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The Application of CTI Teaching Model in High School Mathematics teaching

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Abstract. CTI teaching mode is a kind of teaching mode based on constructivism theory and successful intelligence theory to develop students' core literacy, and its core is to develop students' core literacy in the process of knowledge exploration, construction and application. Based on the introduction of CTI teaching mode, this paper takes the knowledge of " arithmetic progression" as the carrier, and applies CTI teaching mode to high school mathematics teaching, in order to provide reference for the utilization of CTI teaching mode in high school mathematics teaching.

Keywords: CTI Teaching Model; High School Mathematics; Core Literacy.

1. Introduction

The CTI teaching model is a teaching model constructed by Professor Yu Ping aimed at developing students' core competencies. In the CTI teaching model, "C" represents "construct" construction, "T" represents "transfer" transfer, and "I" represents "innovation". Therefore, it is abbreviated as the "construction transfer innovation" three link teaching model. The essence of the CTI teaching model is to place the process of exploring knowledge on an equal footing with the knowledge itself. Students understand the essence of knowledge and develop mathematical core competencies in the process of exploring knowledge, complete the construction of knowledge, and implement the curriculum goal of developing students' mathematical core competencies[1].

The CTI teaching model builds a platform for students to explore new knowledge in specific and authentic contexts by creating problem scenarios. In the process of exploring new knowledge, complete the construction of new knowledge and enable students to develop their low-level mathematical core literacy. Further construct and understand new knowledge in the understanding, transfer, and innovative application of knowledge, and develop students' high-level mathematical core literacy.

Compared with the traditional teaching model that only emphasizes knowledge mastery, the CTI teaching model not only emphasizes knowledge but also emphasizes the cultivation of literacy. The traditional teaching model evaluates teaching based on the mastery of knowledge, while the teaching evaluation of CTI teaching model focuses on the achievement of core competencies. The traditional teaching model exercises are designed to achieve the teaching goal of mastering knowledge. The CTI teaching model further constructs the core literacy of students in the development of new knowledge through three layers of progressive knowledge application: understanding, transfer, and innovation.

2. Specific aspects of the CTI teaching model

2.1 Designing problem situations

The cultivation of core mathematical literacy requires problem scenarios, and the CTI teaching model starts with designing problem scenarios. In this teaching activity, the teacher designs suitable scenarios and questions for exploration based on the teaching objectives and content that contain core mathematical literacy, stimulates students' learning interest, inspires their thinking, builds a "scaffold" for new knowledge construction, and encourages students to actively participate in the process of exploring and constructing knowledge.

2.2 Exploration and Construction of Knowledge.

The exploration and construction of knowledge is a key link in the generation and development of core competencies. In this section, students explore the problems in the context, reveal the process of knowledge occurrence, development, and formation, and master knowledge and develop mathematical core literacy from it.

2.3 Understanding and applying knowledge

This stage is similar to traditional teaching methods, mainly solving internal problems in mathematics. On the basis of understanding new knowledge, teachers use example questions to illustrate the application of knowledge, and students use basic exercises to understand and consolidate knowledge, gaining a deeper understanding of new concepts. The understanding and application of knowledge mainly focuses on the cultivation of the "four basics", vigorously developing students' mathematical core literacy such as mathematical abstraction, logical reasoning, mathematical operations, and intuitive imagination, while infiltrating the cultivation of character and values.

2.4 Transfer and application of knowledge

The teaching process that plays a bridging role in the CTI teaching model is the transfer and application of knowledge. On the basis of students' understanding of knowledge, cultivate their ability to apply the new knowledge they have learned to solve internal and external problems within the discipline. The transfer and application of knowledge mainly gather the cultivation of the "four abilities", effectively developing students' modeling ability, data analysis ability, and mathematical abstraction ability. At the same time, character and value education should also be integrated into teaching[2].

2.5 Innovative application of knowledge

The final stage of CTI teaching mode is the innovative application of knowledge. On the basis of students' understanding and application of knowledge, cultivate their ability to propose deeper problems and solve problems with poor structure. The key step in cultivating high-level mathematical core competencies such as innovation awareness and practical ability is the innovative application of knowledge.

3. Application of CTI Teaching Model in Mathematics Teaching

Functions as a major strand of math instruction consists of three components. The series is a class of special functions studied in high school mathematics, and the equal-difference series is the first special function that students learn in the series. Isotropic series not only contains rich mathematical ideas and methods, but its study can also provide research ideas for the study of isoperimetric series. This paper introduces the CTI teaching mode and designs the teaching clip of "Equal Difference Series" in order to provide reference for the mathematics teaching to cultivate students' core mathematical literacy. Based on the actual situation of the class taught by the author, the first three steps of the CTI teaching mode are used in the teaching design of this lesson.

