



# Design of a Multidimensional Teaching Effectiveness Evaluation System Based on Information Integration

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**Abstract.** The multidimensional teaching effect evaluation system has the problem of high CPU usage in the process of actual use. To solve this problem, a multidimensional teaching effect evaluation system based on information integration is designed. Hardware part: choose RC punch and discharge circuit, convert TTL level into PC communication mode as well; software part: identify the characteristics of multidimensional teaching effect evaluation elements, divide them into evaluation subjects, **optimize** the system software function by using information integration technology, extract and revise the system log intermediate table. Experimental results: The multidimensional teaching effectiveness evaluation system designed this time is lower than the average CPU usage of the other three multidimensional teaching effectiveness evaluation systems: 9.896%, 11.111% and 10.036% respectively, indicating that the performance of the designed multidimensional teaching effectiveness evaluation system is superior after fully integrating information integration technology.

**Keywords:** Information Integration · Multidimensional Teaching · Teaching Evaluation · Reset Circuit · Teaching Process · Teaching Link

## 1 Introduction

With the continuous development of information technology, corresponding teaching models and methods of evaluating teaching effectiveness are also undergoing changes [1, 2]. Combining the existing multimedia technology and applying the emerging information integration technology to teaching evaluation is an effective way to improve teaching. Despite the rise of online teaching in the current educational environment, it is still fundamentally classroom based, so quality assessment still plays an important role in research and teaching processes. Different measurement standards represent different value orientations. Undoubtedly, the transformation and development have put forward new requirements for the evaluation of teaching quality. As an important part of the teaching monitoring system and an important guarantee for achieving talent cultivation goals, a multidimensional teaching evaluation system urgently needs to be established. Therefore, studying a multidimensional teaching quality evaluation system suitable for

the transformation of applied technology universities, exploring evaluation mechanisms that conform to the development laws of higher education, is of great significance for accelerating the cultivation of applied talents and the transformation of universities, alleviating structural employment conflicts, and providing a more comprehensive interactive way for teaching effectiveness evaluation.

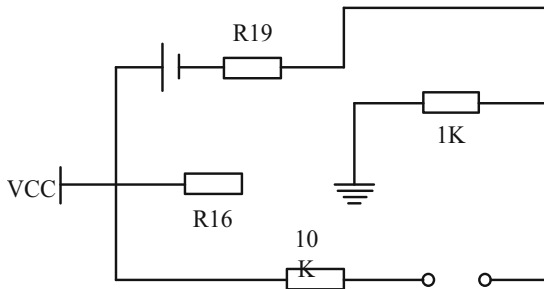
The research on teaching effectiveness evaluation in Western countries began in the early 20th century, mainly through the construction of evaluation scales. In the subsequent development process, classroom observation gradually replaced the scale of evaluation and promoted the standardization of teaching effectiveness evaluation [3]. For example, CHEN Yanhong studied the teaching effect evaluation method of the Internet of Things teaching platform based on long-term and short-term memory networks, and analyzed the current situation of the Internet of Things education platform, including the development and structure of the Internet of Things teaching platform. We have constructed an LSTM model to evaluate the teaching effectiveness of the Internet of Things education platform. Finally, through the study of the model, the teaching effectiveness of the Internet of Things education platform was evaluated. However, in recent years, both Western educators and Chinese scholars have shifted their research focus to the level of developmental teacher evaluation. In addition to clarifying the subject status of teachers, it also acknowledges the value of self-evaluation and mutual evaluation among teachers.

Information integration technology is mainly responsible for mobilizing various data. At the same time, the main way of information integration is to integrate various heterogeneous data sources, and realize data and information sharing while adjusting the consistency of data structure. This paper designs a multi-dimensional teaching effectiveness evaluation system based on information integration. In the hardware part of the system, RC punching and discharging circuits are used, and TTL level is converted to PC communication mode; In the software part of the system, by identifying the characteristics of multidimensional teaching effect evaluation elements, it is divided into evaluation subjects, and uses information integration technology to optimize the system software functions, extract and modify the system log intermediate table. The experimental results show that the average CPU usage of the designed system is lower than that of the comparison system, indicating that the performance of the system in this paper is superior and can effectively improve the quality of teaching evaluation.

