Empirical Study on the Implementation Process and Effect of Problem Chain Teaching Based on Statistical Model

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Abstract. Problem chain teaching is an effective classroom teaching method characterized by problem traction and teacher-student interaction. How to accurately evaluate the process and effect of problem chain teaching is a difficult problem in teaching implementation. In order to evaluate the performance of teachers and students and their teaching effect in the process of problem chain teaching, the original data are obtained by means of questionnaire survey and data recording. Based on the statistical model, the influence of problem traction, problem situation, student activity, student head up rate, teacher-student interaction rate and other factors on problem chain teaching is analyzed in detail. The influence of the effectiveness of teacher-student interaction on the effect of problem chain teaching is studied, and the effective problem traction is obtained The design of problem chain and increasing the interaction between teachers and students are the most critical reasons for the implementation of problem chain teaching, which provides a reference for the effective implementation of problem chain teaching in the classroom.

Keywords: Statistical Model · Problem Chain Teaching · Teaching Effect · Empirical Research

1 Introduction

Problem chain teaching originates from a simple educational concept of stimulating learning by problem thinking [1, 2]. Today, with the rapid development of teaching information technology, problem chain teaching still has a strong enlightenment to modern education and teaching reform because of its characteristics of "problem traction, stimulating thinking and activating classroom". Due to its ingenious design, convenient implementation and interactive efficiency, problem chain teaching has been widely used in multidisciplinary curriculum teaching and produced good teaching benefits [3]. However, in order to effectively use the problem chain teaching in the classroom, we must systematically analyze the various elements affecting the problem chain teaching process [4], and carry out the investigation, research and empirical analysis of various elements on the problem chain teaching process and effect, so as to provide research ideas to ensure the effective implementation of the "problem chain" in classroom teaching and achieve

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the established teaching objectives of stimulating students' thinking and transmitting professional knowledge.

In view of the above problems, this paper carries out an empirical study on the classroom implementation process and effect of problem chain teaching based on statistical model, puts forward the logical process and problem chain framework of single teaching problem implementation of "setting doubt, thinking doubt, discussing doubt and solving doubt", analyzes how to build an "effective" problem chain in line with learning cognition from the perspective of teaching theory, and analyzes the problem quality, performance of teachers and students, interactive communication Through empirical research on the process of teaching effect, we find the factors affecting the teaching effect of problem chain and the relevant conclusions of how to affect it, which provides a new perspective for the research of problem chain teaching.

2 Preparation Problem Chain Teaching Evaluation Description

2.1 Implementation Process of Problem Chain Teaching

The implementation process of single problem teaching in the problem chain is shown in Fig. 1. Its teaching process mainly includes: (1) introducing problems: teachers reasonably introduce problems in combination with students' Preview feedback to stimulate students' thinking; (2) Thinking: set aside some time in class for students to think about problems in combination with learning materials; (3) Discuss problems: students can discuss problems in various forms. For example, students can interact with each other or discuss in groups. In short, this process is a stage for in-depth discussion of teaching problems; (4) Problem solving: teachers solve this problem through knowledge explanation and induction, and use examples; (5) Knowledge construction: master the corresponding knowledge points through thinking, discussion and final solution of problems, and have the ability to flexibly use the knowledge points to solve problems, so as to achieve the teaching purpose of constructing the learned knowledge points. The above is the implementation process of single problem teaching. The so-called problem chain teaching is actually composed of such a number of single problem teaching implementation processes, but it is not a simple repetition, but a logical relationship of relevance and progression.

2.2 Evaluation Problem of Chain Teaching Effect

The difficulty of problem chain teaching is the "effective" implementation of classroom teaching. In other words, how to improve the effectiveness of problem chain teaching is the key to ensure the teaching effect. Among the many factors that affect the teaching effect of problem chain, such factors as problem traction, problem situation, student activity, student rise rate and teacher-student interaction rate should be paid special attention, as shown in Fig. 2. Of course, we should also pay attention to the flexible adjustment of problem chain teaching in the implementation. In the implementation of problem chain teaching, we should comprehensively determine the "loose and tight connection" of the problem chain according to the teaching promotion, student performance and student Q & A in classroom teaching, and may adjust and abandon individual

