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Systematic Teaching and Personalized Assistance Analysis Based on Teacher Module and Student Module

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ABSTRACT

This article implements systematic teaching and personalized auxiliary analysis based on the teacher and student modules. The teacher module mainly includes functions such as course management, homework management, exam management, and student management, which can facilitate the systematic teaching of students. The student module mainly includes functions such as course learning, homework submission, exam review, and problem consultation, which can effectively assist students in autonomous learning. At the same time, the system also combines big data and artificial intelligence technology to analyze students' personalized learning behavior, providing targeted learning suggestions and assistance for each student. The system identifies students' learning characteristics and problems by analysing data such as their academic performance, learning time, and learning path and provides corresponding solutions.

Keywords: System Models, Assisted Teaching, Teacher Module, Innovation

1. Introduction

Since the rapid development of computers and the Internet in the 90s last century, information technology has changed the reform in the educational field gradually and has provided a new way of thinking about education [1]. How this technology can be applied in the educational field has gradually become a hot topic and has also become a common requirement of educational reform, modern education and quality education [2]. The traditional teaching mode is mainly based on the chalk writing on the blackboard. This method has many problems, such as being time-consuming, being strenuous, and causing less communication between teachers and students [3]. The application of computer-assisted instruction systems can improve the learning quality of students effectively, mitigate teachers' teaching pressure, promote education reform and improve the teaching form from boring and rigid to diversified and rich [4].

However, the computer-assisted instruction system also has the following problems: first of all, there is no intelligence. It can only present the knowledge points to students linearly and can't teach students based on their aptitude. Secondly, teachers haven't participated in the interaction. In the use process, the mistakes of the students can't be fed back to the teacher in real-time, and they can only ask the teacher after class individually [5]. Therefore, given the above problems, a personalised computer-assisted instruction system is designed for this paper, and the teaching plans are made for each student by dividing the knowledge system into several knowledge points and analyzing the students' familiarity with each. Then, the teaching plan is modified in real-time through the students' performance in the teaching process [6].

2. The State of the Art

Overseas, the United States, as the earliest country to use a computer-assisted instruction system, has experienced six stages of development: the first stage is 1958-1969, which is the initial stage represented by the PLATO system [7]; the second stage is from 1965 to 1970, and it's the application practice stage with the IBM1500 teaching system as the representative; the third stage is from 1970 to 1975, and the practical stage represented by the PLATO (Programmed Logic for Automated Teaching Operations); the fourth stage is microcomputer application popularization stage, which lasts from 1975 to the late 80s [8]; the fifth stage is from the late 80s to 2000, which is the vigorous development stage of the applied multimedia technology; the sixth stage is the network development stage after 2000 [9].

In 1981, the computer-assisted instruction system was introduced in China. At that time, many colleges and universities, such as Beijing Normal University, Dalian University of Technology, and East China Normal University, had their own computer-assisted instruction systems, and this technology was supported strongly by the state. After that, China developed a unique "CEC-I" with the country's support. Subsequently, the relevant teaching software of "CEC-I" was developed gradually [10]. In the 1990s, due to the development of computer technology, computers entered the school gradually, and multimedia computers were used in teaching officially. Thus, educational software in China has completed marketization [11]. In 1995, Chinese educational software was productised. The teaching content covered the knowledge of various disciplines from primary school to university and included the family, school, society and many other educational levels [12]. Colleges and universities have corresponding teaching application software in literature, science, engineering, and various disciplines [13].

3. Methodology

3.1. The Construction of System Module

A good computer-assisted instruction system should have sufficient learning materials, teach students based on their aptitude and different student situations, and record the students' learning situations [14]. In combination with the above requirements, a system model is designed, as shown in Figure 1 in this paper, and includes three parts: domain knowledge base, student model, and teacher model.