## 2 System Hardware Design

The hardware of this designed multi-dimensional teaching effect evaluation system mainly includes parts such as power supply, serial port, reset circuit and clock signal. The main peripheral circuit interfaces are RS232 serial port and IIC interface circuit, and the digital tube is of 7 segments or more. In order to provide a stable and reliable current and voltage for the whole multidimensional teaching effect evaluation system, the power input method of this system is set to two ways. The two ways are: using the USB interface as a carrier to obtain +5 V power supply; the other is using the power socket as an input port and directly accessing the corresponding AC power supply. The advantage of the former is that it is simple to operate and only requires a computer and

USB cable to be prepared in advance for stable +5 V voltage transmission. In addition to the power supply circuit, the system's clock circuit has to be adjusted accordingly. As some signal interference will inevitably occur in the process of serial communication. The working frequency accuracy of 10.5026 MHz crystal is very high, and after precise adjustment and testing, its frequency stability and accuracy are very high. And the 10.5026 MHz crystal has high reliability, can operate stably in harsh environments, and has good high-temperature resistance. This is particularly important for devices and systems that require high performance in complex environments, long working hours, and require high performance. Therefore, the hardware of the multi-dimensional teaching effectiveness evaluation system designed this time uses a 10.5026 MHz crystal, and the reset circuit of the multidimensional teaching effect evaluation system hardware is set on the basis of the power supply circuit and the clock circuit. According to the needs of the experimental test, the RC punch and discharge circuit is chosen, which only needs to ensure that the system can be quickly reset during the debugging process. The reset circuit diagram of the hardware of the multidimensional teaching effect evaluation system is shown in Fig. 1.



**Fig. 1.** Reset circuit diagram of the hardware of the multidimensional teaching effectiveness evaluation system

In Fig. 1, the reset circuitry needs to match the user application and operating frequency to select the optimum power operation mode, influenced by the performance of the microcontroller in the hardware. In addition to the above circuitry, the erase function of the audio memory is one of the experiences that affect the use of the system. Often, systems need to be repeatedly debugged under specific conditions during the development and programming process. It is therefore essential to select audio memory that can be erased and written repeatedly. In addition, the two ends of the serial port were connected to the PC port and the peripheral circuit RS232 serial port respectively, while ensuring that the development board of the microcontroller was properly powered up.

In this design of the multi-dimensional teaching effectiveness evaluation system, 8 and more diodes are selected for the light emitting diode circuit. Ensure that the entire circuit can be lit when the output level is low and can be extinguished when the output level is high. Due to the strong conversion performance of the MAX232 level, it is also possible to convert the TTL level to PC communication mode as well after accessing the RS232 serial port. According to the above settings, the operating frequency range in

the system is set to 10–50 MHz, ensuring that its operating frequency is kept at around 45 MHz. At the same time, three to five 16-bit timers are set in the system, and one of them is used as the main counter, while the rest of the counters can be used as several 8-bit counters. In order to be compatible with several models of microcontrollers at the same time, the PowerDown mode is introduced in the system and increased to 5 with the guarantee of two basic external interrupts INT.

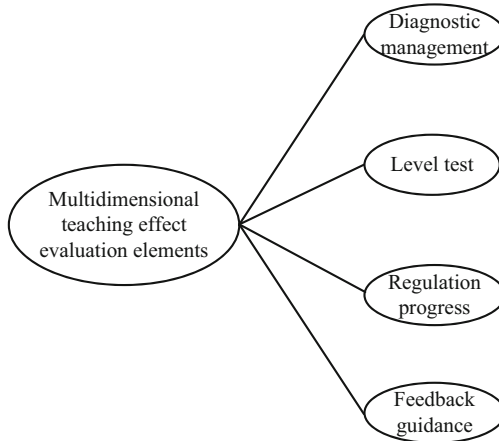
During the interrupt process, the original wake-up method is used as a technical guarantee to set up branches that can be triggered by external interrupts at low level. At the same time, in order to improve the anti-interference capability of the communication serial port, the ALE clock signal is adjusted to disable the output, which also suppresses power jitter to a certain extent. When the external clock frequency is reduced, the system microcontroller will be in 6T mode for a long time. Based on the above description, the steps to design the hardware of the multi-dimensional teaching effect evaluation system are completed.