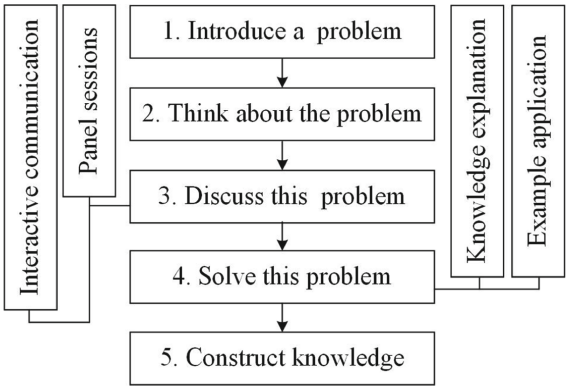

Fig. 1. Implementation flow chart of single problem teaching in problem chain.

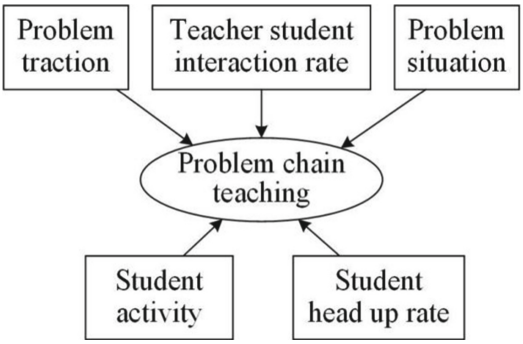

Fig. 2. Influencing factors of problem chain teaching effect.

teaching problems. Teaching questions should be mainly introductory questions, so as to facilitate the traction of classroom ideas and stimulate students' thinking.

These factors are the key reasons affecting the implementation effect of problem chain teaching, and they are also the key factors concerned in teaching evaluation.

3 Analysis Method of Problem Chain Teaching Process and Effect Based on Statistical Model

For the problem chain teaching, the problem chain is the carrier and form of the teaching method. The key of the problem chain teaching method is to build an effective "problem chain" that reflects the characteristics of the curriculum, conforms to the cognitive law. This paper puts forward the analysis method of problem chain teaching process and effect based on statistical model.

Table 1. Survey of Problem Chain Teaching.

Course name	Questionnaire information		
	Distributed	Recovered	Valid
Weapon launching technology	46	46	44

3.1 Problem Chain Teaching Process Data Acquisition

In the process of question chain teaching, there are mainly two methods to obtain the original data: first, the teacher and a teaching assistant record and analyze the original data by means of classroom questions, student performance, head up rate records, in class tests and so on; Second, through the questionnaire survey of students' problem chain teaching before, during and after class, we can obtain the data of students' problem understanding, preference, impression and learning feeling in the process of problem chain teaching. Of course, the validity of the questionnaire needs to be analyzed here.

3.1.1 Classroom Records of Teaching Team

In question chain classroom teaching, ask a teaching assistant to record the classroom performance of teachers and students, mainly including classroom questions, students' head up rate, in class tests, etc. By recording the data in the implementation of problem chain teaching, it provides data support for the empirical research of problem chain teaching.

3.1.2 Questionnaire Survey on Students

In order to obtain the original data, data records and questionnaires are carried out. The course name of the questionnaire survey is weapon launching technology, and the number of students participating in the course is 46. Through the questionnaire survey, the satisfaction and learning experience of students participating in problem chain teaching are investigated to provide data support for the follow-up improvement of problem chain teaching, as shown in Table 1. In the form of anonymous, 46 copies are distributed and 46 copies are recovered, including 44 valid samples, as shown in Table 1.

3.2 Raw Data Preprocessing Method

Raw data preprocessing refers to the use of mathematical methods such as grey system, dimensional analysis and equivalence processing to reasonably convert a large number of data of different types and measures collected in the evaluation into scores between 0 and 100, so as to facilitate subsequent calculation and comprehensively obtain the evaluation value. In order to facilitate the synthesis of various influencing factors, it is necessary to preprocess the original data. This part of work mainly includes the quantification of qualitative indicators, the consistency of indicator types, the dimensionless of indicators, the normalization of indicator value range and other specific processes.

