



Research on Online Course Teaching Quality Evaluation Method Based on Internet of Things Technology

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Abstract. Network teaching is a new modern teaching mode. Network teaching evaluation is a key link in the whole network teaching process and an effective method to ensure the quality of network teaching. Therefore, this paper puts forward the online course teaching quality evaluation method under the Internet of things technology. By analyzing the influencing factors of online course teaching quality, it constructs the online course teaching quality evaluation system, determines the online classroom teaching evaluation index of colleges and universities, and calculates the final teaching quality evaluation result according to the evaluation proportion by using the Internet of things technology. The simulation results show that the proposed method is effective in online course teaching quality evaluation.

Keywords: Internet of things technology · Online course · Quality evaluation

1 Introduction

With the vigorous development of computer, multimedia, network and other technologies, the network teaching mode has provided an excellent opportunity for the leap forward development of China's education. The so-called network teaching refers to a kind of teaching activity that students with certain self-learning and self-discipline ability use network technology and multimedia technology to realize in different places through the interaction with computer network, which is mainly based on active learning, supplemented by teacher guidance and computer intelligent coordination [1]. As a new type of teaching form, network teaching emphasizes students and self-learning as the center, which is more open, flexible and diverse than traditional teaching. To ensure the quality of network teaching, we must build a reasonable and perfect network teaching quality evaluation and monitoring system. Teaching evaluation is a key link in the whole teaching process, which refers to the process of making value judgment on students' behavior changes through teaching according to teaching objectives, so as to provide basis for improving and optimizing teaching [2]. Network teaching evaluation belongs to the sub category of teaching evaluation, which has three meanings of teaching evaluation, namely value judgment, evaluation development and reference standard. However,

compared with traditional teaching, network teaching has its own unique characteristics, such as the separation of teaching and learning activities in time and space, the need for reliable and safe network transmission system for the realization of teaching, learners' learning is mainly autonomous learning, etc., which makes network teaching evaluation often show its unique characteristics [3]. How to establish an effective network teaching evaluation system has become an important issue for modern educators. Because the traditional online course teaching quality evaluation method has the problem that the evaluation effect is not ideal, the online course teaching quality evaluation method is proposed under the Internet of things technology. This paper discusses the network teaching mode and characteristics, analyzes the remarkable characteristics of network teaching evaluation, expounds the system structure of network teaching quality evaluation, and focuses on the design and implementation of network teaching evaluation system. The simulation results show that the online course teaching quality evaluation effect of this method is good, which lays the foundation for online course teaching.

2 Evaluation Method of Online Course Teaching Quality

2.1 Factors Influencing the Teaching Quality of Online Courses

In China, the practice and theoretical research of teaching quality evaluation in Colleges and universities started late, only a few decades of development. Compared with the western developed countries with more than 100 years of history, the theoretical research is not deep enough, and the practice is still in the exploratory stage. However, under the guidance of national policies and school exploration, the theory and practice of teaching quality evaluation in Colleges and universities have also been greatly developed [4]. The teaching quality of university teachers is an important part of teaching quality. At present, the domestic factors affecting the teaching quality of university teachers can be summarized into the following six aspects: the quality of teachers, the way of knowledge accumulation, classroom practice, teaching auxiliary conditions, incentive mechanism and external environment. The specific influencing factors of online course teaching quality evaluation are shown in the Fig. 1.

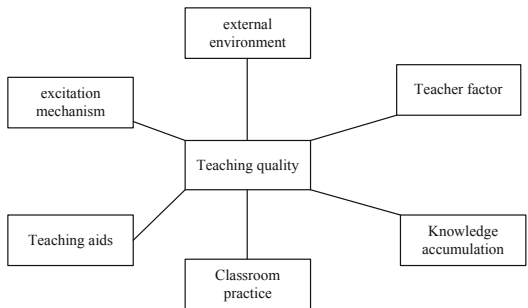


Fig. 1. Factors Influencing online course teaching quality evaluation

Among them, the elements included in each link can be determined according to the actual situation.