### 3 System Software Design

#### 3.1 Identifying the Characteristics of Multidimensional Teaching Effectiveness Evaluation Elements

Multidimensional teaching effectiveness evaluation is based on multiple dimensions and uses multiple criteria to measure the performance of teachers throughout the teaching process. Multidimensional teaching effectiveness evaluation is a comprehensive and objective evaluation of the teaching implementation process and student learning effectiveness, in order to understand the quality of teaching effectiveness, the intensity of teaching activities, and the learning status of students, in order to timely identify problems, adjust teaching strategies, improve teaching methods, and improve teaching quality. It is also a model for testing the quality of teaching and learning that incorporates planning and objectives. As a common means of evaluating teaching quality, it can be divided into three main subjects, namely teachers, learners and administrators [4, 5]. The basic elements of the teaching and learning process have been broadly encompassed in terms of the teaching dimension of the teacher, the learning dimension of the student and the management dimension of the school. Combined with the above descriptions, the elements of evaluation of multidimensional teaching effectiveness can be summarised in the following four points, as shown in Fig. 2.

As can be seen from Fig. 2, the evaluation elements of multidimensional teaching effectiveness mainly include four levels: level checking, diagnostic management, feedback and guidance, and regulation of progress. Level check: Level check is the foundation of multidimensional teaching effectiveness evaluation, mainly including the inspection and evaluation of students' knowledge, skills, and attitudes, in order to have a basic understanding of students' actual level and potential problems. The elements of proficiency check include: mastery of basic knowledge, mastery of skills, attitude, and values. Diagnosis management: Diagnosis management mainly focuses on the problems that students encounter during the learning process, using various methods to conduct comprehensive analysis, identify the root causes, and promptly adopt targeted teaching methods and management measures, so that students can truly master the knowledge and



**Fig. 2.** Elements of evaluation of multidimensional teaching effectiveness

skills they have learned and improve. Diagnostic management elements include: analyzing student differences, scientific diagnosis, problem positioning, and problem-solving solutions. Feedback guidance: Feedback guidance mainly aims to provide targeted guidance and suggestions to students through timely transmission of student performance and performance feedback, helping them summarize their experiences, identify deficiencies, correct problems in a timely manner, and make rapid progress and improve learning outcomes. The elements of feedback guidance include: performance feedback, performance analysis, providing personalized guidance, encouragement, and motivation. Progress adjustment: Progress adjustment mainly refers to the scientific planning and adjustment of the progress in the teaching process to adapt to students' learning progress and characteristics, and ensure that the teaching achieves the expected results. The elements of progress adjustment include: teaching schedule planning, synchronous adjustment of teaching and learning, adjustment of teaching methods and means, and adjustment of teaching duration. Based on these four levels of evaluation, the overall quality of teaching can be judged to be at a certain level, and the subsequent teaching plan can be adjusted according to the evaluation results.

As a rule, the students are the focus of the training and their academic performance is a visual indication of the level of teaching at a given stage and allows the teacher to see how they compare with other teachers in the overall teaching environment. Although there may be some subjective elements in the evaluation process, the overall results of student evaluations are credible in light of the data from the research data. From the teacher's perspective, the multidimensional teaching effectiveness evaluation system includes personal evaluation, evaluation by others and mutual evaluation. From the learner's point of view, this includes logging into the system, making remarks, marking and evaluating and managing the evaluation. Evaluation includes aspects such as teaching attitude, teaching management and the use of modern multimedia. From the level of school management, this includes teaching effectiveness evaluation maintenance, comment management maintenance, and speech warning control.

Combined with the principle of the role of information integration, the system should fully understand the links between the various teaching effectiveness evaluations and identify commonalities and differences in order to achieve data integration and information integration of teaching effectiveness. From a multi-dimensional standpoint, the evaluation of teaching effectiveness should not only be limited to students' report cards, but also consider aspects such as teaching attitudes, students' interest in learning and teacher-student relationships. In today's increasingly diverse teaching formats, teaching effectiveness evaluation should also be adjusted in the direction of diversity and democratisation [6].

According to different evaluation criteria, a variety of evaluation types can be summarised for different scenarios. From the point of view of the teaching process, multi-dimensional evaluation of teaching effectiveness focuses on the continuous acquisition of information and the continuous improvement of the teaching model through data and information, i.e. on the process as opposed to the results. The overall evaluation is more global in nature and requires the evaluation of teaching effectiveness after all teaching sessions and interactions have been completed. The essence of multidimensional assessment of teaching effectiveness is to ensure that each student gains in knowledge or life experience by means of scoring, so it is important to examine the teacher's level while still basing the assessment on the student's experience. Based on the above description, the steps to identify the characteristics of the elements of multidimensional teaching effectiveness evaluation are completed.