According to the scoring standard, assume that {fully consistent, consistent, neutral, inconsistent and completely inconsistent} correspond to {100, 80, 60, 40 and 20} respectively, and arithmetically average the scores obtained from multiple elements, and use the average value obtained as the score of the qualitative index. In this way, the qualitative index is quantified as a score with statistical characteristics between 0 and 100. The model can be described as:

$$F = \frac{N_1 \times 100 + N_2 \times 80 + N_3 \times 60 + N_4 \times 40 + N_5 \times 20}{N_1 + N_2 + N_3 + N_4 + N_5} \tag{1}$$

Where: N_1, N_2, N_3, N_4 and N_5 represent the number of people with a score of "fully qualified, qualified, neutral, unqualified and completely unqualified". Through the data preprocessing method, it can be converted into score FJ, and the results can also be further converted into different scores such as percentage score B_{j} (the highest score is 100, the same below), tenth S_{j} or five point W_{j} for comparison. The calculation formulas are:

$$B_j = F_j \big/ F_{max} \times 100 \tag{2}$$

$$S_j = F_j \big/ F_{max} \times 10 \tag{3}$$

$$W_j = F_j \big/ F_{max} \times 5 \tag{4}$$

Where: $F_{\max}$ is the maximum of all F_{j}.

3.3 Appropriateness Test of Questionnaire

Topic appropriateness refers to testing whether the actual observation times of a variable are consistent with the expected theoretical frequency distribution. If the two match, it indicates that the number of times the sample checks each option in a certain variable is roughly the same, and the number distribution of the sample in the variable is the same as the overall theory.

The test method used in this paper is chi square test, which tests the appropriateness of the factors such as problem traction, problem situation, student activity, student head up rate and teacher-student interaction rate in the questionnaire, sets the confidence level as 0.05, and makes the following assumptions:

H1: there is a significant difference in the selection times of each item of the primary index;

H0: there is no significant difference in the selection times of each item of the primary index.

See Table 2 for the test results of the appropriateness of each influencing factor.

Table 2. Appropriateness test of questionnaire survey.

Influence factor	Problem traction	Problem situation	Student activity	Student head up rate	Teacher student interaction rate
Chi square	28.248	12.448	6.734	5.490	24.374
Significance level	0.000	0.013	0.018	0.038	0.000

It can be seen from the above test statistics results that the significance level of each index is less than 0.05. Reject the zero hypothesis H0 and accept the hypothesis H1. It is considered that there are significant differences in the selection times of each influencing factor, so a questionnaire survey can be conducted.

3.4 Data Processing Method Based on SPSS Software

SPSS software is selected to analyze the results of this questionnaire survey, and discuss the role of various influencing factors on the teaching process of problem chain. The statistical idea of this questionnaire is to make statistics on all 44 effective samples recovered and calculate the mean value of their correlation degree. During statistical analysis, for the four levels of "strong correlation, general correlation, weak correlation and no correlation", the data of 3 points, 2 points, 1 point and 0 point are given respectively for quantification, and then all 33 effective samples are added for average. Then the calculation formula of the mean value of correlation degree is:

$$\overline{F} = \frac{3n_1 + 2n_2 + n_3 + 0n_4}{N} \tag{5}$$

Where: n_1, n_2, n_3 and n_4 respectively represent the number of valid questionnaires in which the relevance degree of a proposition in the valid questionnaire is rated as strong relevance, general relevance, weak relevance and no relevance. $N = 44$ is the number of all valid samples, so there are:

$$n_1 + n_2 + n_3 + n_4 = N \tag{6}$$

Before statistical analysis, strict inspection and screening should be carried out, the questionnaire should be numbered, and the closed questions in the questionnaire should be entered into excel and SPSS software. In order to prevent accidental errors caused by manual input, the database information is sampled and inspected. The error rate of this statistical inspection result is 0%.