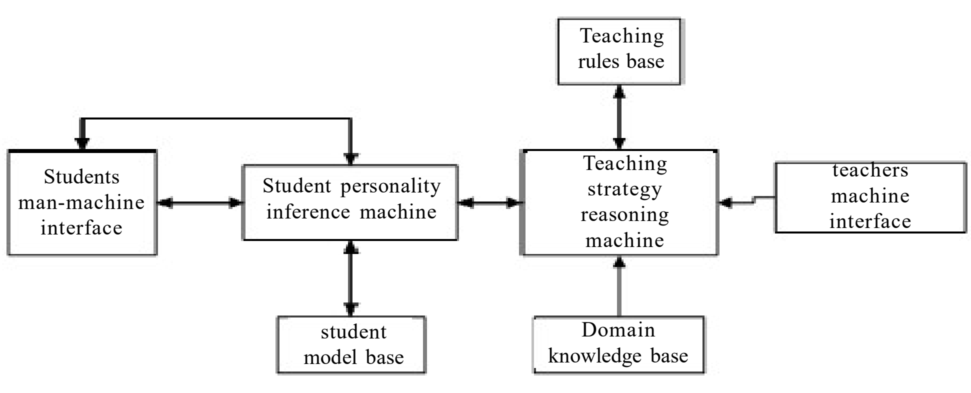

Figure 1. The system model of personalized computer-assisted instruction

Among them, the domain knowledge base, as the storage unit of knowledge, is the foundation of system construction [15]. The student module is divided into the personality inference engine and the student model base. The personality inference engine is used to evaluate students' basic knowledge, cognitive ability, and learning interest, and the teacher module is uploaded to draw up the corresponding learning plan according to the result. The function of the student model library is to store student information as the basis for future teaching strategy formulation. The teacher module contains the teaching strategy inference engine and the teaching rule base. The teaching strategy inference engine can formulate each student's study plan and assign the learning resources based on the student information obtained in the former student module. The rules these plans are based on are stored in the teaching rule base.

3.2. The Design of the Teacher Module

The teacher model can evaluate the students' achievements according to the corresponding teaching strategies and draw up the students' learning plans according to the corresponding achievements. The teaching strategy established in this paper is divided into two parts. Firstly, the knowledge points are divided in line with the difficulty and importance of the knowledge point, and then the students are classified according to their interests and cognitive abilities. In the division of knowledge points, the knowledge points are divided into five levels from simple to difficult, and the membership function is $\mu_d(x) = \{0.2/1, 0.4/2, 0.6/3, 0.8/4, 1/5\}$. Secondly, knowledge points are divided into three levels according to the importance of the knowledge point and the membership function $\mu_m(x) = \{0.3/1, 0.6/2, 1/3\}$. The fifteen types of knowledge points obtained are shown in Table 1.

	Important $0.6 < \mu_m(x) \leq 1$	Generic $0.3 < \mu_m(x) \leq 0.6$	Unimportant $0 < \mu_m(x) \leq 0.3$
Largest $0.8 < \mu_d(x) \leq 1$	1	6	11
larger $0.6 < \mu_d(x) \leq 0.8$	2	7	12
generic $0.4 < \mu_d(x) \leq 0.6$	3	8	13
smaller $0.2 < \mu_d(x) \leq 0.4$	4	9	14
Smallest $0 < \mu_d(x) \leq 0.2$	5	10	15

Table 1. Knowledge point classification table

After dividing the knowledge points, the students are classified. In this paper, the students are divided into nine grades on the basis of students learning ability, and the corresponding learning plan is formulated by the different levels of students at each grade. The details are shown in Table 2.

According to the above division, different types of courses are designed for different types of students, and the students are taught according to their aptitude. After the division of teaching strategies, the teaching rules library should be divided to achieve the dynamic adjustment of each student's teaching plan in teaching so that the teaching plan is no longer rigid. In this paper, the rules of the teaching rules library are as follows: (1) when students are learning for the first time or their learning ability has changed, the student's ability values judge the students' grades, and the knowledge points that students should learn are allocated according to table 2; (2) after the student accepts unit test, students' ability values are compared with a threshold of this unit set. If the student's ability value is not up to the threshold, the system will reduce the student's ability value by two and relearn this unit. If the student's ability value exceeds the threshold, the system will add the student's ability value by two and assign a study plan based on the student's current level.

Through the above teaching rules, the student's achievements are evaluated after the periodicaltest, and the results are used as the baseline to determine whether students should continue to study this chapteror move on to the next chapter, thus achieving the purpose of real-time modification of each student's teaching plan.

