Research on the results of the advanced mathematics teaching of college students of science: the effect of STC teaching mode based on “Internet +”

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Abstract. We uses markov evaluation model to evaluate the effectiveness of STC teaching (STC teaching mode is a method of combining online services and offline services mode of "Self-directed learning-Traditional teaching-Collaborative learning"). In the 2018-2019 academic year, Control class group (traditional teaching mode) and experimental class group (STC teaching mode) will be taught for the Advanced Mathematics Teaching of college students of science. We use the score data of the two classes as the evaluation basis. The results show that the STC teaching effect is significant.

1. Introduction
In recent years, with the rapid development of computer internet, computer internet technologies become more widespread. Internet promotes the diversification of education forms (especially for higher education), Higher Education presents a entirely new Interactive educational environment and teaching model(Such as STC teaching mode).

1.1. STC teaching mode
The teaching mode of STC is a method of combining online services and offline services mode of "Self-directed learning-Traditional teaching-Collaborative learning". Here, S refers to self-directed learning, that is, the regulated learning behavior of the learning subject that makes full use of the high-quality resources of the Internet to meet the personalized learning needs under the condition of self-planned and deployed learning schedule. T refers to Traditional teaching, that is, the process in which the learning subject receives knowledge from the teacher in a fixed environment, and the main mode adopted is offline teaching. C refers to Collaborative learning, that is, the whole process of learning and mastering knowledge by the subject of learning making full use of the learning process of traditional teaching and taking "Internet + mathematics" online education as the auxiliary carrier [1].

1.2. Markov chain model
Markov Chain is in theory of probability and mathematical statistics, which has the Markov property and exists in a discrete index set and the state space in the stochastic process [2-3], application field widely, the Markov Chain model in physics and chemistry, Markov Chain and Markov process is used
for the dynamic system modeling, Markov dynamics was formed [4]. In queueing theory, markov chain is the basic model of queueing process (Constantin, H. 2011). In terms of signal processing, markov chain is some sequence data compression algorithms, such as the ziv-lempel coded mathematical model [5]. In the financial field, markov chain model is used to predict the market share of enterprise products [6]. There is also a preliminary involvement in efficiency evaluation and measurement, for example, Zhu Bo applied markov chain model to evaluate students' learning efficiency [7].

2. Methods

2.1. Sample and data collection
In the academic year of 2018-2019, I also taught advanced mathematics in physics class of 2018 (39 students) and water and hydroelectric project class of 2018 (48 students). In the two classes, the teacher and the teaching materials are the same and the students' levels of the two classes are nearly the same. The water and hydroelectric project class is denoted by class A and the physics class is denoted by class B. We randomly selected class A as the Parallel-control group and class B as the Experimental class group during the teaching process of the first semester of the 2018-2019 academic year. The traditional teaching mode is adopted in the first semester. In the first semester, students' test scores are defined as pre-test scores, which are recorded as BeforeA and BeforeB respectively. In the teaching process of the second semester, class A continued to adopt the traditional teaching mode, and class B adopted the STC teaching mode. In the second semester, students' test scores are defined as posttest scores, which are recorded as AfterA and AfterB respectively. Through one year's teaching, we have collected 174 pieces of data. The effective rate is 100%.

2.2. Measures used
Based upon the problems needs to be solved and the data constraints, we propose the following definitions.

Definition 1: In the first semester, students' test scores are defined as pre-test scores, and in the second semester, students' test scores are defined as posttest scores in the 2018-2019 academic year. The scores were organised into m different categories. \( n_i \) is the number of people whose pre-test score belongs to category \( i \), \( n_{ij} \) is the number of students whose pre-test scores belong to category \( i \) transferred to the posttest scores belong to category \( j \) in the second semester. \( p_{ij} = \frac{n_{ij}}{n_i} \) is the transfer rate from category \( i \) to category \( j \) in the second semester. Then, the transfer matrix is \( p \) [8].

\[
P = \begin{pmatrix}
    n_{11} & n_{12} & \cdots & n_{1m} \\
    n_{1} & n_{1} & \cdots & n_{1} \\
    n_{21} & n_{22} & \cdots & n_{2m} \\
    n_{2} & n_{2} & \cdots & n_{2} \\
    \cdots & \cdots & \cdots & \cdots \\
    n_{m1} & n_{m2} & \cdots & n_{mm} \\
    n_{m} & n_{m} & \cdots & n_{m}
\end{pmatrix}
\]

Definition 2: \( s_{ij} \) is called the transition improvement degree of \( p_{ij} \), and

\[
s_{ij} = (i - j)^3 p_{ij}, (i, j = 1, 2, \cdots, m),
\]
\((i - j)^3\) is called the weight of \(p_{ij}\), and the matrix \(s = (s_{ij})_{mxn}\) is called the progress matrix of the transition matrix \(p\) [9].

