Design of Mobile Education Evaluation System for College Students Based on Digital Badge Technology - Taking Legal Education as an Example

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Abstract. In the process of education evaluation, a lot of analysis and calculation are needed for different parameters. Once the original data is abnormal, the reliability of the evaluation results will be greatly reduced. Therefore, a design of mobile education evaluation system for college students based on digital badge technology is proposed - taking legal education as an example. In hardware design, FK-SK7-M2 is used as the storage device of the system to meet the data management requirements of the system, and STC12C5A60S2 is used as the digital terminal microprocessor of the system to meet the operation requirements of the evaluation system. In the aspect of software design, the digital badges with visual images are designed and classified according to the educational objectives. In the stage of education evaluation, the principal component analysis method is introduced, and with the help of an orthogonal transformation T, the original random digital badge vector whose components are related is transformed into a new random digital badge vector whose components are not related, and the contribution rate of the cumulative eigenvector in the covariance matrix is used to achieve the final teaching evaluation. In this test result, the evaluation result error of the design system for the sample data is stable within 0.15, and the average evaluation accuracy is 98.49%, with high reliability.

Keywords: Digital Badge Technology · Educational Evaluation · Digital Terminal Microprocessor · Principal Component Analysis · Random Number Badge Vector · Cumulative Eigenvector

1 Introduction

The evaluation of educational quality in colleges and universities is a relatively complex problem. The evaluation of educational quality includes many factors, such as educational conditions, curriculum difficulty, teacher education, and learning effects. They interact with each other. At the same time, the relationship between teachers and students is complex, and there are many factors that affect the quality of education [1]. At present,

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there is no recognized and ideal educational quality evaluation system. As far as the current research situation is concerned, it focuses on three aspects: the first is the research on the evaluation subject, the second is the research on the content of the education quality evaluation system, and the third is the research on how to finally evaluate the education quality grading method after the indicators in the system are determined [2]. First of all, the study of the subject of education quality evaluation. There are many ways or methods to evaluate the quality of education, such as teacher self-evaluation, peer evaluation, administrative leadership evaluation, expert evaluation, and student evaluation of teachers [3]. Due to the different roles of evaluation subjects, their roles in evaluation should be different. Each evaluation method and its results are only a part of education quality evaluation, not the whole of education quality [4]. Due to the large number of college teachers and the frequent evaluation times, if the organization leaders and peer experts adopt the evaluation method of census, it will not only take time and effort, but also be difficult to operate because it is impossible to exclude the influence of interpersonal relationships, unfamiliar with the education process and other factors [5]. Therefore, the way of student oriented education quality evaluation of teachers is widely adopted by most colleges and universities. Since the 1980s, colleges and universities have gradually carried out student evaluation of teaching activities, which has played a certain role in promoting the quality of education in colleges and universities [6]. As the direct object of education, students have the right and ability to evaluate teachers' education. Due to the diversity of types of colleges and universities, the complexity of majors, and the uneven level of students, the requirements for teachers' education quality evaluation are also different [7]. The second is to determine the content of education quality evaluation. When designing the content of the education level evaluation system, it is difficult to quantify the role of a teacher in a certain course or learning stage because learning and development is a continuous process and the learning and growth environment is diverse [8]. Generally, curriculum performance is not the main indicator, or education effect is not the main indicator, The evaluation content is put on the education process [9]. From the perspective of process management, the school education process is manifested in the interaction of multiple factors and the combination of multiple links. It is also difficult to compare the education of different subjects, different courses, different education links, and different teaching objects. There is personal bias among evaluators in the process of educational evaluation, which makes the evaluation results not objective. In addition, inconsistent scoring standards may also lead to deviations in the evaluation results. Education evaluation usually relies on students' exam scores, neglecting their comprehensive abilities and potential, and this indicator evaluation cannot fully reflect their actual level and development. Therefore, the consideration of the education quality evaluation system is mainly designed from the most basic factors that can directly reflect the education level and have commonalities.