3.1 Creating a Teaching Situation

Teacher: Students watch the board (three teaching situations created by the teacher) and think about and answer the following questions.

Situation 1: In order to help residential students contact their parents, the school contacted a mobile company to install telephones in the school, and the call billing standard is 1.9 yuan per minute, and the call charges are 1.9, 3.8, 5.7, 7.6, 9.5..... in descending order.

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Question 1: Students observe the set of numbers above and think about how it could form a series. How did you determine this?

Situation 2: Our country has the habit of using twelve zodiac signs to date the year, 2024 is the year of the dragon, starting from 2024, the year of the dragon in order of 2024, 2036, 2048, 2060, 2072....

Question 2: Students observe the set of numbers above and think about whether it can form a series. How do you judge it? Follow-up question: is 2084 the year of the dragon, and what is the tenth dragon year after 2024?

Situation 3: The Olympic Games began in Greece, organized once every four years, held in Paris, France in 2024. China's first participation in the Olympic Games was in 1932, only Liu Changchun as a participating athlete, with the country's prosperity, the 2008 Olympic Games were held in Beijing, the five Olympic Games before 2008 were held in 2004, 2000, 1996, 1992, 1988.

Question 3: Students observe the set of numbers above and think about whether it can form a series. How do you determine this? Observing the three sets of number series above and with the help of mathematical operations, think about what are the characteristics of each set of series? And what do they have in common?

Design intention: The first step of CTI teaching mode is to design the problem situation. In this paper, by showing three situational problems with living and realistic significance, we stimulate students' desire for knowledge, guide students to take the initiative to enter into the investigation and learning of new knowledge, cultivate students' ability to observe situational problems, discover mathematical problems, generalize and summarize mathematical phenomena and study mathematical problems in the problematic context, and develop students' core literacy in mathematical abstraction.

3.2 Exploring and Building Knowledge

Question 1, Expected Student Answer: Based on the definition of a series: In general, we call a column of numbers arranged in a definite order a series, and we can determine that the set of numbers can constitute a series[3].

Question 2, Expected Student's answer: determine that this set of numbers can form a series based on the definition of a series. Since 2084 = 2071 + 12, 2084 is a dragon year. Since 2024 + 10 × 12 = 2144, the tenth dragon year after 2024 is 2144.

Question 3, Expected Student Answer: Based on the definition of a series, this set of numbers can also form a series.

By observing and doing the math I found that the first series is monotonically increasing, the latter minus the former is 1.9, the second series is monotonically increasing, the latter minus the former is 12, and the third series is monotonically decreasing, the latter minus the former is 4.

Teacher: Very good, how can you describe the pattern you found in mathematical language?

Student: the latter term minus the former term in the series is the same constant.

Teacher: The students answered very well, is there any student to add?

Student: Because the first term does not have a previous term, so it should be from the second term, the latter term minus the previous term is the same constant.

Teacher: This student observed very carefully, it is worthwhile for students to learn. From this we derive the concept of the equal difference series (Teacher board the concept of the equal difference series.) .

Teacher: This is a verbal description of an equal-difference series, can the students define an equal-difference series in mathematical notation?

Student: $a_n - a_{n-1} = d$

Teacher: Any other students want to add?

Student: $a_n - a_{n-1} = d(n \geq 2, n \epsilon N^*)$

Teacher acknowledges.

Design intention: A highlight of the CTI teaching mode is that it does not only emphasize knowledge, but also focuses on the process of knowledge generation, in which students' core mathematical literacy is cultivated. In this session, students are guided to think step by step in specific and real teaching situations, guided to observe, analyze and summarize the rules of the series involved in the situations with mathematical vision, from which the concept of the equidistant series is abstracted, and guided to describe the equidistant series step by step from the use of natural language to literal language to symbolic language. Until the concept of equal difference series is presented in a mathematical and concise state in the students' cognition. In the process of abstraction of the concept of equal-difference series, students mastered the understanding of the nature of mathematical concepts and expanded the core literacy of mathematical abstraction and logical reasoning. Finally, through practice problems, new knowledge is further constructed in the application of knowledge.

Exercise : Insert a number between the following two numbers to make it an arithmetic sequence:

（1）647、895；（2）$-12\frac{1}{3}$、$24\frac{3}{5}$

Student: Let the number inserted between 647 and 895 be x, in order to make 647, x, and 895 an arithmetic sequence. According to the concept of arithmetic sequences, x-647=895-x, 2x=647+895, x=771. Similarly, it can be inferred that inserting $6\frac{2}{15}$ between $-12\frac{1}{3}$ and $24\frac{3}{5}$ can make it an arithmetic sequence.