- (1) The quality of university teachers includes educational background, knowledge structure and personal charm;
- (2) The ways of knowledge accumulation include self-study, further study, training, academic exchange, expert guidance, etc.;
- (3) Classroom practice includes classroom teaching hours, the number of different teaching objects and other elements;
- (4) Auxiliary teaching conditions include computer, teaching projector, teaching software and other facilities;
- (5) The incentive mechanism includes teaching and research awards, professional title recognition and other elements;
- (6) The external environment includes the social respect for university teachers and the status of teachers;

The so-called influence factor refers to the most important component of the system. Without a certain basic element, the system cannot be formed. Teachers, teaching content, online classroom teaching environment and students are indispensable basic elements in the online classroom teaching process. Teachers are the main body of “teaching” in the online classroom teaching process, and they are the designers and implementers of online classroom teaching process [5]. The influence of teaching content on teaching quality mainly refers to the satisfaction degree of teaching content on teaching objectives and the influence of teaching content on online classroom teaching quality in form of expression. Online classroom teaching environment refers to the environment in which teachers and students carry out teaching activities, and students are the main body of “learning” in the process of online classroom teaching [6]. In the process of online classroom teaching, the relationship between the influencing factors is analyzed, as shown in the Fig. 2:

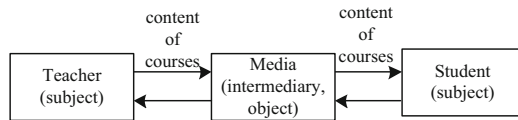


Fig. 2. Relationship between the influencing factors of teaching evaluation

At present, the classification of teaching quality evaluation content in Colleges and universities is relatively unified, as shown in the table below:

Table 1. Content optimization of online course teaching quality evaluation

Classification criteria	Evaluation type	Remarks
Evaluation criteria	Relative evaluation	To understand the differences between students and reflect the position of individuals in the group; the disadvantage is that the benchmark of different groups is different, and the relative evaluation should not be used as the basis to judge the distance between individual and mathematical target
	Absolute evaluation	It is difficult to distinguish the differences between the students and the students in learning
Evaluation function	Diagnostic evaluation	Through this kind of evaluation, we can understand the students' learning readiness, judge whether they have the conditions required to achieve the current teaching objectives, and provide the basis for teaching students in accordance with their aptitude
	Formative assessment	It can timely understand the results of stage teaching and the progress of students' learning, existing problems, and then timely adjust and improve teaching
	Summative evaluation	The purpose is to test whether the students' academic achievement has finally reached the requirements of teaching objectives, and to evaluate the effect of the whole teaching activity, which attaches importance to the results
Evaluation method	Qualitative evaluation	Using the logical analysis methods of analysis, synthesis, comparison, classification, deduction and induction, the data and data obtained from the evaluation are processed in thinking, and the analysis results are mainly descriptive data
	Quantitative evaluation	Using mathematical statistics, multivariate analysis and other teaching methods, regular conclusions are extracted from the complex evaluation data

The research on the evaluation index system of teaching quality in Colleges and universities is the focus of this paper. Now we choose the teaching evaluation index system of some colleges and universities in China and the United States for horizontal comparison [7]. Through the comparative analysis of this table, we can see that the teaching quality evaluation index of colleges and universities in China is relatively unified,

and the teaching quality evaluation index of colleges and universities is relatively rich, including the objective evaluation of teaching and curriculum, the relationship between teachers and students, etc.

2.2 Improvement of Online Course Teaching Quality Evaluation System

From the meaning of online classroom teaching and the development mode of online classroom teaching, there are many factors that affect the quality of online classroom teaching in Colleges and universities, including subjective factors and objective factors, and the relationship between these factors is very complex. Their role in online classroom teaching in Colleges and universities is not played alone, but linked and restricted each other. The online classroom teaching process in Colleges and universities is an integral system composed of multiple elements [8]. The process of online classroom teaching in Colleges and universities consists of four basic elements: teachers, teaching content, online classroom teaching environment and learners. Further construct the model diagram of influencing factors of online classroom teaching quality in Colleges and universities, as shown in the figure, in order to get the online teaching quality evaluation system conveniently (Fig. 3).