From the existing education level evaluation system, the design of indicators is mainly reflected in the following aspects. Education attitude, whether the education is serious and responsible, whether the class spirit is full, whether the lesson preparation is sufficient, and whether the coaching, question answering, and homework correction are serious. Whether the education content, content selection and processing are appropriate, whether the concept is accurate and clear, whether the key points are prominent, whether the difficulty and depth are appropriate, whether the theory is closely linked with the practice, and whether the content is rich. Whether the teaching ability and organization are clear, Whether the language is vivid, concise and attractive, whether the key points and difficulties are described accurately, and whether the blackboard writing is neat. Whether the education methods are individualized and flexible, whether they focus on inspiring students' innovative awareness and ability, and whether they focus on communication and interaction with students. To teach and educate people, whether they are rigorous and exemplary in their studies, and whether they are strict and fair in their requirements for students. Education effect: whether it can promote students to think positively, whether students' scores are improved, and whether students have a comprehensive grasp of knowledge points. Because different schools have different understanding and emphasis on education quality, there are certain differences in the content of evaluation. Analyze the current evaluation methods of education quality. After the establishment of each indicator system in the education quality evaluation system, certain methods should be used to process these data, to get the final education quality level. However, the corresponding evaluation methods have played a positive role in improving the quality of education and promoting the level of teacher education, but these methods have certain shortcomings. The traditional teaching quality evaluation method and fuzzy comprehensive evaluation method can no doubt get rid of the direct influence of human factors on the evaluation results. The Markov chain evaluation method only evaluates students' transcripts, which obviously has a great one-sided nature.

For this reason, this paper takes legal education as an example, proposes the research on the design of mobile education evaluation system for college students based on digital badge technology, and analyzes and verifies the operation performance of the design system through comparative testing. In terms of hardware, FK-SK7-M2 is used as the storage device of the system, and operating parameters are set according to its configuration. The microprocessor selected for the system is the STC12C5A60S2 chip, which has fast speed, low power consumption, and strong anti-interference ability, and can meet the operational requirements of the system. In terms of software, the digital badge designed using the evaluation gauge correlation model has strong objectivity and can provide reliable data support. The principal component analysis method is used to achieve comprehensive evaluation of mobile education for college students.

2 Design of Mobile Education Evaluation System for College Students

The mobile education evaluation system for college students includes hardware and software parts. The overall structure of the mobile education evaluation system for college students is shown in Fig. 1.

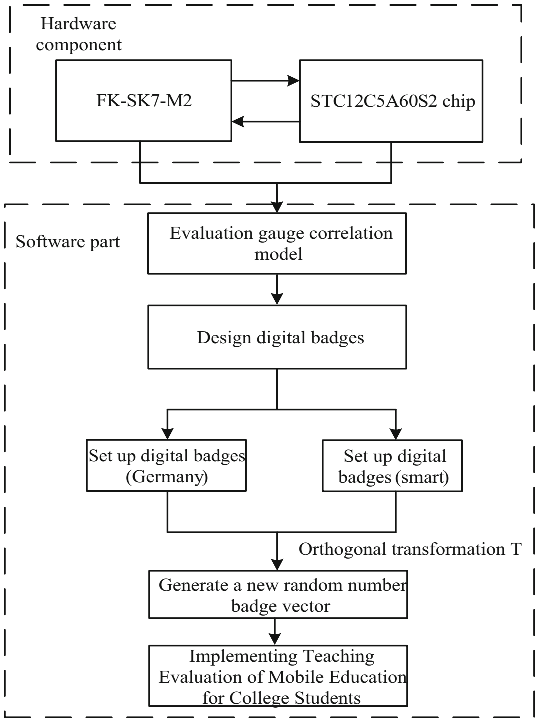

Fig. 1. Structure of Mobile Education Evaluation System for College Students

From Fig. 1, it can be seen that the hardware part mainly consists of FK-SK7-M2 and STC12C5A60S2 chips. The software part mainly designs digital badges through the evaluation gauge correlation model, setting up digital badges (German) and digital badges (intelligent) respectively. By using orthogonal transformation T, a new random number badge vector is generated to achieve the design of a mobile education teaching evaluation system for college students.

