Research on the diversified evaluation system of student for engineering course based on Artificial Neural Network

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Abstract: With the deepening and development of educational reform, more efforts are paid to improve education quality. The key to improving education quality is to improve the teaching quality. Improving the evaluation system of students is the key measure to improve the teaching quality. At present, there are some problems in the evaluation system of students, such as the single subject of evaluation, single criteria of evaluation and outdated content of evaluation. Therefore, one diversified evaluation system of the student was developed based on the Artificial Neural Network (ANN). The course of mechanical design was used as the research object of the student evaluation system. Both the establishing and implementing guidelines of the developed student evaluation systems were addressed and discussed. It was found that the developed student evaluation system can provide feasible solutions.

1. Introduction

Along with the change of the times, in order to improve the education quality, concerns are growing about the educational reform for higher education. In terms of educational reform, courses and teaching are the core links to achieve the training objectives of colleges and universities. The student evaluation is always the focus of course teaching. It is related to the realization of teaching objectives, the feedback of teaching results and the improvement of teaching methods [1]. In particular, in terms of the courses for engineering majors, these courses have their own characteristics. Generally, evaluating the ability of students based on the engineering course should balance the theory part and practice part [2].

Regarding the student assessment, teachers should use specific criteria and indicators to evaluate the learning behavior and academic achievement of students under the established teaching objectives. The evaluation results can guide the learning behavior of students in the future. The student assessment should be goal-oriented, which decomposes the objectives to be achieved in the course layer by layer. Through the assessment and analysis of students' learning behavior and academic achievements, the students' potential and enthusiasm can be actively mobilized. In this way, the teaching objectives can be better realized.

In general, the students' abilities can be evaluated by two aspects: the first is related to the students' learning outcomes. In the course of learning, students' learning outcomes are manifested in the quantity and quality of homework and test. The second is the learning behavior that affects students' learning outcomes. Student assessment is regarded as the process of evaluating and defining students' individual learning abilities. It can help students improve their learning ability and help them obtain ideal academic results. The success of student assessment depends not only on the assessment itself but also largely on the whole assessment process. The effective assessment depends on the successful development of the whole assessment activities.

Teachers are the main implementers of students' assessment. The traditional assessment methods mainly concern summative assessment, focusing on the students' mastery of theoretical knowledge. Because of the lag of information feedback, and the backwardness of assessment means, it is difficult for traditional assessment methods to obtain the timely feedback on the development of students in the whole learning process [3]. The traditional assessment method is hard to evaluate students' learning ability objectively and comprehensively. A complete and effective student assessment method should link students' learning activities with the learning objectives of the curriculum, and provide effective information for teachers. At the same time, the accurate information feedback should be provided to students timely, promoting students' development and developing students' potential.

Evaluation of students' abilities is a task of complexity which originates from the high nonlinearity and multi-parameters. To evaluate the ability of students comprehensively, the corresponding assessment system often comes with many parameters and also nonlinearity, resulting in the complex of evaluation. In fact, the evaluation of the complex nonlinear system can be used by the ANN [4]. The ANN is an emerging tool of artificial intelligence and has been shown to be effective in modeling and solving a wide range of nonlinear problems. The ANN is based on a collection of connected units or nodes called artificial neurons. Each connection can transmit a signal to other neurons. An artificial neuron that receives a signal then processes it and can signal neurons connected to it.

This paper will introduce the method of ANN into the evaluation of learning ability, to realize the assessment of the students' ability. The course of the mechanical design was used as the research object of student evaluation, as it is one of the important technical foundation courses for engineering students. Both the establishing and implementing guidelines of the developed student evaluation system would be addressed and discussed in the following sections.

2. Background on the student evaluation

At present, some colleges and universities still use examination results as the main criterion of student assessment and evaluation. They are far from the training objectives of talents in terms of evaluation objectives, evaluation content, evaluation methods, evaluation subjects and so on. An effective student evaluation system should include the following points:

(1) Diversification of assessment subjects.

The evaluation of curriculum learning should be made up of different subjects. It is because that the curriculum learning has increased a lot of after-class learning, group cooperative learning, and teacher-student interaction learning. Once the evaluation subjects are diversified, the evaluation results can be more objective. In addition, the traditional teacher-centered assessment tends to focus on the evaluation of the knowledge and ability of students. The development of students' emotions and learning attitudes is easy to be neglected.

(2) Combining summative evaluation with procedural evaluation.

