**A Study on Teaching Strategies for Cultivating Mathematical Operations Literacy in High School Students under the CTI(Construct-Transfer-Innovate) Teaching Model**

**Abstract:**

The General High School Curriculum Standards outline six core competencies, among which ‘mathematical operation’ is the most fundamental, critical, and frequently used. Under the current educational reform, how to effectively cultivate students' mathematical operation competencies has become a topic of significant concern both domestically and internationally. CTI (Construct-Transfer-Innovate) teaching model was proposed by Chinese education researcher Ping Yu in recent years. It is a teaching model designed primarily to develop students' core mathematical literacy. This paper employs theoretical research methods to explore the application of the CTI teaching model in fostering students' core mathematical operation competencies. Based on a clear understanding of the definitions and requirements of the CTI teaching model and mathematical operation literacy, and in conjunction with the current state of mathematical operation literacy in secondary schools, this paper proposes strategies for cultivating students' core mathematical operation literacy under the CTI teaching model: 1) Teachers should create authentic contexts to facilitate knowledge construction; 2) Emphasise foundational knowledge and place importance on teaching demonstrations; 3) Design variant problems to drive transfer and application; 4) Design innovative problems to stimulate creative thinking. These strategies can effectively enable students to actively construct computational rules and logical systems in appropriately designed real-world contexts. Emphasising foundational knowledge and instructional demonstrations helps students to value foundational computational skills, while appropriately designed transfer problems establish connections between mathematical knowledge and mathematical thinking methods. These problems also assist students in developing computational strategies and speed, as well as multiple solutions to a single problem. Addressing deep-level mathematical problems and structurally complex issues helps to expand students' thinking and cultivates their ability to apply operations innovatively to solve complex problems. It is hoped that educators will draw inspiration from these strategies, combine them with reflection and evaluation, and ultimately enhance students' core mathematical operational literacy.

**Key words:** CTI teaching model; Core literacy; High school mathematics; Mathematical operations literacy; Teaching strategy

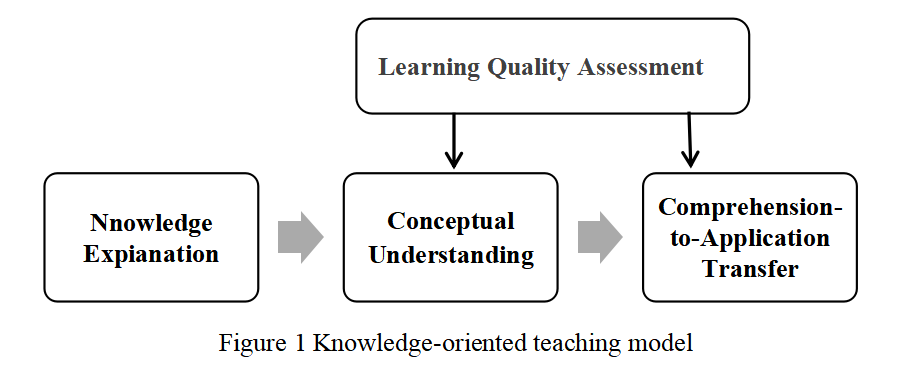
1. INTRODUCTION

With the deepening of education reform, the cultivation of students' core literacy has become a focus of attention in the education sector at home and abroad. Six core literacies, namely "mathematical abstraction", "logical reasoning", "mathematical modelling", "mathematical operations", "intuitive imagination", "data analysis", are put forward in the General Senior Secondary School Mathematics Curriculum Standards (2017 Edition) published in China, "Mathematical Operations", "Intuitive Imagination", and "Data Analysis". Of these, 'mathematical operations' literacy is the most fundamental and critical, as well as being the most frequently used. It is the centralised presentation process of the other core literacies and plays a vital role in students' learning development and the cultivation of other literacies.However, there are certain limitations in the current high school mathematics teaching, and there are still many problems in the cultivation of mathematical operations literacy, which makes it difficult to effectively develop and improve students' mathematical operations literacy. CTI (Construct-Transfer-Innovate), a teaching model put forward by the Chinese education researcher Ping Yu in recent years, is a teaching model that is mainly directed to the development of students' mathematical core literacy. It is a teaching model mainly directed to the development of students' core mathematical literacy (Nasrulloh et al., 2023). As an innovative teaching mode, it emphasises the exploration and construction of knowledge, the understanding and application of knowledge, the transfer and application of knowledge and the innovative application of knowledge, and the teaching goal focuses on the transformation from the understanding of knowledge to the enhancement of literacy, which is potentially valuable for the enhancement of students' core mathematical literacy. Based on the CTI teaching mode, how to develop the core literacy in mathematical operations of high school students, and what are the effects of the CTI teaching mode on the development of the core literacy in mathematical operations of high school students? This paper tries to explore the practical significance of CTI teaching mode on the development of mathematical arithmetic literacy of high school students, hoping that it can provide more teaching methods for the development of mathematical arithmetic literacy, and provide theoretical support and strategic guidance for the practice of mathematics education.