### 3.2 Information Integration Optimisation System Software Features

Information integration presupposes that all data and information is open and transparent in order to ensure that users in the system are independent of each other [7, 8]. The ultimate goal is that both the heterogeneous data sources and the distribution of educational information are transparent, but not directly accessible to the users of the system. The transparent distribution of educational information required by information integration consists of two aspects, namely the transparency of the location where the data is located and the transparency of the storage path [9]. This is to ensure that the system host can extract the required data at any time without the need for additional sorting. At the same time, in order to enhance the sense of use for system users, it is necessary to set up separate storage paths for local data and remote data, and to provide the corresponding device directories by the system for system users to choose from. Teaching data and teaching information can usually form the structure of a single data image after the information has been integrated. The concept of neural network is introduced in the system software to optimise the data and information integration structure of the system software with the following expression formula:

$$G = \sum \exp(\alpha - 1)^2 \times \frac{\alpha}{d} \quad (1)$$

In Eq. (1),  $\alpha$  indicates the number of nodes in the network adoption number, and  $d$  indicates the output weight of the data information in the system. In a multidimensional teaching effectiveness evaluation system, student examination results can directly reflect the effectiveness of teaching at a certain stage. In order to produce more accurate

evaluation results, the relationship between the difficulty of the examination paper and the examination results is defined, resulting in the expression formula:

$$H = \frac{L}{\delta} \times \left( \frac{d}{r} \right) - L \quad (2)$$

In Eq. (2),  $L$  represents the average time taken by the students in the paper,  $\delta$  represents the number of questions,  $r$  represents the number of knowledge points and  $d$  has the same meaning as in Eq. (1). Combining formula (1) and formula (2) yields the formula for the fitness function, as shown below:

$$y = \frac{h}{\eta} + \frac{1}{\phi} + \frac{L}{h} + \sum |\phi - \eta| \quad (3)$$

In Eq. (3),  $h$  represents the error of data integration in the system,  $\eta$  represents the data integration rate,  $\phi$  represents the data weights and  $L$  has the same meaning as Eq. (3).

In the system software, information integration technology is used to make a series of data on the browsing traces of teachers, students and school administrators in the system and to set up a visualisation module of the system to facilitate system improvement and upgrading during subsequent use. The data stored in the database is first extracted and collated into the log information required by the user, and duplicate data is eliminated when carrying out multidimensional teaching effectiveness evaluation. Amongst other things, there are also many-to-one and many-to-many correspondences between teachers and students in the system database. To ensure that the data structure is standardised, the intermediate tables of the system logs are extracted and revised. In addition, the diversity of the evaluation of teaching effectiveness, lecture progress and classroom atmosphere has to be highlighted in the system to meet the needs of curriculum reform [10]. For the user, as long as the local data and the heterogeneous data sources are transparent, it is possible to ensure that the data remains consistent with the original data after the next login to the system. Based on the basic functions of the system software, the multidimensional teaching effectiveness evaluation can be divided into four modules, namely the information login module, the system management module, and the registration evaluation module. Based on this, the steps to optimise the functionality of the system software using information integration are completed.

## 4 System Testing

As the multidimensional teaching effectiveness evaluation system is designed to be used primarily in a teaching environment, both ease of application and operability need to be taken into account. The following is a test of the system based on practical application needs.

### 4.1 Test Preparation

The hardware configuration of this system test is mainly: Windows 10 Education Edition, 2.5 GHZ, i7 4720hq + GTX 965 m, memory 4G, hard disk 350G; development

language: PHP, Bootstrap front-end framework, C#, python, CSS; database: Mysql database; development platform: Zend Studio.

The language environment for this test is not limited by hardware conditions and has the advantage of being highly readable and at the same time highly portable. A compiler with automatic management is embedded in the system to ensure automatic allocation of system registers. As the data structures in the programming process take up different space, the variables need to be assigned after full consideration of the application scenario. Different data ranges are set for different types of data to drive reasonable allocation by the compiler.

To ensure that different numbers of IIC bus devices can be bundled smoothly onto the same root bus, synchronous communication is used for programming. In some modules, the system is required to provide power-down protection, in which case a chip-switching function is introduced in time. Data with significant changes are extracted to the host display and displayed on the corresponding digital tube according to the needs of the system test. Also, in order to solve the compatibility problem between the plug-in and the system, an additional SDK installation package needs to be downloaded and imported into the system. In this experiment, the main board of the system hardware was modelled in a stand-alone manner, docking the interfaces and components of each part.