On the basis of definitions 1 and 2, we give new definitions based on this study, such as the definition of efficiency and evaluation criteria.

**Definition 3:** \(E(S)\) is defined as the efficiency of the transfer matrix \(p\), and

\[
E(S) = \sum_{i=1}^{m} \sum_{j=1}^{n} s_{ij} = \sum_{i=1}^{m} \sum_{j=1}^{n} (i - j)^3 p_{ij} = \sum_{i=1}^{m} \sum_{j=1}^{n} (i - j)^3 \frac{n_{ij}}{n_i}
\]

On the basis of the above definition, we can put forward the evaluation criterion based on markov chain evaluation model, and the specific theorem is as follows.

**Theorem:** if the teaching results meet the requirements of definition 1, 2 and 3, and the teaching efficiency is improved, the number of students of equal \(i\) to equal \(j\) \((i < j)\) will increase, This is, \(i - j > 0\) and \(E(S) > 0\). On the contrary, if the teaching efficiency decreases, the number of students of grade \(i\) to grade \(j\) \((i < j)\) will increase, This is, \(i - j < 0\) and \(E(S) < 0\).

**Proof:** reference can be made to literature [7, 10], which is not stated here.

### 3. Results

#### 3.1. Distribution of teaching achievements

After the teaching of the first semester of the 2018-2019 academic year, the students of the two classes have a certain understanding of course, content and theoretical basis of advanced mathematics. In the second semester of advanced mathematics teaching, the traditional teaching mode was maintained for the Class A, and CTC teaching mode was applied to the Class B. In the 2018-2019 academic year, the distribution of scores of two classes and two semesters of advanced mathematics examination is shown in Figure 1.

![Figure 1. Score distribution before and after advanced mathematics teaching.](image-url)
Notes: Before A, The achievement of class A under the traditional teaching mode in the first semester; Before B, The achievement of class B under the traditional teaching mode in the first semester; After A, The achievement of class A under the traditional teaching mode in the second semester; After B, The achievement of class B under the STC teaching mode in the second semester.

From the results distribution diagram, Experimental class group's performance is becoming more and more stable, and the Average scores is higher than that before the Experimental teaching. The results of traditional classes are relatively poor, which may be related to the long-term weakness of students' learning. In order to further illustrate the effectiveness of our teaching, we then used markov chain model to quantitatively evaluate STC teaching effectiveness.

3.2. Evaluation based on markov chain model

In the second semester of the 2018-2019 academic year, the class B was selected as the experimental class group, the STC teaching mode was adopted for teaching, and the class A was selected as the Parallel-control group, and the traditional teaching mode was adopted for teaching. The final score of the first semester of the 2018-2019 academic year was taken as the pre-test scores, and the scores was divided into five categories from low to high, namely, Low-quality : The score is between 0 and 59; Qualified : The score is between 60 and 69; Medium : The score is between 70 and 79; Well : The score is between 80 and 89; Excellent: The score is between 90 and 100. Then, we can obtain the original state matrix of classes A and B respectively.

\[
\begin{bmatrix}
6 & 11 & 19 & 6 & 6 \\
48 & 48 & 48 & 48 & 48
\end{bmatrix}
\]

\[
\begin{bmatrix}
3 & 13 & 15 & 5 & 3 \\
39 & 39 & 39 & 39 & 39
\end{bmatrix}
\]

The final score of the second semester of the 2018-2019 academic year is taken as the post-test score, and the post-test result matrix of classes A and B respectively as follows:

\[
\begin{bmatrix}
1 & 23 & 18 & 5 \\
48 & 48 & 48 & 48
\end{bmatrix}
\]

\[
\begin{bmatrix}
4 & 18 & 17 & 0 & 0 \\
39 & 39 & 39 & 39
\end{bmatrix}
\]

At the same time, the change of the number of students from categories \(i\) to categories \(j\) in the final exam of the second semester is obtained, as shown in Figures 2 and 3, \(i, j = 1,2,\cdots,5\) .