3 Hardware Design

3.1 Storage Device Design

Considering that the mobile education evaluation system for college students designed in this paper is based on digital badge technology, and the yin deficiency needs to analyze and mark large-scale data, FK-SK7-M2 is used as a storage device. In terms of structure, FK-SK7-M2 adopts a single board design and a 2-bay bit group Raid 0. In addition, FK-SK7-M2 also adopts the Fengke NVME storage architecture, which has the characteristics of miniaturization, low power consumption and standard eXFAT file system. The relevant basic parameter information is shown in Table 1.

Table 1. FK-SK7-M2 Basic Parameter Information

Index	Parameter
Working temperature	Standard temperature: 0 °C to +55 °C Military temperature: -40 °C to + 70 °C (optional, only some hard drives are used, bandwidth reduced)
Heat dissipation method	Compatible with air cooling and air cooling, supporting structural customization
Power waste	Full load operation $\leq$ 20 W
Dimensions	92. 00 mm x 69. 00 mm
Data interface	2 $\times$ GTH $\times$ 1, supports AURORA, SRIO protocols
Control interface	10 Gigabit Ethernet ports/1 Gigabit Ethernet port

It can be seen from the information shown in Table 1 that FK-SK7-M2 provides a 2-way 10G high-speed interface to the outside world, and can provide FTP or network disk access functions through the gigabit network interface. This attribute feature meets the data management requirements of the system to a great extent. Figure 2 shows the configuration of FK-SK7-M2.

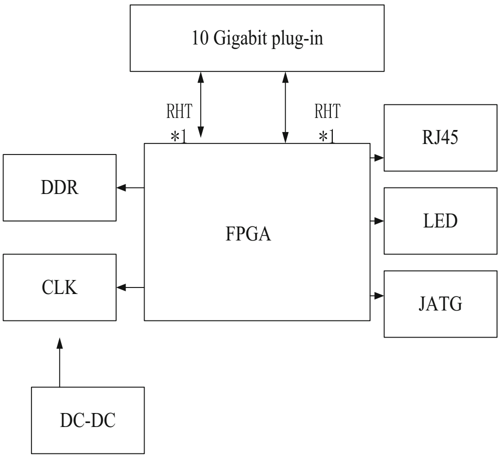

Fig. 2. Schematic diagram of FK-SK7-M2 configuration

In combination with the above configuration settings, the operation parameters of FK-SK7-M2 are shown in Table 2.

With the help of the configuration of operation parameters shown in Table 2, FK-SK7-M2 can be widely used in data acquisition, record storage and data management in related fields, and has high applicability to the mobile education evaluation system for college students designed in this paper.

Table 2. FK-SK7-M2 Operation Parameter Information

Index	Parameter
Storage capacity	Supports 2 NVMe SSDs with M. 2 interfaces; Capacity support for 2TB/4TB/8TB/16TB with multiple specifications available
Storage bandwidth	Continuously stable recording bandwidth ≥ 2GB/s; Continuously stable read bandwidth ≥2 GB/s
File management	Standard File System (exFAT File System)
Control protocol	The network adopts standard FTP communication protocol; Support standard FTP tools for accessing files
Download bandwidth	Gigabit Ethernet port ≥100 MB/s; 10 Gigabit Ethernet port ≥ 1000 MB/s
Software function	Real time recording function, data playback function, data access, online file management function, self inspection and fault detection function, abnormal fault tolerance protection mechanism, and other functions

3.2 Model Selection of Digital Terminal Microprocessor

Since cost control and energy consumption reduction should be considered in the project, the microprocessor itself is required to support low-power design with high integration, and include as many functional peripheral modules as possible, such as multi-channel I/O, analog-to-digital conversion, timer, UART serial communication, etc. required by the system. At the same time, it is necessary to respond to the sampled signals in a fast and real-time manner for processing and judgment, which has certain requirements on the processing speed of the microprocessor. The 1T enhanced series 51 single chip microcomputer produced by domestic STC company has great competitive advantages. The STC series 51 single chip microcomputer is compatible with 8051 instructions and pins, and its internal integrated large capacity memory is FLASH process. The FLASH ROM of STC12C5A60S2 single chip microcomputer is up to 60K. With this process memory, users can easily erase and rewrite instantaneously by using electricity. STC series MCU supports.

