

# Application of EEG to Evaluation of Teaching Effect

Liyi Zhu, Tiantian Lu, Limin Zhang, Ling Lin, Yuxia You

School of Physics and Information Engineering, Minnan Normal University

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**Abstract:** In this paper, Electroencephalogram (EEG) is applied in teaching research, and its related fields are studied. At the same time, in order to carry out the fundamental task of “cultivating people with three perfections” and “cultivating people with virtue”, this paper also introduces EEG into teaching effect evaluation, so as to adjust teaching design and strategy and improve teaching quality.

**Keywords:** EEG; Teaching effect evaluation; Teaching research

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## 1. Research background

The brain is the control center of all movement and language functions of the human body, and sends out to the body through external nerves. The study found that the brain sends instructions via Electroencephalogram (EEG). It is also found that when people perform some thinking activities or are induced by some external stimuli, the EEG signal will show a corresponding and regular change pattern. Therefore, people's wishes expressed by abstract and virtual brain activities can be "represented" by real and physical EEG signals, which become a bridge between the human brain and the outside world<sup>[1]</sup>.

At present, traditional measures such as questionnaires, achievement assessment and job analysis are mainly used to evaluate teaching effect. Although these measures have certain positive significance in terms of universality and unity, they also have problems such as lack of flexibility and need to be improved in real time, which poses certain challenges for objective and comprehensive evaluation of teaching effect. Then it affects the adjustment of teaching design and teaching strategy. How to evaluate teaching effect objectively, comprehensively and effectively and adjust teaching strategy and teaching design is one of the key problems that educators need to solve at present. Based on educational neuroscience, this project intends to introduce EEG signals to "represent" the brain activities of sample students in class through real and physical EEG signals. Due to the development of weak signal acquisition technology, the acquisition of EEG electrical signals can use non-invasive methods, thus providing real-time information about brain activity. Through the analysis of EEG signals, students' cognitive state, emotion, concentration and other information can be revealed, and the information can be used to assist the evaluation of teaching effects, thus adjusting teaching strategies and teaching design, which is of great significance for the implementation of differentiated teaching and the improvement of teaching quality<sup>[2]</sup>.

## 2. Research design

The application of EEG in the evaluation of teaching effect. In the actual teaching, because the environment, teacher state, teaching strategy and teaching design and other factors will affect the learning state of students, and then affect the actual teaching effect. To this end, the project envisioned to build a relatively ideal environment, design the experimental control group, collect EEG signals from a large number of sample students, and then preprocess the collected signal data to remove interference, and carry out feature extraction and analysis through various methods. Finally, the analysis results are compared to reflect the role of EEG in the evaluation of teaching effects, so as to adjust teaching strategies and teaching design. It provides reference for the improvement of teaching efficiency and quality.

(1) Experimental design: Learners of the same age and different learning levels were selected as experimental objects to carry out specific teaching content. The experiment was divided into experimental group and control group. The experimental group used conventional teaching methods, and the control group used conventional teaching methods combined with EEG analysis.

(2) Data collection: electroencephalograph is used to collect the EEG data of learners before, during and after teaching. At the same time, record the learner's learning performance and achievement.

(3) Data processing and analysis: Use professional software to pre-process and analyze the collected EEG signals and extract relevant indicators. Evaluate the teaching effect by combining the learning performance and achievement of the learners.

(4) Expected results: By comparing the learning effect of the experimental group and the control group, the role of EEG in evaluating the

teaching effect was analyzed. It is expected that the experimental group is better than the control group in learning performance and achievement, and the change of EEG signal in the experimental group is positively correlated with the learning effect. This indicates that EEG signal can be used as an effective method to evaluate the teaching effect.