Learning ability	Student rank	Courses taken
90-100	A	1-15
80-90	B	1-10/12-15
70-80	C	1-10/13-15
60-70	D	1-10/14/15
50-60	E	1-10/15
40-50	F	1-10
30-40	G	1-5/8/9/10
20-30	H	1-5/10
0-20	I	1-5

Table 2. Different types of students should be taught

3.2. The Design of the Student Module

The main function of the student module is to record the students' situation in real time, which is the basis of the formulation of the teaching strategy. The design of the student module begins with the design of the student model library. The student model library designed in this paper mainly records the students' memorization, comprehension, application, and analysis of

Field Count	data type	explain
User	Char	Student user name
KPID	Int	Point number
KPTest	Float	Tested or not
KPRetain	Float	Ability to remember scores
KPCompreh	Float	Ability to understand scores
KPApp	Float	Ability to apply scores
KPAnalyse	Float	Ability to analyze scores
KPIntegra	Float	Ability to synthesize scores

Table 3. Students learning library

learning content, as well as their comprehensive ability. The parameters that need to be registered are shown in Table 3.

After establishing the student model base, the evaluation index system should be established. Among them, indicators are divided into cognitive ability (U_1) and learning interest (U_2), marked as $U=\{U_1,U_2\}$. Among them, U_1 includes memory ability, comprehension ability, application ability, analytical ability, and comprehensive ability, which is marked as $U_1=\{u_{11},u_{12},u_{13},u_{14},u_{15}\}$. The comment set is defined as *V* and divided into excellent, good, medium, pass, poor and bad, and it's marked as $V=\{v_1,v_2,v_3,v_4,v_5,v_6\}$. The achievements indicated are 90-100, 80-90, 70-80, 60-70, 40-60 and 0-40 respectively. U_2 only indicates the level of interest in the course, and it's marked as $U_2=\{u_{21}\}$. The comment set V is divided into the corresponding scores of very interested, interested, relatively interested, general, less interested and not interested, the same as the comment set U_1. In the system designed in this paper, the weight coefficient of is, and the weight coefficient of is. After that, the corresponding membership function should be constructed. The value of the evaluation index in U is x, so the membership function is:

$$\mu_{r1}=\begin{cases}\frac{1}{10}(x-90) & 90<x<=100\\ 0 & x<=90\end{cases}$$

$$\mu_{r2}=\begin{cases}\frac{1}{10}(100-x) & 90<x<=100\\ \frac{1}{10}(x-80) & 80<x<=90\\ 0 & x<=80\end{cases}$$

$$\mu_{r3}=\begin{cases}0 & x>=90\\ \frac{1}{10}(100-x) & 80<x<=90\\ \frac{1}{10}(x-80) & 70<x<=80\\ 0 & x<=70\end{cases} \quad (1)$$

$$\mu_{r4}=\begin{cases}0 & x>=80\\ \frac{1}{10}(100-x) & 70<x<=80\\ \frac{1}{10}(x-80) & 60<x<=70\\ 0 & x<=60\end{cases}$$

$$\mu_{r5}=\begin{cases}0 & x>=70\\ \frac{1}{10}(100-x)60<x<=70\\ \frac{1}{10}(x-80)60<x<=70\\ 0 & x<=40\end{cases}$$

$$\mu_{r6}=\begin{cases}0 & x>=60\\ \frac{1}{20}(60-x)80<x<=90\\ 1 & 0<=x<=40\end{cases}$$

After completing a chapter, the system will grade the results of the students' study. If a student's cognitive ability scores are 72, 71, 68 and 64, the following can be obtained by the formula (1).

$$R_1=\begin{bmatrix}0 & 0 & 0.6 & 0.4 & 0 & 0\\ 0 & 0 & 0.2 & 0.8 & 0 & 0\\ 0 & 0 & 0.1 & 0.9 & 0 & 0\\ 0 & 0 & 0.8 & 0.2 & 0 & 0\\ 0 & 0 & 0.4 & 0.6 & 0 & 0\end{bmatrix} \quad (2)$$

The direct product of the fuzzy matrix with A1 is carried out, and then there is:

$$B=A\oplus R=\begin{pmatrix}0 & 0 & 0.145 & 0.775 & 0.1 & 0\end{pmatrix} \quad (3)$$

The scores of 95, 85, 75, 65, 50 and 20 are correspond to excellent, good, medium, pass, poor and bad, and then the total score of cognitive ability can be obtained after normalization.

$$\begin{bmatrix}0 & 0 & 0.145 & 0.775 & 0.1 & 0\end{bmatrix}\begin{bmatrix}95\\ 85\\ 75\\ 65\\ 50\\ 20\end{bmatrix}=61.95 \quad (4)$$

Next, the student's interest score is 75; the following can be obtained by the formula (1).

$$\begin{aligned}R_2 &= (0,0,0.5,0.5,0,0)\\ B_2 &= (0,0,0.5,0.5,0,0)\end{aligned} \quad (5)$$