**Figure 2.** The number of students whose pre-test scores belong to category \(i\) transferred to the post-test scores belong to category \(j\) in the second semester in class A.
Figure 3. The number of students whose pre-test scores belong to category i transferred to the posttest scores belong to category j in the second semester in class B.

From Figure 2 and 3, we obtain the probability transfer matrix of A and B:

\[
P_A = \begin{pmatrix}
\frac{1}{6} & 0 & \frac{1}{2} & \frac{1}{3} & 0 \\
0 & \frac{1}{11} & \frac{5}{11} & \frac{5}{11} & 0 \\
0 & 0 & \frac{13}{19} & \frac{4}{19} & \frac{2}{19} \\
0 & 0 & 0 & \frac{2}{3} & \frac{1}{3} \\
0 & 0 & \frac{1}{3} & \frac{1}{2} & \frac{1}{6}
\end{pmatrix}
\quad \text{and} \quad
P_B = \begin{pmatrix}
1 & 0 & 0 & 0 & 0 \\
\frac{1}{13} & \frac{12}{13} & 0 & 0 & 0 \\
\frac{1}{5} & \frac{4}{5} & \frac{0}{5} & 0 & 0 \\
0 & 0 & \frac{2}{3} & 0 & 0 \\
0 & 0 & \frac{1}{3} & \frac{2}{3} & 0
\end{pmatrix}
\]

We can further obtain the forward matrix of A and B as follows:

\[
S_A = \begin{pmatrix}
0 & 0 & -4 & -9 & 0 \\
0 & 0 & -\frac{5}{11} & -\frac{40}{11} & 0 \\
0 & 0 & 0 & -\frac{4}{19} & -\frac{16}{19} \\
0 & 0 & 0 & 0 & -\frac{1}{3} \\
0 & 0 & \frac{8}{3} & \frac{1}{2} & 0
\end{pmatrix}
\quad \text{and} \quad
S_B = \begin{pmatrix}
0 & 0 & 0 & 0 & 0 \\
\frac{1}{13} & 0 & 0 & 0 & 0 \\
\frac{1}{5} & 0 & -\frac{4}{5} & -\frac{4}{5} & 0 \\
\frac{8}{3} & \frac{3}{5} & 0 & 0 & 0 \\
0 & 9 & \frac{16}{3} & 0 & 0
\end{pmatrix}
\]

Finally, the efficiency degree are

\[
E(S_A) \approx -15.3, E(S_B) \approx 18.55
\]

From this, we can conclude that the teaching effect of the Experimental class group is obviously better than that of the Parallel-control group. The students in the Experimental class group made positive progress, but the students in the Parallel-control group made negative progress.
4. Discussion
According to the research results, the results of the experimental class improved significantly, that is to say, the STC teaching model achieved remarkable results. We further used SPSS statistical software to conduct the t-test of two paired samples [11-13], and analyzed the significant changes of students' performance before and after the experiment (BeforeA Vs AfterA, $75.97 \pm 10.649$ Vs $80.21 \pm 6.433$). The correlation coefficient between "before test " and "after test" was 0.598, and correlation coefficient test $p = 0.000 < 0.001$. Before and after performance difference test $p = 0.000 < 0.001$). Therefore, there is a close relationship between "before the experiment" and "after the experiment" students' math performance, with a positive correlation. In other words, the mean value of math scores before and after the experiment is significantly different, which may be caused by such factors as the richness of STC teaching information, the flexibility of teaching methods and the multi-dimensional adaptation to individual students. This is consistent with the quantitative evaluation result of markov chain model on STC teaching performance, so the influence of STC teaching mode on mathematics learning is significant, which is consistent with the research result of sun jiangjie et al [14].

5. Conclusions
Through the above analysis, we can conclude that the STC teaching mode is more effective than the traditional teaching mode. STC teaching mode is conducive to improving the lack of individualized talent training in traditional teaching mode, making up for the dullness of traditional teaching and improving the quality of higher education as a whole.

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Conflicts of interest
The authors declare no conflicts of interest regarding the content and implications of this manuscript.

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