Serial program programming 1381. To sum up, STC series MCU has very low requirements for developing equipment, and the development time is also greatly shortened. At the same time, this series of MCU can encrypt the programs written into it, which also protects the labor achievements of developers. In comprehensive consideration, the microprocessor model selected for this project is STC12C5A60S2 chip. It is a new 8051 single chip computer produced by Hongjing Science and Technology, whose speed is 8–12 times faster than the traditional 8051 single chip computer. It has the advantages of high speed, low power consumption and super anti-interference. Internal integrated MAX810 special reset circuit, 2-way PWM, 8-way 10 bit high-speed AD conversion, for motor control, strong interference occasions. The STC12C5A60S2 single-chip microcomputer mainly has the following characteristics:

(1) High speed: 1 clock/machine cycle, enhanced 8051 core, 6~12 times faster than ordinary 8051.
(2) Wide voltage: 5.5~4. 0 V, 2.1 ~3. 6 V.
(3) Add the second reset function pin/P4. 6 (high reliable reset, adjustable reset threshold voltage, when the frequency is less than 12 MHz, it is unnecessary to add an external power down detection circuit/P4. 6, which can save the data into EEPROM in time when the power is down, and it is unnecessary to operate EEPROM during normal operation.
(4) Low power design: idle mode (can be awakened by any one interrupt).
(5) Low power consumption design: power-off mode (wake-up by external interrupt), which can support falling edge/rising edge and remote wake-up.

Pins supporting power down wake-up: P3. 2/INTO, P3. 3/INTI, T0/P3. 4, TI/P3. 5, RxD/P3. 0, P1. 3/CCP0 (or P4. 2/CCP0), P1. 4/CCP1 (or P4. 3/CCP1), EX_LVD/P4. 6.

(6) Operating frequency: 0 ~35 MHz, equivalent to common 8051: 0~420 MHz.
(7) Clock: optional external product or internal R/C oscillator, 8/1 6/32/40/48/56/60/62K byte on-chip Flash program memory is set when ISP downloads the programming user program, with more than 100000 erasures.
(8) 1280 byte on-chip RAM data memory.
(9) High capacity on-chip EEPROM function, ISP/AP with more than 100000 erasures, programmable in the system/programmable in the application, without programmer/emulator.
(10) 8-channel, 10 bit high-speed ADC, speed up to 250000 times/second, 2-way PIM can also be used as 2-way D/A.
(11) The 2-channel capture/comparison unit (CCP/PCAPWM) can also be used to implement 2 more timers or 2 external interrupts (support rising edge/falling edge interrupts).
(12) Two 16 bit timers (compatible with common 8051 timer T0/T1), and two more timers can be realized by 2-way PCA.
(13) Programmable clock output function (TO outputs clock at P3. 4, TI outputs clock at P3. 5, BRT outputs clock at P1. 0.

In addition, STC12C5A60S2 is also equipped with an independent baud rate generator and SPI high-speed synchronous serial communication interface dual serial ports. With the support of full duplex asynchronous serial port (UART), it is compatible with the common 8051 serial port. Time sharing multiplexing can be used as three groups. In terms of structure, STC12C5A60S2 is an advanced instruction set structure that is compatible with the common 8051 instruction set. It has hardware multiplication/division instructions. It uses the common I/O ports (36/40/44), and after reset, it is a quasi bidirectional port/weak pull-up (common 8051 traditional I/O ports). In the specific operation process, it can be set into four modes, quasi two-way port/weak pull-up, strong push pull/strong pull-up, which are only input/high resistance, so as to meet the operation needs of the mobile education evaluation system for college students in different states.