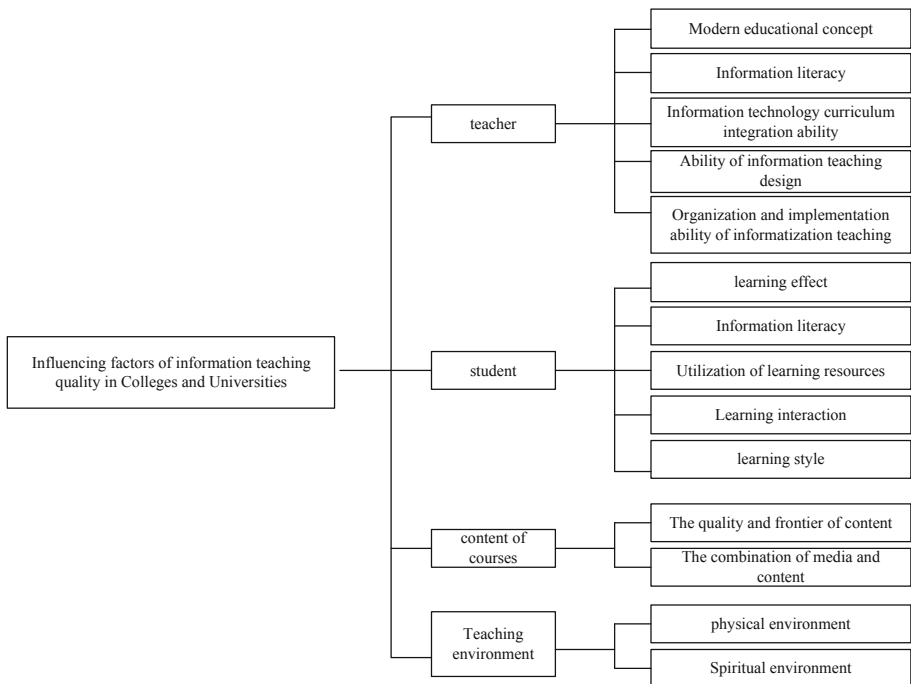


Fig. 3. Online teaching quality evaluation system

To determine the evaluation index of online classroom teaching in Colleges and universities, in addition to considering the factors that affect the quality of online classroom

teaching in Colleges and universities, we must also have a certain theoretical basis and research as the basis, with the help of certain scientific procedures and methods, so as to ensure the scientificity, objectivity and effectiveness of the evaluation index [9]. On the basis of extracting the influencing factors of online classroom teaching quality in Colleges and universities, combined with the principles of online classroom teaching quality evaluation in Colleges and universities, this paper preliminarily formulates the online classroom teaching quality evaluation indicators, as shown in Table 1 (Table 2):

In the process of developing the evaluation index, if we classify the evaluation index from the process of preparation, implementation and feedback of online classroom teaching in Colleges and universities, there will be many factors that affect online classroom teaching in Colleges and universities. For example, the modern education concept, information quality and teaching environment of university teachers play a certain role in the process of teaching design, teaching activities and teaching feedback [10–12]. This paper classifies the evaluation indicators from the elements contained in the process of online classroom teaching in Colleges and universities. When determining the secondary indicators under the two primary indicators of teachers and students, it is determined according to the time sequence of teaching activities: teaching preparation, teaching implementation, and the main influencing factors in teaching feedback. Combined with experts' opinions, the index system was modified and improved. In the process of accepting experts' opinions, different experts put forward the problem of "teaching effect as the subordinate index of students' index", and pointed out that this is a problem that should be paid attention to in the development of evaluation system. The student evaluation model includes four major categories: teaching effect, teaching content, teaching method and teaching attitude. Then each category is subdivided, and different evaluation standards are set for each category. Thus, students can score various indicators based on the comprehensive teaching situation, so as to get the quantitative results of student evaluation, which is a part of the evaluation results. This paper sets up the student evaluation form from the actual situation, as shown in the table (Table 3).

