Eeg experimental study on the influence of learning activity design on learning effect

Qianqian Zhang,Haiying Wang
(College of Art and Design, Zhejiang A&F University, Hangzhou 31000, China)

Abstract: With the rapid development of new media, online learning has become an indispensable form of educational practice all over the world. A large number of studies and practices have shown that the gamification of online learning has improved students' engagement and attention to a certain extent, but there are still some problems in some aspects. This study intends to use EEG interaction technology to monitor students' learning situation in real time, and study the influence of different learning activity designs on students' learning efficiency and continuous learning willingness through the design of different elements of learning activities, such as learning knowledge density design and knowledge quantity design. To further understand the learning efficiency and continuous learning willingness of students when they participate in different learning activities, propose and verify the relationships and principles between different parameters, and provide scientific methods and theoretical basis for the design of gamified education system.

Key words: knowledge intensity; Knowledge quantity; Eeg experiment; Learning effect; Willingness to continue learning

1. Theory and research review

1.1 Overview of brain-computer interface technology

1.1.1. Definition

Brain-computer interface (BCI) is a new artificial intelligence technology that establishes direct communication and control channels between the internal nerves of the brain and the external devices with high biocompatibility, so as to realize information interaction and functional integration between human and machine. It collects and processes brain signals, uses the computer to identify and classify the signals, and converts them into instructions for controlling external devices, so that some simple instructions can be realized by the user. At present, as the most practical technology in the field of brain science, brain-computer interface technology has played an important role in many fields, and has attracted more and more scholars' extensive attention and attention. Brain computer interface is mainly divided into two categories: active brain computer interface and passive brain computer interface.

Active BCI is the traditional brain computer interaction, which requires the user to actively and consciously issue a certain task or command, induce the brain to produce different activity patterns, and emphasize the user's brain intention. Passive BCI focuses on monitoring the user's emotional or cognitive state, which can optimize the user's interactive experience. It provides a way to deal with the shift of focus from disabled users to healthy users, and it can coexist with other means of human-computer interaction in a complementary form. Thus, passive BCI can be either dependent on the existence of traditional HCI or independent of it.

1.1.2. Applications of BCI in the field of education

The continuous development and improvement of brain-computer interface technology provides the possibility for its application in the field of education, showing considerable development prospects. The traditional way to measure learning efficiency and active learning willingness is to carry out scale measurement. The use of brain-computer interaction technology can accurately monitor and analyze learners' cognitive mechanism and learning situation, help teachers timely adjust teaching plans and teaching strategies, and improve students' learning efficiency. At present, the relevant research of BCI technology in the field of education mainly focuses on three aspects, namely, the emotion recognition of learners, the measurement of learners' attention level and the measurement of teaching quality in the field of cognitive knowledge.

1.2 Current research status of learning activity design

In the design of learning activities, there are many factors that affect the learning effect. Teachers need to arrange and adjust teaching activities according to students' cognitive rules in order to achieve better learning effect and better learning experience. Reasonable design of learning activities is an important condition for learners to achieve good learning results. At present, there are two kinds of dynamic adjustment methods for knowledge difficulty. One is the adjustment of knowledge difficulty based on intelligent optimization algorithm. As learners use certain devices to continuously deepen the learning process, the devices can summarize learners' cognitive characteristics and learning effects, establish student models, and thus carry out adaptive adjustment of the difficulty. The second is the difficulty adjustment method based on neurofeedback index, which adjusts the difficulty coefficient of knowledge by monitoring the learners' EEG signal and feedback index. Literature research shows that at present, many scholars at home and abroad focus on the influence of knowledge difficulty adjustment on learning results, while there are few related studies on other factors such as knowledge density and knowledge quantity.

2. Experimental research on the intervention of concentration in learning activities

2.1. Study the reasons

With the development of new media, online learning occupies an increasing proportion of learning forms. However, due to the inconvenience of online supervision and management, learners are prone to the phenomenon of inattention, lack of active continuous learning willingness and low learning efficiency. At present, relevant literature has discussed that in the learning process, achieving flow state is an important way to improve learners' attention level and learning efficiency, and appropriate knowledge difficulty design is an important condition to trigger flow. However, students' attention level changes dynamically with the intervention of learning tasks. In this case, knowledge difficulty is not the only factor that determines the level of attention. This paper intends to study the influence of different learning elements design on students' attention level and continuous learning willingness through EEG experiments, so as to provide designers with the basic design principles of learning system design direction and parameters for reference.

2.2. Research hypothesis

Based on the characteristics of periodic intervention of knowledge learning tasks in the learning process, the parameters that affect attention level and intrinsic motivation level are determined, including knowledge quantity and knowledge intensity. Based on EEG interaction technology, the theoretical hypothesis about the relationship between knowledge representation design parameters and target parameters is proposed:

Hypothesis 1: If the knowledge quantity and knowledge difficulty of knowledge representation design are determined, too high intensity of knowledge learning will lead to a cyclical downward trend of learners' concentration index, which will lead to a gradual decline in the level of attention concentration and internal learning motivation.

Hypothesis 2: If the knowledge difficulty and knowledge intensity of knowledge representation design are determined, too much knowledge will lead to a cyclical decline in learners' concentration index, which will then lead to a gradual decline in the level of attention concentration and intrinsic learning motivation.