4 Software Design

4.1 Digital Badge Design

Digital badges, as digital stamps and marks in an online environment, facilitate timely feedback in classroom teaching. For this reason, this paper designs an intuitive digital badge. Figure 3 is the schematic diagram of the digital badge in the system.

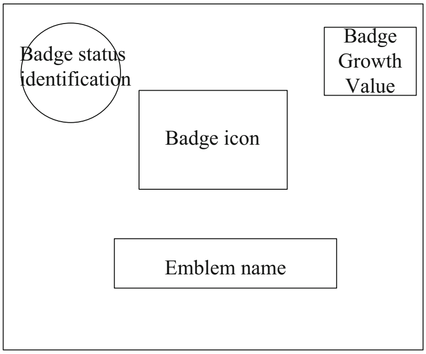

Fig. 3. Schematic diagram of digital badge

Class teaching time is very limited. Only the badges needed by teachers are presented. Teachers can find the badges they need faster to issue when evaluating, improve the efficiency of badge issuance, and complete the timely evaluation of classroom teaching. Students can also check their badges when logging into the evaluation system. Schematic diagram of the digital badge seen in the student port. Students can see the name of each badge and its corresponding growth value, the discipline in which it was obtained, and the specific time when it was obtained. The design of this evaluation system and the development team designed this system to develop a digital badge evaluation system for students in the field of comprehensive quality evaluation. This system involves a large number of evaluation systems, including.

The setting of character badges is also rich in variety, involving morality, intelligence, physique, beauty, labor and other aspects. However, the original digital badge in the system.

It is not necessarily appropriate for the needs of information technology classroom teaching. Therefore, this paper analyzes the preliminary proposed basis.

Based on the mobile education evaluation system of digital badges, combined with the correlation model of digital badges and evaluation gauges, 18 key badges are selected as the key research data of this study. The set digital badges are shown in Tables 3 and 4.

According to the way shown above, the digital badge is designed to provide a reliable data basis for subsequent education evaluation.

4.2 Analysis and Evaluation of Education Quality

Combined with the digital badges constructed above, this paper uses principal component analysis to analyze and evaluate the quality of education. When analyzing and processing

Table 3. Digital Badge Attribute Settings (Germany)

Emblem name	Badge Growth Value	Student activities
Attendance on time	1	Attend classes in the computer classroom on time
Bring books to class	1	Teaching with information technology textbooks
Discipline Pacesetter	1	Adhere to classroom discipline
Best Group	2	Class teacher, actively helping classmates solve learning difficulties The problem of arrival
Be ready to help others	1	Exhibition and others

teaching data, the samples involved often contain multiple variables, and more variables will bring complexity to the analysis problem. However, these variables have a certain dependence on each other, that is, they often have a certain degree, sometimes even quite high correlation with each other, which makes the information in the observation data overlap to a certain extent [10]. In this paper, the mechanism of principal component analysis can be simply stated as follows: with the help of an orthogonal transformation T, the original random number badge vector whose components are related is transformed into a new random number badge vector whose components are not related.

On the one hand, the original random number badge vector covariance matrix is transformed into a diagonal matrix, and on the other hand, the original coordinate system is transformed into a new orthogonal coordinate system, so that it points to the p orthogonal directions where the sample points are scattered most widely, and then the multi-dimensional variable system is reduced in dimension, so that it can be converted into a low dimensional variable system with a high precision. The covariance matrix V and the correlation coefficient matrix R are a measure of the degree of correlation between various components of the random number badge variable x, and contain rich information. From the perspective of refining information, people hope to transform them into diagonal matrices through an orthogonal transformation, and each component of the new random digital badge vector generated from them will become irrelevant.