Teacher evaluation also includes four major categories: teaching attitude, teaching content, teaching effect and teaching method. Then, we divide each category into sub categories, so that teachers can score by category, and take the quantitative results of teacher evaluation as part of the evaluation results. According to the actual situation, the teacher rating table is set up, as shown in the Table 4.

The evaluation index system not only ensures the scientificity and comprehensiveness of the evaluation index, but also has a general understanding of the importance of the evaluation index, which is helpful to grasp the relative weight of each index from a macro perspective. The expression for calculating the weight is:

$$W_j = \frac{E_j}{\sum_{i=1}^m d_j} \quad (1)$$

Among them, W_j represents the attribute weight coefficient, and d_j represents the consistency parameter of the evaluation index.

Table 2. Optimization of teaching quality evaluation index in Colleges and Universities

Primary indicators	Secondary indicators	Third level index	Remarks
Teacher	Teacher literacy	Teaching philosophy	The purpose, task, teachers and students view, talent view of modern education
		Awareness information	Information insight, enthusiasm for information utilization and information security
		Information capability	Ability of information acquisition, understanding, processing and expression
		It operation	Information technology equipment, teaching software use, courseware production resources processing
		Curriculum integration	The ability of using information technology to support subject teaching
	Instructional design	Teaching analysis	Analysis of teaching content and teaching object
		Strategy design	Teaching goal design, teaching strategy design, media use design, teaching practice design
		Teaching evaluation	Teaching process evaluation and teaching effect evaluation
	Teaching implementation	Target control	Knowledge goal, ability goal, emotion goal and their relationship
		Activity organization	The choice of teaching form and the distribution of effect, content and time
		Media application	Media application opportunity, standard operation and proficiency, maintenance

(continued)

Table 2. (continued)

Primary indicators	Secondary indicators	Third level index	Remarks
		Learning guidance	Learning content, method guidance, students' question answering, special task
Student	Student literacy	Learning philosophy	Cognition, understanding and application of modern learning concept
		Awareness information	Information curiosity, awareness of active use, information technology knowledge
		Information capability	Ability to acquire, screen and process
		It operation	The basic operation of information technology, follow the teacher's requirements
	Learning process	Emotional Participation	Learning attitude, enthusiasm and interest
		Resource utilization	The utilization of teaching resources and the frequency of inquiring materials
		Learning style	Understanding and choice of learning style

2.3 The Realization of Online Course Teaching Quality Evaluation

Based on the determination of the evaluation scheme, the teaching quality evaluation is started. The evaluation results come from the data of students, teachers and leaders. On the basis of all the data, the final teaching quality evaluation results are calculated according to the evaluation proportion, so as to sort and publicize. In teaching evaluation, its core functions are evaluation notification function and student evaluation function. In order to understand the implementation details, the workflow of the above functions is explained by using sequence diagram. As part of the evaluation, the workflow is as follows:

Using 360° evaluation method to evaluate the teaching quality of online courses, each user needs to fill in the evaluation data, so students need to fill in according to the student evaluation scheme, and the filling page is `studentestimate.jsp`. According to the student evaluation scheme, the students are scored one by one. After scoring, the evaluation results are submitted to the system.