### 3. Collection and application of EEG signal in educational effect evaluation

#### 3.1 Learning state induction

To induce (elicit) the learning state of the experimental object in some appropriate way, that is, learning state induction, is the key step of learning state detection based on EEG signal. This project intends to use event induction to collect and analyze EEG signals of learning states. Event induction is to induce different learning states by showing subjects emotional video, audio, pictures and other stimulating materials. This is a common elicitation method that allows participants to generate emotional states and label them objectively. When video induction is used, it can stimulate the learning state more effectively because it stimulates both vision and hearing at the same time<sup>[3]</sup>.

#### 3.2 Learning state recognition

##### A. EEG signal collection

Electroencephalogram (EEG) is a direct representation of brain activity and is of great significance to the study of human brain physiological phenomena. Its main characteristics are: EEG is a non-stationary nonlinear signal, which is easily affected by the body and external environment during the acquisition process. It is usually mixed with other signals (including ophthalmic, cardiac and myoelectrical), interference, artifacts and noise, which need to be preprocessed to obtain a pure EEG signal. EEG can be divided into spontaneous and induced EEG. Spontaneous electrical changes in the brain generated by the nervous system are called spontaneous EEG. Because the stimulation in the corresponding part of the brain induced electrical potential changes is to induce brain electricity.

The generation mechanism of EEG is complex, and it can be divided into five categories according to the frequency band changes: delta(0.1-3 Hz), theta(4-7 Hz), alpha(8-12 Hz), beta(12.5-28 Hz) and gamma(29-50 Hz). The frequency band changes correspond to the brain activity state one by one.

EEG signal acquisition equipment includes electrode, data storage unit, amplifier and display unit. Collection methods are mostly non-invasive, which can be divided into dry and wet electrode methods, the difference is whether the medium is applied on the scalp, in addition to invasive intracranial collection method, which needs to pierce the scalp and has a certain risk. This project uses dry electrode method to collect EEG signal.

##### B. Pre-process the collected signal to remove interference

At present, the commonly used EEG signal preprocessing methods include filtering, independent component analysis (ICA), principal component analysis (principal component analysis). PCA, common average reference (CAR) and common spatial patterns (CSP). In addition, there are some hybrid denoising methods, the more typical one is the combination of blind source separation and wavelet transform. Through these methods, the collected signals are denoised to achieve the expected effect of the project.

##### C. Feature extraction

The main purpose of feature extraction is to obtain information that can effectively reflect individual learning state. The extracted feature is an important factor affecting the accuracy of learning state recognition. At present, there are four main methods for EEG feature analysis: time domain, frequency domain, time-frequency domain and nonlinear feature analysis.

At present, differential entropy feature is a common and more effective feature extraction method in nonlinear feature analysis. D. Build a deep learning hybrid model.

The classification algorithm model of learning state recognition has important influence on the accuracy of learning state recognition. At present, there are a variety of networks for the construction of deep learning models for EEG recognition, but each has its own advantages and disadvantages. In order to overcome the shortcomings of a single network and further improve the accuracy of learning state recognition, this project attempts to combine multiple features of time, frequency and space, as well as Recurrent Neural Networks (RNN) and Convolutional Neural Networks (Convolutional Neural Networks). CNN, Deep Belief Network (DBN) and other networks are combined to build a hybrid model.

The large and flexible model structure of deep learning enables it to have powerful representational capabilities, which enables it to process large-scale EEG data. The deep distributed representation of deep learning gives it good generalization ability, which enables it to capture the intrinsic properties that complex EEG data may share in different environments. With the growth of data scale, the hybrid model of deep learning is more widely applicable, and the recognition of learning states is more reasonable. At the same time, it can be better applied to

evaluate the teaching effect so as to adjust the teaching strategy and teaching design.

#### 4. Summary

As a physiological index, EEG provides a new perspective and method for teaching effect evaluation. By monitoring students' EEG signals in real time, teachers can better understand students' learning status and needs, so as to adjust teaching strategies and improve teaching quality. However, in order to give full play to the role of EEG in evaluation teaching, it is still necessary to overcome the technical and application challenges. With the continuous development and improvement of relevant technologies, we look forward to seeing more research on the application of EEG in the field of education in the future to promote the innovation and development of education.

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