Summative evaluation is a conclusive evaluation of the stage teaching effect. It is regarded as a confirmation of the learning effect at the end of a semester or a course. The procedural evaluation focuses on the dynamic evaluation of the whole learning process for students. Its fundamental purpose is to give full play to the role of incentive, supervision, and guidance. Simple summative evaluation or procedural evaluation can only reflect some aspects of students' learning, but cannot fully reflect the whole of students' learning.

3. The improved student evaluation approach

As a part of curriculum evaluation, evaluating the ability of the student is important work. The developments of the student assessment systems are hot spots in related fields. The student evaluation includes three aspects: the subject of evaluation, the index of evaluation and the method of evaluation. For the evaluation subjects, leadership evaluation, mutual evaluation, self-evaluation,

and expert evaluation are prevalent. For the evaluation indicators, there are no universal indicators. For the evaluation method, this work adopts a behavior-oriented assessment method. The diversified student evaluation system developed in our work includes the following aspects:

(1) Proper selection of evaluation indicators.

Choosing the evaluation indicators is the basis of realizing scientific student evaluation. It is a complex task. In this work, through in-depth investigation and collection of relevant expert opinions, combined with the methods provided by existing literatures at home and abroad, some dozens of comprehensive evaluation indicators are chosen. These evaluation indicators can comprehensively reflect the various factors of student evaluation.

(2) The development of the multi-level and multi-variable system evaluation.

The developed comprehensive evaluation system has the characteristics of multi-indicators. Each indicator affects each other. In this work, principal component analysis (PCA) is introduced into the student evaluation system, and the dimension of variables can be reduced by PCA. The ANN is introduced into the student evaluation system. By using its powerful non-linear processing ability, the effect of each index on the evaluation results is simulated. In this way, the reasonable and scientific evaluation results can be obtained.

To embody the scientific, fairness, and rationality of student evaluation, the index system plays a key role. In the student evaluation system proposed in this work, the following principles were used to establish the student evaluation index system:

(1) The principle of comprehensiveness. The evaluation index should reflect the teaching objective comprehensively. In other words, all the factors that may affect the student assessment should be taken into account. At the same time, it should be clear and orderly, so as to avoid the complexity of the index system and provide the comprehensive information for the evaluation of students' abilities.

(2) The principle of incentive. Through the evaluation index and results, students can know their strengths and weaknesses. Students can take measures to improve their work and ability.

(3) The principle of consistency. The evaluation index of student assessment must be employed in the current teaching management system in colleges and universities.

(4) The principle of independence. Indicators are independent of each other. The scientific of evaluation should be not affected because of overlapping indicators. Meanwhile, the workload of evaluation should be not increased because of redundant indicators.

(5) The principle of fault-tolerance. There are qualitative and quantitative evaluation indicators. Quantitative indicators will be inevitably disturbed by the subjective will of the evaluators in the evaluation process, affecting the accuracy of evaluation results. It requires better fault tolerance in the setting of evaluation indicators. Under the condition of incomplete evaluation information or other interference, more accurate conclusions can be drawn with the principle of fault-tolerance.

The student assessment is carried out on their learning content, learning attitude and learning effect, and learning methods. To embody the principles of comprehensiveness, consistency, motivation, independence, and fault tolerance, this work sets the learning effect as the evaluation goal. The main contents of the evaluation goal include students' achievement examinations and lessons, discipline, understanding and mastery of knowledge, the ability to solve problems, etc.

Student assessment is a dynamic process. It has many factors and different degrees. It is difficult to express the student evaluation by a mathematical analytic formula. The student assessment is a complicated and non-linear comprehensive decision-making problem. The BP neural network can fully approximate any complex non-linear relationship. It can simulate the non-linear process without knowing the cause of the data. The BP neural network is based on the existing knowledge (learning samples) through training to get the value model of the evaluated object. The BP neural network can effectively solve the problem of non-linear comprehensive evaluation and reduce the influence of human factors on decision-making results. Because of the strong non-linear processing ability, it is more scientific to use the neural network to evaluate students’ abilities. Through the training of BP model with a large amount of data, the weight of each evaluation index is automatically adjusted by the self-learning and self-organizing ability of the BP network. The

influence of human factors on the evaluation results can be avoided. Through data training, the training error of the model reaches a very small order of magnitude. Meanwhile, the validity of the training model can be verified by testing data.

4. Conclusions

In this work, one diversified evaluation approach of the student was developed based on the Artificial Neural Network (ANN). The course of mechanical design was used as the research object of the student evaluation system. The student comprehensive evaluation method proposed in this paper is an effective and scientific evaluation method, which is easy to operate. Meanwhile, through the principal component analysis method, the complexity of the neural network model is reduced and the efficiency of the neural network model is improved. It was found that the developed student evaluation system can provide feasible solutions.

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