Let the digital badge orthogonal matrix to be sought T by:

$$T = [t_1, t_2, ..., t_p]_{t*t} \tag{1}$$

Among them, $t_j = [t_{1j}, t_{2j}, ..., t_{pj}]^T$, and j = 1,2,., p.
Generated new random number badge vector u by:

$$u = [u_1, u_2, ..., u_p]^T \tag{2}$$

Then there is:

$$u = T^T x \tag{3}$$

Table 4. Digital Badge Attribute Settings (Smart)

Emblem name	Badge Growth Value	Student activities
Interactive experts	1	Actively raise your hand to answer questions
question answering	1	Answer the teacher's questions correctly
A knowledgeable listener	1	Listen attentively to the class
Finish one's homework	1	Complete learning tasks
Excellent homework	2	High quality completion of assignments (integrity, creativity Artistry, etc.)
Rich imagination	2	Proficient in thinking from multiple perspectives and imaginative
Best Ideas	1	Works with high originality and creativity
Technical experts	1	High level of professionalism in the work, proficient in operational skills Be good at discovering the excellence of classmates' works and expressing oneself
Commenting experts	1	Proficient in mastering the knowledge learned, able to transfer and expand knowledge
Be ready to help others	1	Exhibition and others
Knowledge expert	1	Significant progress in learning performance
Star of Progress	1	Actively participate in learning activities, group activities, etc
Actively participate in	1	Mutual assistance and sharing among team members for common progress
Extracurricular expansion	1	Extend classroom learning beyond the classroom and apply what is learned

I. e:

$$u_i = t_i^T x, i = 1, 2, ..., p \tag{4}$$

Set up:

$$X = [x_1, x_2, ..., x_p]^T \tag{5}$$

And formula (5) is a p-dimensional random vector, whose i-th principal component can be expressed as $u_i = t_i^T x, \ i = 1, 2, ..., p$, where t is the i-th column vector of orthogonal matrix T, and meets the following conditions:

(1) U1 is the random variable with the largest variance in formula (4);
(2) U2 is the random variable with the largest variance among the other variables unrelated to u1in formula (4);
(3) Uk is the same as u1, u2,The random variable with the largest variance among the other variables that are not related to uk-1,

k = 3, 4,…, p. On this basis, in the covariance matrix of the random number badge vector, the corresponding feature vector is a, and the cumulative contribution rate of the feature vector is the final teaching evaluation result, which can be expressed as.

$$A = (\sum a_i)(\sum a_i)^{-1} \tag{6}$$

Among them, A It represents the final teaching evaluation result.

The evaluation of mobile teaching can be realized according to the way shown above.

5 Test Experiment Analysis

5.1 Test Environment Parameter Setting

In the testing phase, comparative testing is carried out based on the actual data information of law education. A total of 300 groups of data were determined to participate in the cps were used for training, and the remaining 30 groups of data were used for testing in order to test the performance of the system. The evaluation index parameters of the test data are shown in Table 5.

Table 5. Test data evaluation index parameters

Number/Group	Evaluation index parameters				
	Student behavior	Student feedback	Academic record	…	Teaching quality
1	0.81	0.59	0.75	…	0.76
2	0.35	0.71	0.73	…	0.53
3	0.86	0.92	0.78	…	0.85
4	0.83	0.49	0.77	…	0.74
5	0.69	0.65	0.28	…	0.62
…	…	…	…	…	…
30	0.75	0.63	0.74	…	0.74

On this basis, the system designed in this paper is used for testing. Through comparing the test results of different systems, its performance is analyzed.

5.2 Test Results

(1) System performance test.

The simulation experiment of teaching quality evaluation is realized through MATLAB 2013b programming, and the mean square error change diagram of the output results of the design system in this paper is shown in Fig. 4, the evaluation accuracy is shown in Fig. 5, the error square sum of the output results of the design system in this paper is shown in Fig. 6, and the fitness function curve of the output results of the design system in this paper is shown in Fig. 7.