Teacher: If we use a, A, and b to represent the three terms of an arithmetic sequence, what relationship do they satisfy?

Student: defined by $A-a=b-A$，$2A=a+b$，$A=\frac{a+b}{2}$

Teacher: Now we can abstract the concept of arithmetic mean (teacher writes on the board)

Teacher: Through the study of sequences, we know that there are general formulas for sequences. As we mentioned earlier, what are the three sets of mathematical general formulas in a context?

Student: The formula for the general term of the sequence in scenario one is $a_n=1.9+1.9(n-1)$.The general formula for the sequence of numbers in scenario two is $a_n=2024+12(n-1)$.The general formula for the sequence of numbers in scenario three is $a_n=2008-4(n-1)$.

Teacher: If a sequence $\{a_n\}$ starts with a_1 and takes d as the tolerance, what are a_2，a_3，a_4?

Student: From the definition of arithmetic sequences $a_2-a_1=d$, $a_2=a_1+d$

$a_3-a_2=d$, $a_3=a_2+d=a_1+2d$,

$a_4-a_3=d$, $a_4=a_3+d=...=a_1+3d$

Teacher: What about a_n?

Student: From the definition of arithmetic sequences, it can be concluded that $a_n-a_{n-1}=d$,$a_n=a_{n-1}+d=...=a_1+(n-1)d$ $(n\geq 2, n\epsilon N^*)$

Teacher: This method of deducing the recursive formula of arithmetic is called mathematical induction. Do you have any other methods to derive the general term formula of arithmetic sequences? Let's explore in groups (limited to five minutes).

Student: $a_2-a_1=d$，$a_3-a_2=d$，$a_4-a_3=d$，…，$a_n-a_1=d$，$a_n-a_1=(n-1)d$，$a_n=a_1+(n-1)d$.

Design intention: The teacher drives students' thinking activities in the form of problems by setting exercise questions. Students solve problems, apply ideas from special to general, abstract the definition of the arithmetic mean, form internal logical relationships between concepts, and develop core competencies such as mathematical abstraction, logical reasoning, and mathematical operations. Teachers use three sets of sequences in the context to guide students to explore independently, and use mathematical induction to obtain the general formula for arithmetic sequences. In addition, students explore other methods for deriving the general term formula of arithmetic sequences in the form of group cooperation, deepen their understanding of knowledge,

develop their logical reasoning and mathematical calculation abilities, and cultivate their sense of cooperation.

3.3 Understanding and application of knowledge

Example 1 (1) Given that the formula for the general term of the arithmetic sequence $\{b_n\}$ is $b_n = 8 - 6n$, find the tolerance of $\{b_n\}$ and the first term;

(2) Find the 20th item of the arithmetic sequence 9, 6, 3;

(3) Is -402 a term in the sequence -4, -6, -8? If so, which item is it?

Example 2: Given a sequence $\{a_n\}$ with a general formula of $a_n = -3n + 6$, determine if $\{a_n\}$ is an arithmetic sequence?

If so, prove it, and if not give reasons.

Follow-up: What if the generalized formula is $a_n = pn + q$?

Design intention: The application of knowledge understanding is an important part of the CTI teaching model. Students have completed the construction of knowledge in the previous session. In this session, by setting example problems and practice problems, students not only further construct new knowledge in the application of knowledge, but also cultivate the ability of analyzing and solving mathematical problems in problem solving, and develop students' core mathematical literacy.

Example 1 helps students clarify the relationship between a_n, a_1, d, n by setting three practice problems from shallow to deep. Students use the general formula of the equal-difference series to solve problems, feel the idea of using equations to know one and three, and develop students' mathematical operation literacy.

Example 2 guides students to explore the equal difference series from the perspective of function. Deepen the understanding of the equation of the general term of the equal difference series, initially establish the connection between the equal difference series and the primary function, so that students understand that the equal difference series is a special class of functions, and provide research paths for the connection between the equal difference series and the function.

4. Summary

The CTI teaching mode provides new teaching concepts and methods for teaching equal difference series in high school, and through the implementation of this mode, it can stimulate students' learning interest, cultivate students' independent learning ability, and improve students' core mathematical literacy.

This paper is based on the core concept of CTI teaching mode, closely related to the specific situation of the teaching of the equidistant series. The sequence of teaching was designed according to "creating problematic situations, exploring and constructing new knowledge, understanding and applying knowledge". It provides a reference for the use of the CTI model in teaching mathematics in senior secondary schools. Looking ahead, should continue to explore and improve the CTI model to adapt to the diverse learning characteristics and needs of high school students and to create a more efficient and interactive teaching environment.

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