Afterwards, the fuzzy matrix can be obtained:

$$R = \begin{bmatrix} B_1 \\ B_2 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0.145 & 0.775 & 0.1 & 0 \\ 0 & 0 & 0.5 & 0.5 & 0 & 0 \end{bmatrix} \quad (6)$$

The direct product of the fuzzy matrix with A is carried out, and then there is:

$$B = R \oplus A = \begin{pmatrix} 0.6 & 0.4 \end{pmatrix} \begin{bmatrix} 0 & 0 & 0.145 & 0.775 & 0.1 & 0 \\ 0 & 0 & 0.5 & 0.5 & 0 & 0 \end{bmatrix} = \begin{pmatrix} 0 & 0 & 0.287 & 0.653 & 0.06 & 0 \end{pmatrix} \quad (7)$$

The student's total score for the study is:

$$\begin{pmatrix} 0 & 0 & 0.287 & 0.653 & 0.06 & 0 \end{pmatrix} \begin{bmatrix} 95 \\ 85 \\ 75 \\ 65 \\ 50 \\ 20 \end{bmatrix} = 66.97 \quad (8)$$

Thus, the design of the student module has been completed.

4. Result Analysis and Discussion

The system designed in this paper was tested experimentally. Through the sampling, analysis, and processing of data, the teaching quality of the system was judged, thereby achieving the purpose of evaluating the system. The evaluation targets of this experiment are divided into the following points: first of all, whether the students can achieve the requirements of syllabus for the target course after using the system or not should be judged; secondly, whether the system's evaluation and classification of students is accurate or not should be judged; thirdly, the system should be compared with the traditional system to observe whether the system designed in this paper has its advantages compared with the traditional system or not; finally, the system defects are found to facilitate the subsequent experimental study and improve it.

The evaluation system of the student module in the system for students is divided into cognitive ability and interest. Therefore, the sampling method in this paper was adopted to conduct a questionnaire survey among students of our school in this paper, and the questionnaire mainly included the grades of the students when they first entered school, students' self-cognitive ability and the predicted grades of their interests in "Advanced Mathematics". Later, twenty students were randomly selected as the samples of the experiment. Then, the twenty students were divided into two groups. The first group was odd-numbered students, and they used the teaching system designed in this paper to learn "Advanced Mathematics" in their subsequent experiments. The second group was even-numbered students who used the traditional teaching system to study "Advanced Mathematics". To make the experimental results relatively correct, the scores of students with adjacent numbers were approximate values in the numbering process. The selected result is shown in table 4:

The college entrance examination scores in the table can be used as reference values for students' learning ability. According to the college entrance examination results, students were divided into six grades. Two students were excellent, and their college entrance examination scores were 500 points or above; four students were good, and their college entrance examination scores were between 450 points and 500 points; four students were relatively good, and their college entrance examination scores were between 400 points and 450 points; there were four people in the grade of medium, and their college entrance examination scores were between 350 points and 400 points; four students were poor with the score between 300 points and 350 points; two students were bad, and their college entrance examination scores were below 200 points. At the same time,

ID	entrance scores	Cognitive ability estimates	Interest estimates	System score
1	511	90	90	B
2	506	93	95	
3	492	95	100	A
4	487	80	90	
5	463	65	80	E
6	457	75	75	
7	431	92	75	C
8	445	83	75	
9	418	75	80	D
10	409	75	75	
11	385	85	85	C
12	382	70	90	
13	376	78	75	D
14	365	86	80	
15	349	30	85	G
16	336	70	80	
17	310	55	50	F
18	300	65	60	
19	285	60	55	E
20	276	58	50	

Table 4. Student sampling information

students' cognitive ability was divided into six grades: excellent, good, relatively good, general, poor and bad. Similarly, students' interest values were also divided into six levels, and 90-100 points, 80-90 points, 70-80 points, 60-70 points, 40-60 points and 0-40 points represented very interested, more interested, interested, general interested, not very interested and not interested respectively. It should be noted that cognitive ability here is just the student's estimate of themselves; it doesn't mean the actual situation, and the system will adjust it in the learning process. The value of interest will change independently while students are learning the course. After that, the "Advanced Mathematics" which needed to be studied was divided into 15 chapters. According to the specifi content and the analysis of each chapter's degree of difficulty, the experiment cycle was set for 5 weeks and 12 class hours per week with 60 class hours.