Table 3. Student evaluation index

	Learning interaction	Students' cooperation and communication with teachers
Content features	Content quality	Enrichment, content and teaching objectives in accordance with the degree
	Content update	The cutting edge of content
Content organization	Hierarchy	The organization has different levels and takes care of individual differences
	Applicability	The teaching content is suitable for the form of presentation
Physical environment	Hardware environment	Multimedia teachers, network room, voice room, micro classroom and other normal use
	Software environment	Normal use of network teaching platform and teaching software
Spiritual environment	Organizational system	Teaching management standard, teacher standard, student discipline assessment
	Interpersonal psychology	Teacher student relationship, teaching atmosphere and study style
Subject knowledge	Basic knowledge	Basic contents of teaching objectives
	Expanding knowledge	Network resources development learning
Ability and quality	Quality	Learning habits, interest cultivation and learning methods
	Ability	Exploration and innovation, cooperation and practice ability

Check the values, including the value type check and the value range check. If the check fails, it will prompt the students the reason for failing. If the check passes, it is necessary to save the values in the student evaluation results for use. Thus, the sequence diagram of evaluation function can be obtained, as shown in the Fig. 4.

Before starting the evaluation process every semester, the academic affairs office needs to send the evaluation deadline and other information to the email or mobile phone of students, teachers and leaders in the form of SMS and e-mail, so that users can complete the evaluation in time. The workflow of the evaluation notification function is as follows:

After starting the teaching quality evaluation, the staff of the educational administration office need to send the evaluation notice information to remind users to complete the evaluation in time. The evaluation notice page is smsNotice.jsp Page. The staff of the educational administration office need to submit the evaluation information and the notice list, so as to batch notify according to the list, which can improve the efficiency.

Table 4. Teacher evaluation table

Evaluation items (full marks)	Breakdown item (full score)	Evaluation criterion
Teaching effect (20)	Clear learning purpose (5)	Excellent (5), good (3), qualified (2), poor (1)
	Pay attention to the cultivation of students' independent ability and enrich the knowledge system (5)	Excellent (5), good (3), qualified (2), poor (1)
	Pay attention to the cultivation of students' analytical ability (5)	Excellent (5), good (3), qualified (2), poor (1)
	Cultivate hands-on ability (5)	Excellent (5), good (3), qualified (2), poor (1)
Teaching content (30)	Comprehensive teaching content (4)	Excellent (4), good (3), qualified (2), poor (1)
	Challenging teaching content (8)	Excellent (8), good (6), qualified (4), poor (2)
	Pay attention to the teaching of basic courses (8)	Excellent (8), good (6), qualified (4), poor (2)
	Whether the amount of work is appropriate/the practice time is sufficient (5)	Excellent (5), good (3), qualified (2), poor (1)
	Whether the teaching content is substantial (5)	Excellent (5), good (3), qualified (2), poor (1)
Teaching methods (12)	Proper teaching methods (4)	Excellent (4), good (3), qualified (2), poor (1)
	Colorful explanations (4)	Excellent (4), good (3), qualified (2), poor (1)
	Integrating multiple teaching methods (4)	Excellent (4), good (3), qualified (2), poor (1)
Teaching attitude (38)	Have a strong sense of responsibility, do not hold classes, answer students' questions in time (4)	Excellent (4), good (3), qualified (2), poor (1)
	Reasonable and fair assessment method (4)	Excellent (4), good (3), qualified (2), poor (1)
	Strict discipline (4)	Excellent (4), good (3), qualified (2), poor (1)
	Good classroom atmosphere, frequent communication with students (4)	Excellent (4), good (3), qualified (2), poor (1)

(continued)

Table 4. (continued)

Evaluation items (full marks)	Breakdown item (full score)	Evaluation criterion
	Solve students' problems in time (4)	Excellent (4), good (3), qualified (2), poor (1)
	Being a teacher (4)	Excellent (4), good (3), qualified (2), poor (1)
	Have detailed record and know the teaching content well (8)	Excellent (8), good (6), qualified (4), poor (2)
	Whether the teaching process is normal (6)	Excellent (6), good (3), qualified (2), poor (1)