4 Results and Analysis

4.1 Students' Interest in Different Teaching Problems

The distribution of students' interest in the five questions in the teaching question chain of this course is shown in Fig. 3. The dotted line in the figure is the polynomial prediction

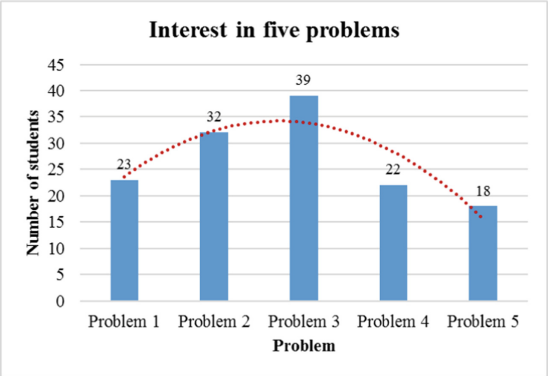

Fig. 3. Students' interest in five questions.

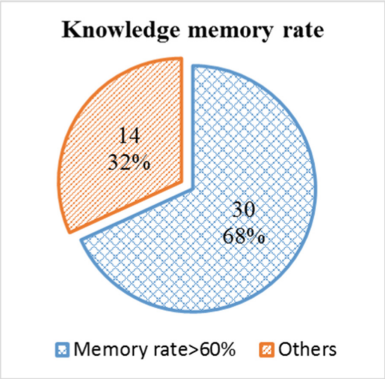

Fig. 4. Statistical results of students' knowledge memory rate.

trend curve of students' interest in the problem. Through data analysis, the following conclusions can be drawn: from the results, students have high interest in the five questions designed in this course (more than 40%), and the fifth question has the lowest interest, which also reached 40.9%. Moreover, the number of interested people shows the law of normal distribution, which shows that the teaching problem chain is well designed to a certain extent.

At the same time, according to the Ebbinghaus forgetting curve, students' forgetting of the learned knowledge presents a certain regularity. After the course, organize a questionnaire survey to investigate and analyze the knowledge points in the question chain, as shown in Fig. 4. It is found that 68.1% of the students have a memory rate of more than 60% of the problem chain, which is much higher than 30%–40% of the students in the previous course. This shows that problem chain teaching has certain advantages for students to understand and master curriculum knowledge.

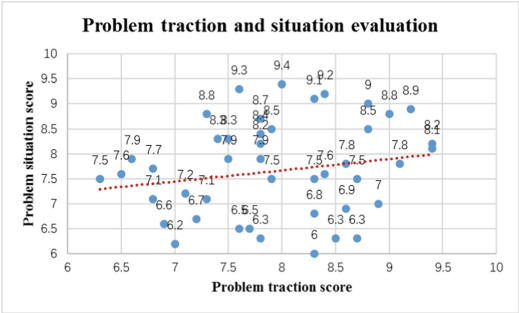

Fig. 5. Influence of problem traction and problem situation.

4.2 Influence of Problem Traction and Problem Situation

Problem traction and problem situation are important reasons affecting the effect of problem chain teaching. The impact analysis of problem traction and problem situation on teaching effect is shown in Fig. 5. It can be seen from the figure that the students' scores of teaching problem traction and problem situation are between 6.0 and 10.0 (out of 10 points), and the scattered points are evenly distributed in the figure, indicating that the problem traction and problem situation have been recognized by most students. These two factors have played a positive role in promoting the effect of problem chain teaching. The dotted line in the figure is the influence law of two factors on the teaching effect, which shows that improving the problem traction and building a better problem situation will effectively improve the problem chain teaching effect.

4.3 Analysis of Students' Activity in Problem Chain Teaching

Record and questionnaire the activity of students in question chain teaching, as shown in Fig. 6. It can be seen that in a 45 min class, the part with the highest jump in learning and life is the period at the beginning and after the middle of the class. After analysis, these are basically the two main stages for teachers to raise questions and discuss problems. It can be seen that in the implementation process of problem chain teaching, the two links of teachers raising questions and organizing discussion can most arouse the positive response of students.