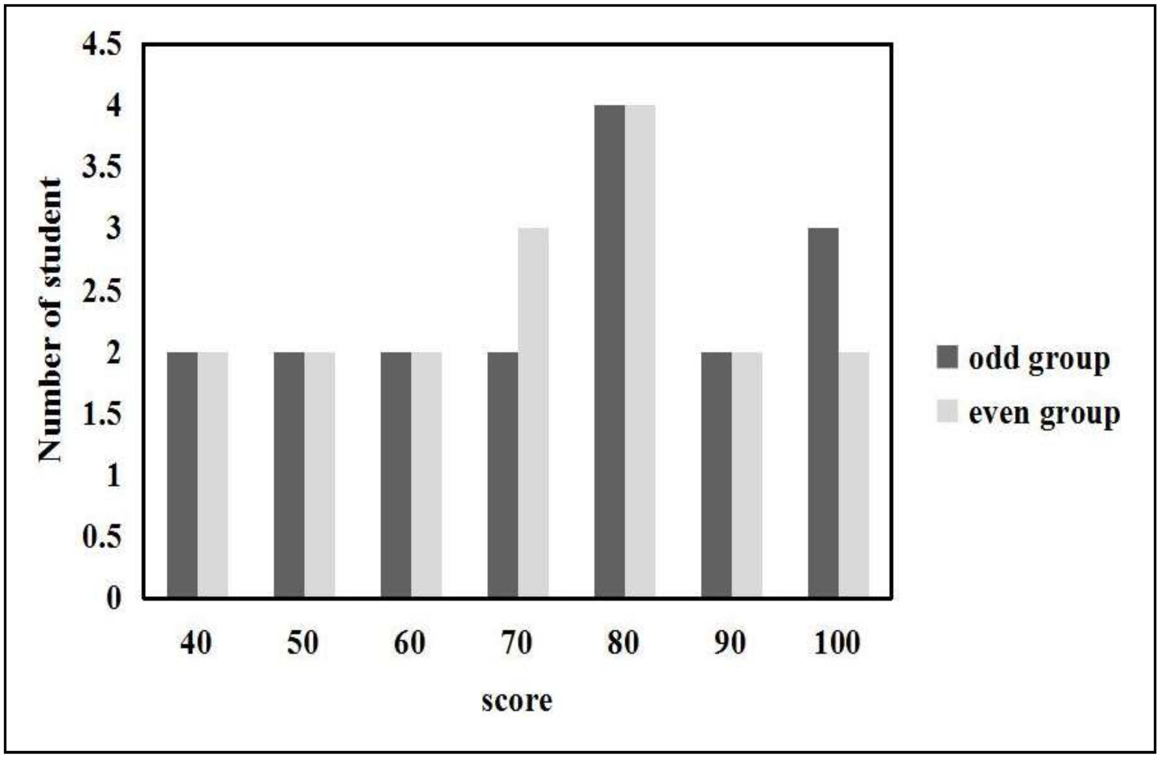

Figure 2. Test grade distribution

In the course of learning, the entire group used the traditional teaching system only, and its learning plan remained unchanged from beginning to end. The odd group used the teaching system designed in this paper. Initially, each person's study plan was based on the students' assessment of themselves; students were examined after the study plan of each chapter was completed, and the student's next study plan was modified according to the results. After all the studies were completed, the same test was conducted on the studies of the two groups. The results obtained are shown in Figure 2.

As can be seen from Figure 2, the average score of the odd group was 69, its passing rate was 70%, and the average score of the even group was 60.2, and its passing rate was 60%. After learning, students of the two groups completed the learning program customized by the system. However, from the result, it is clear that students of the odd group who used the teaching system designed in this paper have achieved better results. As a result, the teaching result of the new computer-assisted instruction system designed in this paper is superior to that of the traditional teaching system.

Figure 3 compares students' cognitive ability scores given by the system after the end of the learning phase and test scores. From the data in Figure 3 and the students' estimated values of their cognitive abilities in Table 4, it can be found that the system designed in this paper can modify the evaluation of students in real-time according to the students' various performances in the learning process, and make study plans with the evaluation, thus achieving the purpose of adopting different teaching methods for different students. As seen in Figure 3, the system's final evaluation of students is almost the same as students' scores on the test. The results show that, after completing all the course study plans, the system's evaluation of students' cognitive ability is very close to the students'actual situation; that is, the system can accurately evaluate students' cognitive ability.

