traditional classification of EEG measurement, it focuses on positive emotion and negative emotion. But in emotional research, there are not enough to express students' emotional state. Therefore, this paper will add the hidden exponent-voltage, it can help us to description the strength of emotion. The second section is building the emotional model. In order to analyze and reflect the students' learning situation more accurately, we must establish a model of learning emotion as the standard. The third section is to classify emotions. In this paper, we will use SVM to classify emotions. SVM is a supervised machine learning algorithm which is mainly used to deal with data classification, and has the ability of high dimensional data processing ability and variable quantity larger than sample data. Considering that the data of brain wave is high-dimensional, and the brain wave has multiple characteristics, it is suitable to assist this study in dealing with classification problems. In this step, the characteristics will be found from the collected data, and then the relationship between the two characteristics will be determined. Finally, SVM uses these to classify emotions. For example, if the emotion is concentrated, the α wave will be high, and we can set α wave as our characteristic point. Figure 2(a) is the result of classification after using the SVM.

3.2 Dynamic instruction emotion feedback

In the most of traditional instruction feedback mechanism is still need individual interview machine or instruction guidance evaluation. However, these mechanisms have been all learned and corrected after class, and the whole cannot directly reflect the learning emotion and the problems faced by the students. In view of this, this study developed an application to let teachers know the current state of learning, as shown in Figure 2(b)(c). When the database receives the data of learning emotion, it starts to carry on the instruction emotion classification. When the server classifies the data, it will return the classification result to the instruction application. At the same time, educators are able to see all students' learning emotion through the interface, as shown in Figure 2(c). The important thing in this study is that feedback on learning emotions will affect how educators adjust their instruction in the current situation, assuming that if only a handful of students are not focused on learning, should instruction strategies still be change? Therefore, in this study, we will set a threshold to determine the current learning situation, Table 1 shows what adjust in diffident threshold.

According to the adjustment of instruction strategies, the learning emotion has different influence. When the system received feedback, it will use the big data to analysis after changed the instruction strategies to statistics the learning emotion and feelings, as a follow-up to the instruction strategy and the realization of positive feedback. In other words, when the learning emotion is low, the system can provide a strategy that fits the current situation based on the results of big data analysis.

3.3 Instruction strategies for learning emotions analysis

In this sub-section, we will describe in detail the impact of the proposed brainwave analysis on the adjustment of instruction strategies. As the background knowledge indicates, there are some literatures that show that the learning emotion can influence the learning outcomes. Therefore, how to make the most student in a suitable learning emotion by using correct instruction strategy, which

adjustment from system, is a problem. In this paper, we use the concentration and distracted of learning emotions in the previous sections to adjust dynamically, using six different instruction strategies to focus and analyze emotions. Table 2 shows six instruction strategies and how they use in different learning emotion.

Figure 3(a) shows that after a student completes a group discussion, they can quickly reach a focused emotion. Figure 3(b) is a combination of pop quiz and dumb down the difficulty of instruction. It shows learning emotions become higher and more focused. Figures 4(a)(b) show a change in the students' learning emotion after diversion of the students' attention. Figure 4(a) shows when students are focused, teachers can effectively lower their concentration by using this strategy, and students can quickly raise their concentration as the course begins. Also, Figure 4(b) shows when the student's attention is too low, after using this strategy, although the concentration of students was not as fast as Figure 5(a) in the beginning, it still slowly rose to the standard value of concentration.

Table 1

Threshold of Learning Emotion

threshold	learning emotion	adjust
$> \boldsymbol{\theta_n}$	Most students have cannot focus on class.	Teachers should immediately formulate instruction strategy adjustment.
$< \boldsymbol{\theta_p}$	Most students can continue learning.	Teachers can still instruction.
$\boldsymbol{\theta_p}$<x<$\boldsymbol{\theta_n}$	Students' learning emotion can improve.	instruction must attend on Instant learning emotions.