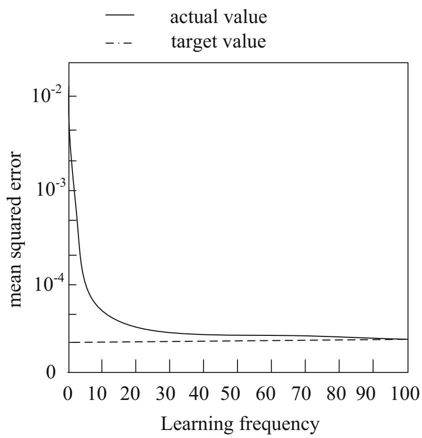

Fig. 4. Mean Square Error Variation Diagram of System Output Results

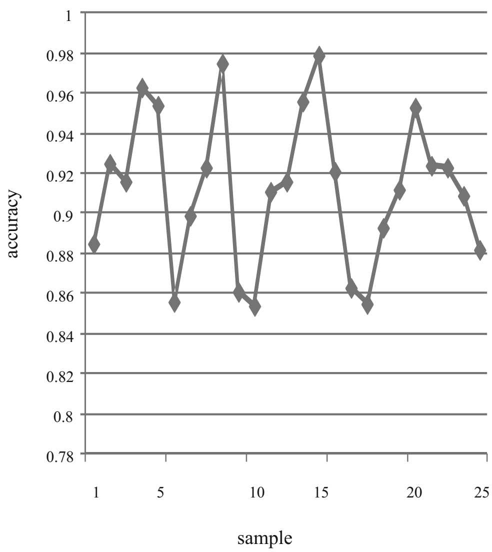

Fig. 5. Accuracy change diagram of system output results

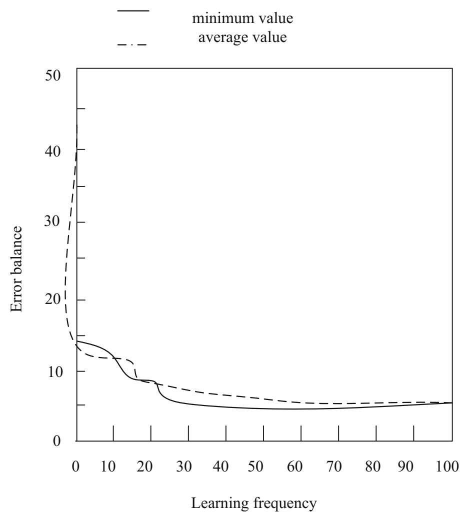

Fig. 6. Variation of the sum of squares of the system output error

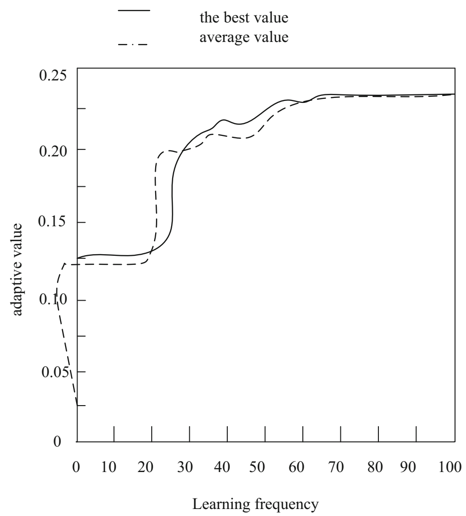

Fig. 7. Adaptability Change Diagram of System Output Result Evaluation

Figure 4 shows that the system designed in this paper meets the stop condition in the 60th generation, that is, the number of convergence steps is 60, indicating that the use of the system designed in this paper can accelerate the convergence speed in the evaluation phase. From Fig. 5, it can be seen that the evaluation accuracy of 29 groups of 30 test samples is 0. 90, and the evaluation accuracy of 22 groups is above 0. 87,It can be seen that the designed system in this paper has a good approximation effect. Figure 6 shows that the sum of squares of errors converges faster before the 5th generation, and the convergence speed is relatively slow in the 10th to 30th generation. After the number of iterations is 34, the sum of squares of errors of the network is stable, indicating that the designed system in this paper can achieve global optimization faster. Figure 7 shows that the fitness of the output results of the design system in this paper converged quickly before the 10th generation, and basically reached a stable state after 45 iterations. It can be seen that the adaptability of the system is high. In a word, the internal mechanism of the design system in this paper determines its training and evaluation performance. From the perspective of evaluation accuracy and adaptability, the design system in this paper is effective and robust.