**2. Relevant analyses of the CTI teaching model**

**2.1 Constructing a CTI teaching model that points to the development of core mathematical skills**

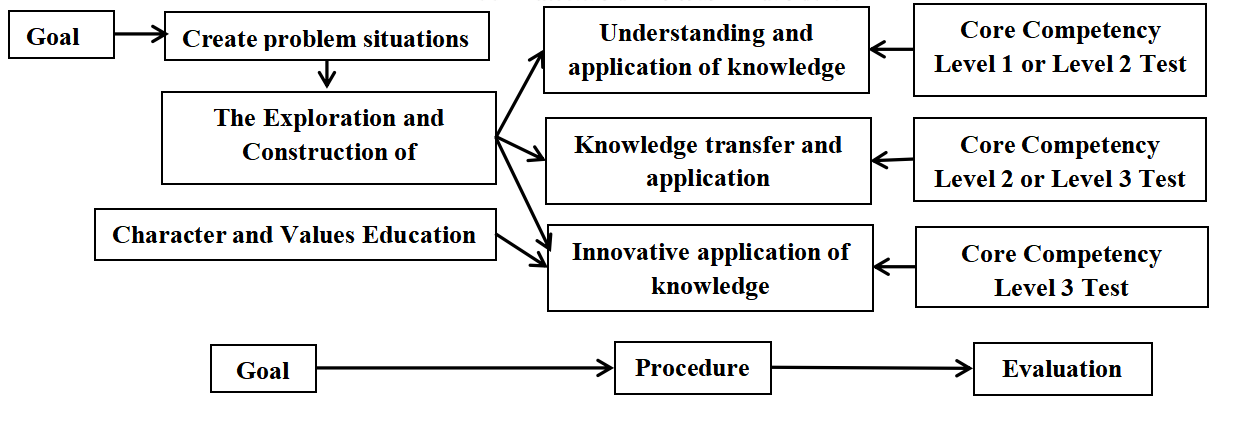
For a long time, teaching has been understood as the transmission of knowledge. The teaching goal is knowledge-oriented and the teaching mode is embodied in the process of learning knowledge, from explanation to understanding to application. The latter two links are embedded with the evaluation of learning quality, as shown in Figure 1. With the progress of society and the deepening of education reform, the society entering the information age has new requirements for the literacy of modern citizens. In terms of mathematics teaching, researchers have proposed a shift from knowledge-focused teaching goals to new teaching goals that place equal emphasis on knowledge and literacy. However, the teaching model in Figure 1 is not up to the task of achieving the dual goal of developing students' knowledge, understanding and literacy. The intermediate conversion mechanism from knowledge and understanding to literacy development also needs to be explored.



**Figure 1** Knowledge-oriented teaching model

In China, many researchers are also exploring this issue, based on which a research team led by Prof. Ping Yu of Nanjing Normal University has proposed a model of conversion mechanism from knowledge learning to the development of students' core literacy. Compared with Fig. 1, It has added three links based on the original linear model, i.e., the exploration and construction of knowledge, the transfer of knowledge, and the innovative application of knowledge, and changed "teacher teaching" to "setting the context". The "teacher teaching" is replaced by "setting the context". Through these three stages of learning, students can go through the path of problem solving to achieve the purpose of learning progression, and the evaluation of learning quality is directly directed to the core literacy. The intervention of these three stages can explain more accurately the internal transition mechanism from knowledge learning to literacy development.