Table 2

Instruction Strategies how Change Learning Emotion

	instruction Strategies	Purpose of Strategies
Check students' learning outcomes.	pop quiz	To help teacher and system to adjust instruction strategies.
Check if the difficulty is Suitable.		
Learning emotion is concentrated and result of pop quiz is good.	advance the difficulty of instruction	Learning efficiency is good, so can teach more in-depth content.
Learning emotion is distracted and result of pop quiz is bad.	dumb down the difficulty of instruction	The difficulty is too difficult to students cannot learn efficiently.
Learning emotion is highly concentrated.	let students take a group discussion	Students can communicate what they have learned and relax their highly concentrated emotions.
Learning emotion is highly concentrated or quite distracted.	diversion of the students' attention	Diversion of students' attention can let them attention in teach content.
Learning emotion is quite distracted.	let students take a break	Students are to tired, cause the reduce of teaching efficiency.

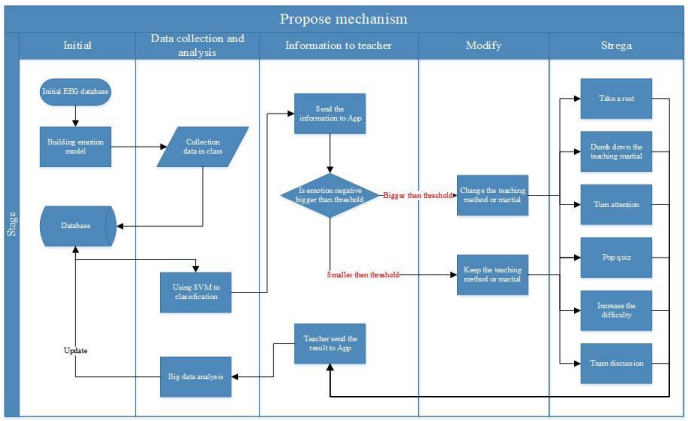

Fig.1. Proposed mechanism flowchart in this paper

Fig. 2(a)(b)(c). (a) The classification result via using SVM (b). The develop application login. (c). the interface to show the learning emotion of students in the class.

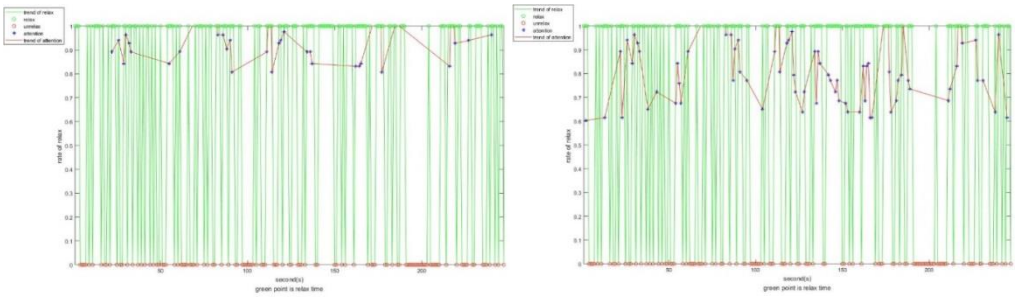

Fig. 3 (a)(b). (a) The result of using group discussion (b). The learning emotion result of a teacher using pop quiz and adjust the difficult

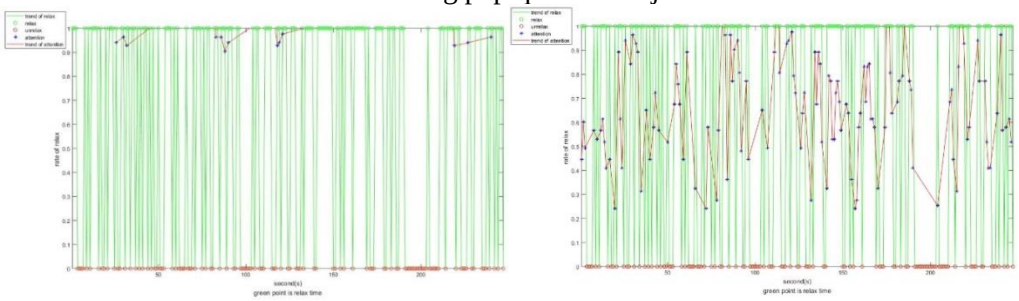

Fig. 4(a)(b). (a). The result of teacher using strategy with turn attention at concentration state. (b). The result of teacher using strategy with turn attention at the non-concentration state