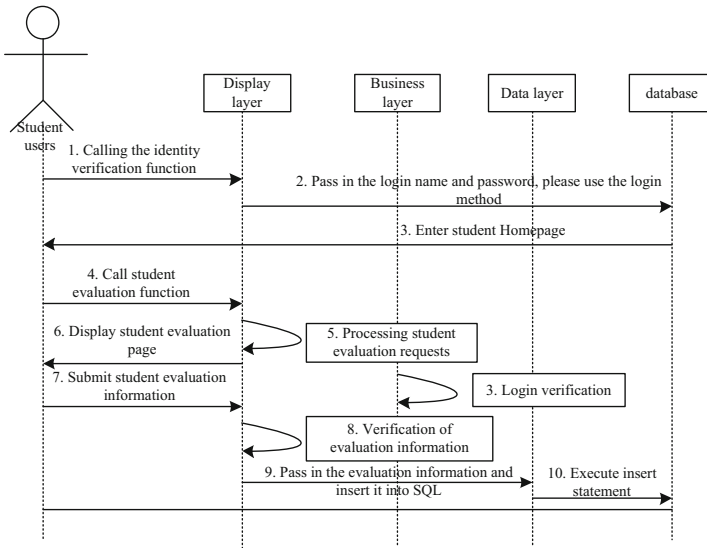


Fig. 4. Sequence diagram of teaching quality evaluation

To verify the content of the notification, we mainly check the format of the empty notification list and the notification list. On the basis of successful verification, we can send the content to the notification list.

Record the notification log, so as to display the list of notification failure and notification success, which is convenient for the staff of the educational administration office to view. In the online classroom teaching quality evaluation model, the online classroom teaching quality evaluation organization is responsible for organizing teachers, students and teaching quality management personnel to obtain the information of each index of online classroom teaching quality evaluation through certain evaluation means, fill in the online classroom teaching quality evaluation survey scale, and then the online classroom teaching quality evaluation organization processes the survey data to obtain the online

classroom teaching quality According to the results of classroom teaching quality evaluation, we find the problems and experience in the process of online classroom teaching. Finally, the online classroom teaching quality evaluation organization is also responsible for the feedback of the evaluation results to the teachers, students and teaching managers of online classroom teaching, so that they can understand the problems existing in online classroom teaching, so as to improve the quality of online classroom teaching in time.

3 Analysis of Experimental Results

After the construction of teaching quality evaluation system is completed, it needs to be deployed to the school network environment. Therefore, the environment used in the implementation phase or test phase is not consistent with the actual environment, which may affect the final deployment of teaching quality evaluation system and cause losses to the school. Through the investigation of the actual environment, the environmental requirements of the system can be made clear, which are described below.

The client does not undertake the key task of the teaching quality evaluation system. It only needs the user to submit the business request through the browser, and the software and hardware can meet the basic application requirements without too high hardware configuration.

Software: support users to submit teaching quality evaluation request by using various types of browsers. Users can choose to install various browsers such as IE and Firefox.

Hardware: the memory is larger than 1 GB, at the same time, there are requirements for the network, must be connectable teaching quality evaluation.

The display of teaching evaluation results is the key of teaching evaluation. Through the progress display of the evaluation results, it is convenient to check the progress of teaching evaluation and receive the opinions or suggestions of teaching evaluation in time, which is conducive to the timely correction of teaching deficiencies and the improvement of education and teaching behavior. Teaching evaluation results can include teacher evaluation results and student evaluation results. By searching the corresponding class in the system, you can view the evaluation progress of class teachers, or view the evaluation progress and evaluation results of a teacher separately. The mutual evaluation results between teachers and students are located in different interfaces. Enter different teacher numbers to view the latest evaluation progress. At the same time, you can modify the corresponding evaluation results and delete the corresponding scores. Through the teaching evaluation results, we can analyze the teaching situation of different teaching and research departments. Histogram is used to reflect the status of teaching evaluation. It can be used to compare the evaluation results of teachers in different semesters or academic years. At the same time, according to the evaluation results, it is convenient for department or college leaders to view the evaluation results. Using the histogram display method, the evaluation results can be displayed more intuitively, and the display results are shown in the Fig. 5.