2.3. Process of experiment implementation

This experiment is divided into two small experiments, and some GRE words are selected as learning materials. The equipment used is the second generation of EEG collection equipment of head-mounted Zhilin Encephalograph. NeuroSky chip biotechnology algorithm is used to analyze and convert the collected EEG signals into corresponding attention level indicators. The value of this parameter is between 1 and 100, which represents the user's current level of concentration, with higher values indicating higher concentration. Participants wore EEG devices throughout the experiment to measure and record their EEG during learning, as well as their performance on a learning test and their willingness to continue learning after learning. The study participants were 25 college students, aged between 18 and 22.

This experiment uses PowerPoint software to make learning PPT and test PPT. The experiment includes the following steps: first, introduce the experimental process and precautions to the subjects; The second is to ask the subjects to watch the learning PPT to learn the words, each ppt contains one word and its Chinese interpretation, and the presentation time of each word is 3 seconds; Third, they were asked to do test questions, the test questions are given words and three options, the subject needs to choose the correct answer among the three options, and need to complete all the questions within the specified time; The fourth is to invite the subjects to fill in the continuous learning willingness questionnaire. After the experiment, Tencent questionnaire and Likert scale were used to test the willingness to continue learning, including two questions: "I am still willing to continue learning" and "this way of learning makes me more focused", and the different groups in the two experiments were ranked respectively.

A pre-experiment was conducted on 7 subjects before the formal experiment, in order to find out the time when the subjects reached the state of learning fatigue, so as to provide reasonable data reference for the design of formal experimental materials. The pre-experiment process was to play the learning PPT automatically at the rate of 3s one word, with a total of 40 words, and the subjects needed to wear EEG equipment. Through the analysis of the EEG data of 7 subjects, the conclusion was drawn: the concentration index of the subjects decreased significantly when they learned the 7th and 17th words, and reached the state of exhaustion.

Therefore, the subsequent experimental materials will be designed according to the conclusions of the pre-experiment. Experiment 1 took density as variable, the number of words was 18, and the difficulty was the same. Group A, with medium density, played a relaxation video for 6 seconds after learning 6 words; Group B was at a high density, playing 12 seconds of relaxation videos after learning nine words. In experiment two, the number was the variable and the difficulty was the same as the density. Group A is a high number with 20 words; Group B is a medium number with 13 words; And group C is a low number with 6 words.

3. Analysis of experimental data

SPSS software was used to analyze the data in this experiment.

3.1. Experiment 1 Influence of knowledge density on learning effect

After data collection of the subjects, SPSS box diagram was used to remove outliers, and the results showed that the data of subject No. 7 was abnormal. Therefore, two indicators of learning attention level and knowledge test score of the remaining 24 subjects were analyzed. Independent sample T test was used to analyze whether the attention level and test scores of the subjects were related to the density, and the significance was 0.031 and 0.002 respectively, both of which were less than 0.05, indicating that the attention level and test scores of the subjects were significantly different under different densities. Through the analysis of the questionnaire data, it can be seen that 75% of the subjects prefer the medium intensity learning form.

3.2. Experiment 2: The influence of knowledge quantity on learning effect

After completing the data collection of the subjects, SPSS box diagram was used to remove outliers, and the results showed that the data of subjects No. 2 and No. 6 were abnormal. Therefore, two indicators of learning attention level and knowledge test score of the remaining 23 subjects were analyzed. The single factor ANOVA test was used to analyze whether the attention level and test scores of the subjects were related to the amount of knowledge, and the significance was 0.003 and 0.002 respectively, both of which were less than 0.05, indicating that the attention level and test scores of the subjects had significant differences under different amounts of knowledge. Through the questionnaire data analysis, it can be seen that 56.3% of the subjects prefer the medium quantity of learning, while 37.5% and 6.3% of the subjects prefer the low quantity and high quantity of learning, respectively.

4. Research conclusion

Using GRE words as learning materials, two learning software were made based on different knowledge density and different knowledge quantity. Through the learning experiment of 25 subjects, the influence of different learning elements design on learning effect and continuous learning willingness was investigated in the learning process.

The results of the experiment show the following conclusions:

(1) Knowledge density has significant influence on learning effect. Through the analysis of the experimental data, it is found that different density has a significant impact on the attention level and test performance of the subjects. The higher the knowledge density, the more tired the subjects were in the learning process, and the concentration showed a downward trend. Therefore, the willingness of the subjects to learn was weakened, resulting in lower test scores. The medium density is based on the conclusion of some subjects' pre-experiments: The concentration of the subjects decreased significantly when they began to learn the 7th word. However, the design of playing relaxation video for every 6 words made the subjects stop the learning activity when they were about to be tired, and then continue to study after relaxation. Therefore, the study willingness of the subjects was enhanced, the concentration was also improved, and the test score was higher in comparison.

(2) The amount of knowledge has a significant influence on the learning effect. When the difficulty and density of knowledge are the same, too much or too little knowledge will have an impact on the learning effect. Through data collection and analysis, it is found that the attention level and test scores of the subjects in group B are generally higher than those in group A and group C. According to the conclusion of the preliminary experiment, the subjects would reach a state of exhaustion when they learned the 7th and 17th words. In group A, which had up to 20 words, participants were more likely to experience fatigue, lower levels of concentration, and lower test scores. Group C had the best number of words with the lowest vocabulary, and the subjects' attention levels and test scores were in the middle of the three groups. The number of words in group B was in the middle, while the concentration level and test scores were the highest of the three groups. This may be because the participants were more focused on the learning process after experiencing the first fatigue, their concentration levels increased and their learning efficiency increased.

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