## 4.2 Analysis of Test Results

The test selected the RBF-based multidimensional teaching effectiveness evaluation system, the UML-based multidimensional teaching effectiveness evaluation system, and the SSH-based multidimensional teaching effectiveness evaluation system, and the multidimensional teaching effectiveness evaluation system designed here for comparison testing. The CPU usage of the four types of multidimensional teaching effectiveness evaluation systems were tested under different concurrent user numbers, and the experimental results are shown in Tables 1, 2, 3 and 4.

According to the experimental results in Table 1, when the number of concurrent users is 80, the highest CPU utilization rate of the multidimensional teaching effectiveness evaluation system designed in this article is 3.115%. The highest CPU utilization rate of the SSH based multidimensional teaching effectiveness evaluation system is 5.447%. The highest CPU utilization rate of the UML based multidimensional teaching effectiveness evaluation system is 5.206%. The highest CPU utilization rate of the RBF based multidimensional teaching effectiveness evaluation system is 5.048%, And the average CPU usage of the multi-dimensional teaching effectiveness evaluation system designed in this article is lower than the other three multi-dimensional teaching effectiveness evaluation systems: 1.729%, 1.635%, and 1.755% respectively.

According to the experimental results in Table 2, when the number of concurrent users is 240, the highest CPU utilization rate of the multidimensional teaching effectiveness evaluation system designed in this article is 7.152%, the highest CPU utilization rate of the SSH based multidimensional teaching effectiveness evaluation system is 14.112%, the highest CPU utilization rate of the UML based multidimensional teaching effectiveness evaluation system is 13.546%, and the highest CPU utilization rate of the RBF based multidimensional teaching effectiveness evaluation system is 13.005%, And the average CPU usage of the multi-dimensional teaching effectiveness evaluation

**Table 1.** CPU usage (%) for systems with 80 concurrent users

Number of experiments	Multidimensional teaching effect evaluation system based on RBF	Multidimensional teaching effect evaluation system based on UML	Multidimensional teaching effect evaluation system based on SSH	The multidimensional teaching effectiveness evaluation system designed for this occasion
1	4.510	3.188	4.516	3.002
2	3.694	4.007	3.418	2.499
3	4.225	3.654	5.216	2.106
4	5.048	4.901	4.815	3.114
5	4.602	3.788	5.447	2.848
6	4.129	4.615	3.744	2.316
7	4.317	3.815	4.006	2.009
8	5.008	5.206	3.447	3.115
9	3.679	3.991	3.599	2.557
10	3.775	4.887	5.044	2.133

**Table 2.** CPU usage (%) for systems with 240 concurrent users(%)

Number of experiments	Multidimensional teaching effect evaluation system based on RBF	Multidimensional teaching effect evaluation system based on UML	Multidimensional teaching effect evaluation system based on SSH	The multidimensional teaching effectiveness evaluation system designed for this occasion
1	12.165	13.545	12.649	6.461
2	11.084	12.165	13.474	7.152
3	10.916	13.119	12.545	6.169
4	9.668	12.774	13.774	5.023
5	11.215	13.004	12.912	5.889
6	12.446	12.466	13.660	5.474
7	11.548	12.877	12.748	6.324
8	12.779	13.546	12.466	5.159
9	11.464	12.779	13.899	6.337
10	13.005	13.545	14.112	5.852

system designed in this article is lower than the other three multi-dimensional teaching effectiveness evaluation systems: 5.645%, 6.998%, and 7.240%, respectively.

**Table 3.** CPU usage (%) for systems with 480 concurrent users(%)

Number of experiments	Multidimensional teaching effect evaluation system based on RBF	Multidimensional teaching effect evaluation system based on UML	Multidimensional teaching effect evaluation system based on SSH	The multidimensional teaching effectiveness evaluation system designed for this occasion
1	26.316	25.910	23.645	12.336
2	24.715	24.778	24.818	11.089
3	22.004	26.141	24.461	11.748
4	23.991	25.097	23.847	11.524
5	25.008	24.711	22.007	12.775
6	24.719	25.912	23.649	11.519
7	23.656	25.446	22.541	12.073
8	22.076	24.078	23.877	12.334
9	23.449	24.933	24.059	11.872
10	24.578	23.545	23.748	12.069

According to the experimental results in Table 3, when the number of concurrent users is 480, the highest CPU utilization rate of the multidimensional teaching effectiveness evaluation system designed in this article is 12.775%, the highest CPU utilization rate of the SSH based multidimensional teaching effectiveness evaluation system is 24.818%, the highest CPU utilization rate of the UML based multidimensional teaching effectiveness evaluation system is 25.912%, and the highest CPU utilization rate of the RBF based multidimensional teaching effectiveness evaluation system is 26.316%. And the average CPU usage of the multidimensional teaching effectiveness evaluation system designed in this case is lower than the other three multidimensional teaching effectiveness evaluation systems: 12.117%, 13.121%, and 11.731%, respectively.