(2) Comparative test.

In order to verify the performance of this model, the BP engine is used.

The sample data is simulated by network method, and the comparison test is carried out. The absolute error comparison diagram of evaluation results is shown in Fig. 8.

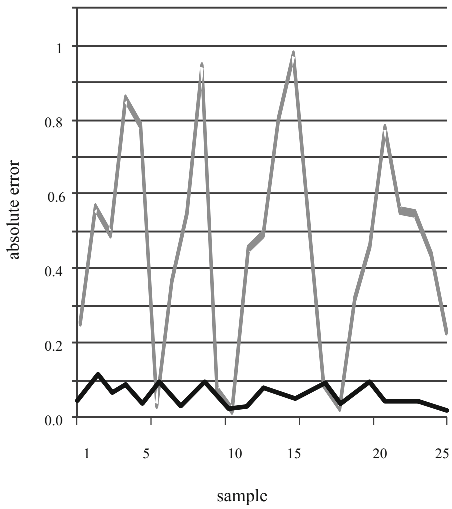

Fig. 8. Comparison Diagram of Absolute Error of Evaluation Results

Combined with the comparative test results in Fig. 8, it can be seen that the absolute error of the evaluation of the teaching quality evaluation system based on BPNN is distributed between 0 and 0. 98, and the absolute error of 10% sample evaluation is relatively large. The absolute error range of the system evaluation designed in this paper is 0–0. 15, and the absolute error of 90% sample evaluation results can be controlled within 0. 2. The prediction results of individual samples of BPNN system deviate greatly, and the evaluation results of this design system are relatively stable. Compared with BPNN teaching quality evaluation system, it can be seen that the evaluation system designed in this paper has better performance.

The comparison results of evaluation accuracy of different systems are shown in Table 6.

Table 6. Comparison of Test Result Precision/%

Test system	BPNN system	This article designs a system
Average evaluation accuracy	83.04	98.49
Maximum evaluation accuracy	92.44	99.30
Minimum evaluation accuracy	80.43	95.63

According to the test results shown in Table 6, the average evaluation accuracy of 30 groups of data based on the BPNN evaluation system is 83.04%, while the average evaluation accuracy of the system designed in this paper is 98.49%, an increase of 15.45%. It can be seen that the evaluation results of the system designed in this paper are obviously better than the BPNN system, and it also shows that the system is feasible for teaching quality evaluation.

Access the two systems on three different devices: desktop computers, tablets, and smartphones, and compare the device access of different systems, as shown in Table 7.

Table 7. Device Access Status of Different Systems

Equipment type/type	BPNN system	This article designs a system
Desktop computer	Fail	Success
Ipad	Success	Success
Smartphone	Success	Success

From Table 7, it can be seen that the BPNN system does not support desktop access, while this article designs a system can be successfully accessed on all devices, indicating that this article designs a system has strong inclusiveness.

6 Conclusion

Education is a dynamic process that integrates teaching and learning. There are many factors that affect the quality of education. In addition, these factors have different degrees of influence. Therefore, it is difficult to express the evaluation results with a mathematical analytic formula. In fact, it is a relatively complex, nonlinear comprehensive decision-making problem. Most evaluation methods comprehensively evaluate the quality of education, and it is difficult to exclude all kinds of randomness and subjectivity, It is easy to cause distortion and deviation of evaluation results, and there is irrationality. For this reason, this paper proposes the design of mobile education evaluation system for college students based on digital badge technology - taking legal education as an example, which effectively ensures that the design system can meet the objective application requirements under different conditions, and has high reliability. The storage device of the system is selected as FK-SK7-M2, and the microprocessor is selected as STC12C5A60S2 chip, ensuring that the system has a faster operating speed and lower power consumption to meet the system's operational requirements. In terms of software, digital badges and principal component analysis are combined to achieve educational evaluation. The future system can expand the dimensions of evaluation indicators to more comprehensively evaluate students' comprehensive qualities and abilities.

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