4.4 Improvement of Students' Rise Rate in Problem Chain Teaching

In problem chain teaching, the rise rate of students is an important index to build an effective classroom. Within 45 min, the number of times the students looked up was recorded, as shown in Fig. 7. It can be seen that students raise their heads more frequently, and they are mainly distributed in the two main stages of discussing and answering questions. It shows that students look up more in these two stages of problem chain teaching, which shows that they expect to make eye contact with teachers, are willing to listen to teachers' introduction and explanation, and the interaction between teachers and students has also achieved good results.

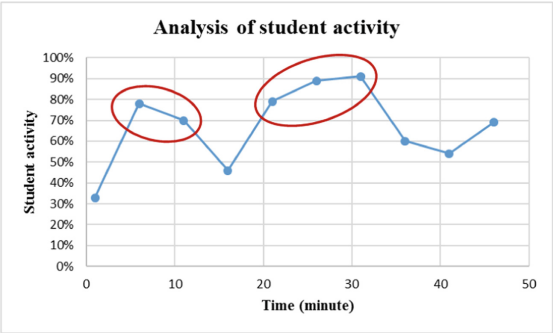

Fig. 6. Student activity in problem chain teaching.

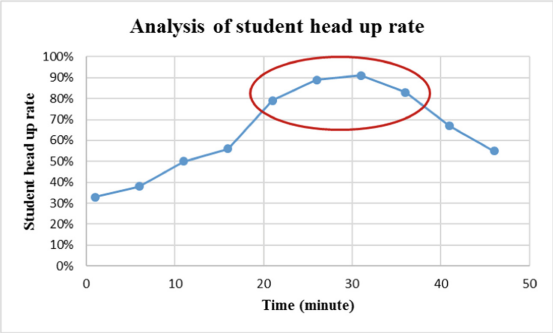

Fig. 7. Student head up rate in problem chain teaching.

4.5 The Influence of Teacher-Student Interaction Rate on Teaching Effect

The interaction rate between teachers and students will also have an important impact on the teaching effect of problem chain. Taking a class as an example, the influence of the teacher-student interaction rate recorded and drawn by the teaching assistant on the teaching effect is shown in Fig. 8. Obviously, the improvement of teacher-student interaction rate has a positive role in promoting the teaching effect of problem chain, and with the improvement of teacher-student interaction rate (e.g. after more than 70%), the role in promoting the teaching effect becomes more and more obvious, showing an exponential growth trend. The dotted line in the figure is the exponential trend curve of this impact. In addition, it is also found that the effect of problem chain teaching is about 30% higher than that of previous sequential teaching. However, problem chain teaching design and effective classroom organization and implementation are still the core to ensure the effect of problem chain teaching.

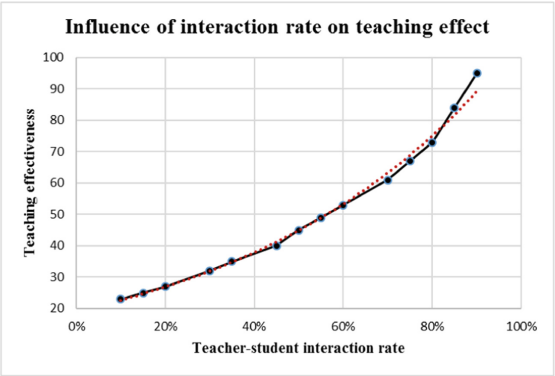

Fig. 8. The influence of teacher-student interaction rate on teaching effect.

5 Conclusions and Prospect

Based on the statistical model, this paper makes an in-depth study on the influence of multiple factors on the process and effect of problem chain teaching, and provides an idea and method for evaluating problem chain teaching. It is found that in the process of classroom implementation of problem chain teaching, effective problem traction, design relevance of problem chain and increasing teacher-student interaction are the most key reasons for the implementation of problem chain teaching, and have the greatest impact on the effect of problem chain teaching. It also studies the impact of the effectiveness of teacher-student interaction on the effect of problem chain teaching, which provides a reference for the effective implementation of problem chain teaching in the classroom.

Although this paper provides a new research perspective for the evaluation of problem chain teaching, it should be noted that due to the different professional nature and curriculum content, the evaluation of problem chain teaching effect is also very different. Therefore, the evaluation of problem chain teaching effect can not be generalized, but should be analyzed in specific circumstances, which is also the next research direction of this paper.

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