Based on this intrinsic transformation mechanism, Ping Yu's team proposes a teaching model for developing students' core mathematical literacy(**Figure 2**). This teaching model is the "Construct-Transfer-Innovate" (CTI) teaching model.



**Figure 2** CTI Teaching Model Focusing on Core Mathematical Literacy

**2.2 Theoretical basis of CTI teaching model**

The theoretical foundations of the CTI teaching model are mainly constructivist theory and successful intelligence theory.

(1) Constructivist Theory

The basic tenets of constructivism are the constructive nature of knowledge , the social nature of knowledge, the contextual nature of knowledge, the complexity of knowledge, and the tacit nature of knowledge. In the CTI model, the "inquiry and construction of knowledge" session shows the "constructive nature of knowledge" and "social nature of knowledge", and the cognition of learning is the process of constructing knowledge; the "creation of context" session embodies the "constructive nature of knowledge" and "social nature of knowledge". The link of "creating a situation" reflects the "contextual nature of knowledge", and the purpose of creating a situation is to assist in the construction of knowledge; the "transfer and application of knowledge" and "innovative application of knowledge". The "transfer and application of knowledge" and "innovative application of knowledge" links are precisely to deal with the complexity of knowledge learning, reflecting the "complexity of knowledge". It can be seen that the CTI teaching model is firmly based on the constructivist theory.

(2) Successful Intelligence Theory

Sternberg further proposed the theory of Successful Intelligence based on his triadic theory of intelligence, which consists of three elements: analytical intelligence, creative intelligence, and practical intelligence. Analytical intelligence is used to solve problems and determine the quality of the results of thinking, creative intelligence helps us to form good questions and ideas from the beginning, and practical intelligence implements ideas and their analyses in a proven way. Successful intelligence is an organic whole and is most effective when the analytical, creative and practical aspects are coordinated and balanced, and analytical, creative and practical intelligence are involved in all three aspects of the application of knowledge in the CTI model. For example, the transfer of knowledge requires the input of "practical intelligence", and the innovative application of knowledge demonstrates the nature of "creative intelligence", and the pursuit of CTI teaching mode fits perfectly with the statute of successful intelligence theory.

**2.3** **Instructional Objectives of the CTI Teaching Model**

The teaching objectives of the CTI teaching model are directly targeted at developing students' core mathematical literacy. In the process of designing teaching objectives based on the CTI teaching mode, the following two steps should be taken. Firstly, the manifestations of mathematical core literacy directly related to the content of the lesson or unit should be identified, as well as the levels of these manifestations that have been reached. Secondly, a specific description of the requirements to be achieved for the basic knowledge, basic skills, basic ideas, and basic activity experiences involved in the mathematical lesson or unit in conjunction with the content of the lesson should be made. Thirdly, it is imperative to establish the problems that are to be identified and addressed by students, along with the methodologies that will be employed for analysis and resolution. Subsequently, there is a necessity to refine the educational components, such as character and values, to be incorporated into the lesson or unit, and to devise strategies for their implementation.

**2.4 Instructional Procedures for the CTI Teaching Model**

The teaching procedure of the CTI teaching model mainly consists of five steps, namely designing problematic situations, inquiry and construction of knowledge, understanding and application of knowledge, transfer and application of knowledge, and innovative application of knowledge. These five steps are from shallow to deep, without the previous learning accumulation, the later steps will not be able to advance, thus, the teaching procedure is generally carried out in this order.

(1) Designing problem situations

Problem context design can be regarded as a form of "prior organiser", the function of which is to facilitate the assimilation and comprehension of knowledge by students. In the field of context design, it is imperative to recognise the inherent challenges that come with the territory. The context, by its very nature, must encompass mathematical problems, encompassing mathematical concepts, propositions, models, and ideas. Moreover, it is crucial to prioritise the authenticity of the context, ensuring that the pursuit of real, rather than artificial, constructs is given utmost consideration. Additionally, the educational aspect of context design should be emphasised, as the design of the context can serve as a conduit for the dissemination of elements that are integral to character and value education.