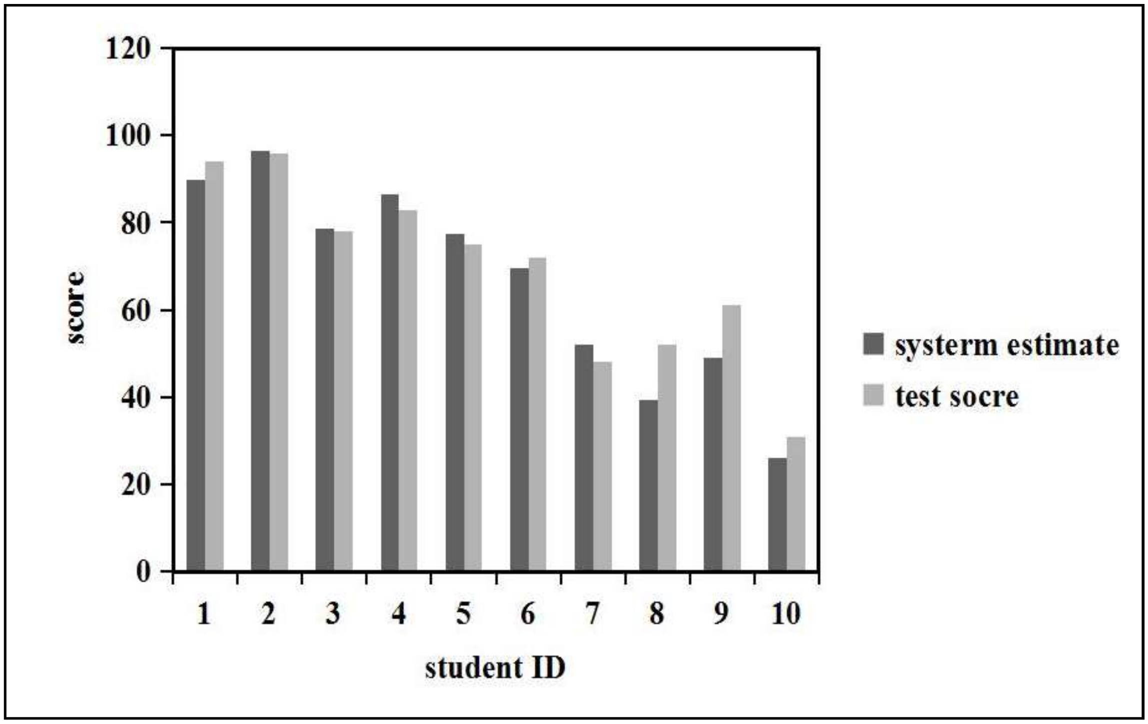

Figure 3. The comparison of learning ability values given by the system and test scores

The two groups of students who completed the study plan with two different teaching systems were investigated. It is found that students of even groups generally believe that the traditional teaching system can't arrange the study plan according to their conditions, which makes studying dull and difficult. Many students' interest in the course has not risen but has declined after using the traditional system. However, students of the odd group say that the teaching system designed in this paper can arrange the study plan more accurately according to their situations, which greatly enhances their interest in the course and also effectively improves their academic performances.

5. Conclusions

With the rapid development of science and technology and the continuous improvement of people's living standards, the innovation requirements of people in the teaching process are higher and higher, and it has been quite difficult for the traditional teaching mode to satisfy the teaching needs of modern teachers and students. To improve modern teaching effectiveness, a new type of personalized assisted teaching system was designed, students' achievements were evaluated by making teaching strategies, and the difficult division of teaching knowledge points was realized; at the same time, based on the student module, the students' memorization, comprehension, application and analysis of learning content as well as comprehensive ability were recorded detail; moreover, to verify the application effect of the system, teaching experiment and judgment were carried out on the teaching quality of the system; finally, the detailed research on the teaching contrast experiment of "Advanced Mathematics" was carried out, in which, students of the odd group adopted the innovative computer technology-assisted teaching method. Those of the even group adopted the traditional teaching method. The result of the teaching experiment showed that the average scores of the odd group and even group were 69 points and 60.2 points, respectively, and their pass rates were 70% and 60%, respectively. The comprehensive analysis shows that computer-assisted instruction based on innovation has a better teaching effect and can improve the students' interest in learning and enhance their cognitive ability. Although the teaching experiment is contrasted with the teaching effect of computer-assisted instruction in this study, the number of subjects is relatively small, and the conclusion has some limitations.

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