The function test process and performance test process of the system are described in detail, and the test results of the two are given. The test results are closely related to the deployment of the system. If any one of the results is not up to the standard,

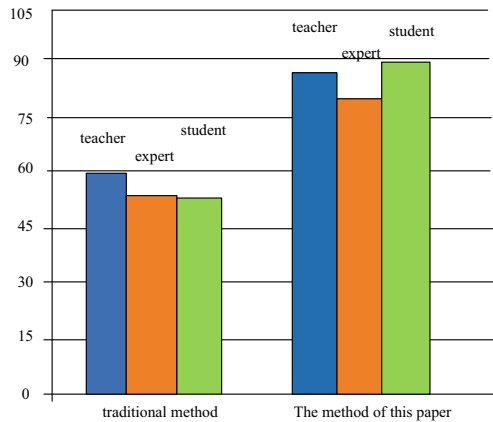


Fig. 5. Analysis of evaluation results

the teaching quality evaluation system can not be deployed to the school to deal with the teaching quality evaluation business. Through the comparative analysis of the test results and requirements, we can see that the teaching quality evaluation system has reached the deployment requirements and can be applied to schools. In order to test the feasibility of the online classroom teaching quality evaluation index constructed in this study. In order to complete the research, the online classroom teaching evaluation scale in Colleges and universities is transformed into the form of questionnaire, and the participants of the course are investigated. The secondary index score is obtained by multiplying each three-level index score by the corresponding weight and weighted sum: the method of obtaining the primary index score and the secondary index score is the same, that is, each secondary index under the primary index is multiplied by the corresponding weight the corresponding weights are obtained by weighted summation.

Based on this, the teaching quality evaluation results are recorded as follows (Table 5):

From the results of the evaluation, we can see that the scores of teachers' indicators, students' indicators and teaching content are relatively high, indicating that the situation of teachers and students participating in teaching activities is better. From a practical point of view, Professor Zhang Yichun is a doctoral supervisor of educational technology. He has a deep research on online classroom teaching, and his own information literacy, online classroom teaching design and implementation ability are very good; Most of the students have a good understanding of online classroom teaching and strong learning and research ability; the teaching content is more in line with the teaching objectives and has a certain cutting-edge, and its presentation form is also in line with the requirements of online classroom teaching. Compared with the other three indicators, the teaching environment indicators are slightly worse, which belongs to the good level. The main purpose of this evaluation is to test the feasibility of the online classroom teaching quality evaluation index constructed in this study. Through this application research, it can be fully illustrated that the evaluation index obtained in this study can comprehensively

Table 5. Teaching quality evaluation results

–	–	Content	Index
Content of courses	Content quality	The consistency of enrichment, content and teaching objectives	3.98
	Content update	Cutting edge of content	4.31
	Hierarchy	The organization has different levels and takes care of individual differences	4.03
	Applicability	The teaching content is suitable for the form of display	4.42
Teaching environment	Hardware environment	Multimedia classroom, network room, voice room, micro classroom, library	4.00
	Software environment	Network teaching platform, teaching software and teaching support system	3.92
	Organizational system	Teaching management standard, teacher standard and student discipline	4.03
	Interpersonal psychology	Teacher student relationship, teaching atmosphere and study style	3.96

and objectively evaluate the quality of online classroom teaching in Colleges and universities. Through the quantification of indicators, the examination data are summarized and analyzed, so that the whole evaluation is more scientific and reasonable, easy to operate, and the evaluation results are clear at a glance.

4 Concluding Remarks

Network teaching evaluation is one of the key links in the whole network teaching process. The network teaching evaluation system can not only evaluate each link of the network course, but also collect information of all stages and aspects according to the actual situation to carry out process evaluation and summary evaluation, so as to make up for the lack of information collection and process evaluation in the existing similar systems. With the improvement of system development and application performance, its application range can break through the limitations of the teaching evaluation field, and provide a basis for further research and development of similar systems. However, in the process of research, the running efficiency of the system is not considered, which leads to a long time for online course teaching quality evaluation. Therefore, in the next research, the running time of the system will be focused on, so as to improve the efficiency of online course teaching quality evaluation.

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