4. Conclusion

In today's society. it is more valuable who cultivate talents with professional quality, teamwork and creativity. In order to train more students with these abilities, how to effectively improve learning emotion is an important issue. In this paper, we suggest using brainwave to analysis learning emotions and develop apps for teachers. In order to improve the quality of instruction, teachers can dynamically adjust instruction strategies in class by feedback of the learning state and emotion of students in real time. In addition, we use this function to analyze the six instruction strategies that can be implemented in class. By analyzing these instruction strategies, we understand how teachers adjust the strategies when students are positive or negative. The experimental results show that it can effectively improve students' learning emotion when using these instruction strategies. In future work, because brain waves can only divide one simple emotion into two types, this will make it impossible for teachers to further adjust instruction strategies. Therefore, we will further divide and improve the accuracy of classification in the study of emotion. In addition, we will further study and analyze the remaining instruction strategies to achieve the most appropriate instruction strategy adjustment mode.

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References

Arai, K., & Mardiyanto, R. (2013). Method for psychological status estimation by gaze location monitoring using eye-based human-computer interaction. *International Journal of Advanced Computer Science and Applications (IJACSA), 4*(3).

Du, R., Raja M.M., & Lee, H.J. (2014), Alpha Activity during Emotional Experience Revealed by ERSP, *Journal of Internet Technology (JIT),* 15(5), 775-782

Ekman, P., Friesen, W. V., & Ellsworth, P. (2013). Emotion in the human face: Guidelines for research and an integration of findings. *Elsevier*.

Fox, E. (2008). Emotion science cognitive and neuroscientific approaches to understanding human emotions. *Palgrave Macmillan.*

Fredrickson, B.L., & Branigan, C. (2005). Positive emotions broaden the scope of attention and thought-action repertoires. *Cognition & Emotion, 19*(3), 313-332.

Gupta, A., Singh, P., & Karlekar, M. (2018). A Novel Signal Modeling Approach for Classification of Seizure and Seizure-Free EEG Signals. *IEEE Transactions on Neural Systems and Rehabilitation Engineering, 26*(5), 925-935.

Hsu ,K.C., Lin K,H.C., Lin ,I.L.& Lin ,J.W. (2014), The Design and Evaluation of an Affective Tutoring System , *Journal of Internet Technology(JIT),* 15(4) , 533-542

Imah, E.M., & Widodo, A. (2017). A comparative study of machine learning algorithms for epileptic seizure classification on EEG signals. *2017 International Conference on Advanced Computer Science and Information Systems (ICACSIS).*

Isen, A.M. (2001). An Influence of Positive Affect on Decision Making in Complex Situations: Theoretical Issues With Practical Implications. *Journal of Consumer Psychology, 11*(2), 75 – 85.

Jayarathne, I., Cohen, M., & Amarakeerthi, S. (2017). Survey of EEG-based biometric authentication. *2017 IEEE 8th International Conference on Awareness Science and Technology (iCAST).*

Murugappan, M., Nagarajan, R., & Yaacob, S. (2009). Comparison of Different Wavelet Features from EEG Signals for Classifying Human Emotions. *IEEE Symposium on Industrial Electronics and Applications (ISIEA).*

Pekrun, R. (1992). The impact of emotions on learning and achievement: Towards a theory of cognitive/motivational mediators. *Applied Psychology, 41*(4), 359-376.

Pekrun, R., Goetz, T., Frenzel, A. C., Barchfeld, P., & Perry, R. P. (2011). Measuring emotions in students' learning and performance: The Achievement Emotions Questionnaire (AEQ). C*ontemporary educational psychology, 36*(1), 36-48.

Plutchik , R. (2002). Nature of emotions. *American Scientist*, 89, 349.

Soleymani, M., Asghari-Esfeden, S., Fu, Y., & Pantic, M. (2016). Analysis of EEG Signals and Facial Expressions for Continuous Emotion Detection. *IEEE Transactions on Affective Computing, 7*(1), 17-28.

Staw, B. M., Sutton, R. I., & Pelled, L. H. (1994). Employee positive emotion and favorable outcomes at the workplace. *Organization Science, 5*(1), 51-71.