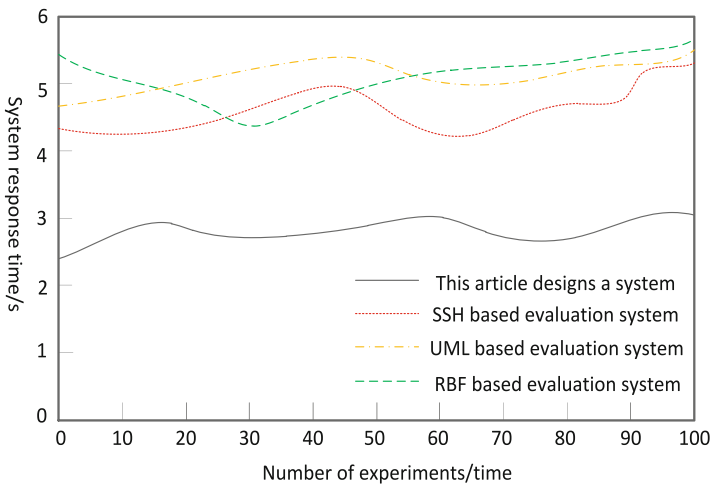
According to the experimental results in Table 4, when the number of concurrent users was 800, the multidimensional teaching effectiveness evaluation system was lower than the other three multidimensional teaching effectiveness evaluation systems in terms of CPU usage: 20.095%, 22.691% and 19.420% respectively. According to the experimental results, when the number of concurrent users increased, the CPU usage of all four systems increased, but the results of the experiment were always lower than those of the other three systems, indicating better operability in use.

To further validate the practicality of the method proposed in this article, a multidimensional teaching effectiveness evaluation system based on RBF, a multidimensional

**Table 4.** CPU usage (%) for systems with 800 concurrent users(%)

Number of experiments	Multidimensional teaching effect evaluation system based on RBF	Multidimensional teaching effect evaluation system based on UML	Multidimensional teaching effect evaluation system based on SSH	The multidimensional teaching effectiveness evaluation system designed for this occasion
1	45.161	45.356	39.464	22.745
2	44.315	44.112	41.499	23.466
3	43.202	46.913	42.077	21.849
4	44.969	44.202	40.336	20.591
5	45.416	45.913	41.549	23.007
6	43.915	44.735	42.883	22.493
7	39.466	46.004	41.964	21.748
8	38.452	45.822	42.718	22.946
9	39.078	44.913	43.553	23.467
10	41.167	43.125	42.349	21.877

teaching effectiveness evaluation system based on UML, and a multidimensional teaching effectiveness evaluation system based on SSH were used as experimental indicators for comparative testing. The test results are shown below.



**Fig. 3.** Comparison of Response Time of the System

According to Fig. 3, it can be seen that the response time of the system designed in this article is around 3 s, while the response time of the comparison system is around 5 s. The response time of the system designed in this article is significantly lower than that of the comparison method, indicating that the efficiency of the system in this article is higher and more practical.

## 5 Conclusion

With the continuous development of information technology, corresponding teaching models and methods of evaluating teaching effectiveness are also undergoing changes. Combining the existing multimedia technology and applying the emerging information integration technology to teaching evaluation is an effective way to improve teaching. Therefore, studying a multidimensional teaching quality evaluation system suitable for the transformation of applied technology universities is of great significance. In this regard, this paper studies the design of multidimensional teaching effectiveness evaluation system based on information integration. The multidimensional teaching effectiveness evaluation system in this paper integrates a variety of influencing factors and provides reliable materials for the academic community to carry out relevant research. At the same time, it provides a feasible basis for the application of information integration technology to a certain extent, and also responds to the call for teaching reform in essence. At the technical level, the functionality of the system software has been optimized, and the efficiency of the multidimensional teaching effectiveness evaluation system has been improved. Due to limited research conditions, the accuracy of the multidimensional teaching effectiveness evaluation system designed in this study still needs further testing and improvement based on test data.

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