(2) Inquiry and Construction of Knowledge

The process of enquiry includes not only enquiry into the acquisition of new knowledge, but more often the proof of propositions and the application of knowledge in the exploration of ideas and methods of solving problems. The exploration and construction of knowledge should be taught in a concept-forming way, i.e., concepts are acquired by thinking from the particular to the general.

(3) Application of knowledge understanding

This session is similar to the traditional mode of teaching, in that it involves students in understanding and consolidating their knowledge through basic exercises. Students' basic mathematical literacy is developed through basic knowledge, basic skills, basic methods of thinking and basic experience of mathematical activities.

(4) Transfer of Knowledge Application

Transfer of Knowledge and Application is the first step forward based on the understanding and application of knowledge , which mainly develops students' ability to identify, formulate, analyse and solve problems. It aims to develop students' abilities in problem identification, problem formulation, problem analysis and problem solving, as well as to enhance students' core mathematical literacy in data analysis, mathematical modelling and application awareness.

(5) Innovative application of knowledge

Creative application of knowledge is the second progression based on the understanding and application of knowledge, teaching is based on students asking deeper questions with poorly structured problems, and the core literacy points to the development of creative awareness and practical skills.

**3. Definition and Requirements for Mathematical Operations Literacy**

**3.1 Definition of mathematical operations literacy**

Many scholars at home and abroad have explored the connotation of mathematical operation literacy, and here, we take the explanation of mathematical operation literacy in China's Standard for the Curriculum of General High School Mathematics (2017 Edition) as the definition of mathematical operation literacy in this paper. That is, mathematical operation is the process of solving mathematical problems based on the laws of arithmetic on the basis of clarifying the object of operation. It mainly includes: understanding the object of operation, mastering the laws of operation, exploring the direction of operation, choosing the method of operation, designing the procedure of operation, and obtaining the result of operation.

**3.2 Levels of Mathematical Operations Literacy and Requirements**

The NSS Mathematics Standard divides mathematical operations literacy into three levels, as described in the table below:

**Table 1. The NSS Mathematics Standard divides mathematical operations literacy into three levels**

|  |  |
| --- | --- |
| level (of achievement etc) | mathematical literacy |
| Level 1 | Be able to understand arithmetic objects and ask arithmetic questions in familiar mathematical situations.  To be able to understand the rules of arithmetic and their scope of application, and to carry out operations correctly; to be able to formulate appropriate arithmetic ideas based on the characteristics of the problem and to solve problems in familiar mathematical situations.  They should be able to appreciate the significance and usefulness of rules of arithmetic and be able to use arithmetic to verify simple mathematical conclusions.  In the process of communicating, be able to illustrate problems with the results of arithmetic operations. |
| Level 2 | Be able to identify arithmetic objects and ask arithmetic questions in connected contexts.  Be able to solve arithmetic problems by choosing arithmetic methods and designing arithmetic procedures.  To be able to understand that arithmetic is a form of deductive reasoning; to be able to appreciate the significance and usefulness of procedural thinking in the integrated use of arithmetic methods to solve problems.  The ability to explore issues with the help of arithmetic in the process of communication. |
| Level 3 | Be able to identify arithmetic objects and ask arithmetic questions in connected contexts.  Be able to solve arithmetic problems by choosing arithmetic methods and designing arithmetic procedures.  To be able to understand that arithmetic is a form of deductive reasoning; to be able to appreciate the significance and usefulness of procedural thinking in the integrated use of arithmetic methods to solve problems.  The ability to explore issues with the help of arithmetic in the process of communication. |

In the above table, Level 1 is the requirement for senior secondary school graduation and the basis for the Mathematics Academic Level Examination for senior secondary school graduation;Level 2 corresponds to the requirements of the college entrance examination and serves as the basis for setting questions in the mathematics section of the college entrance examination; and Level 3 is the requirement for attaining mathematical literacy based on certain elements of the compulsory, optional compulsory and elective curricula, which can serve as a reference for the independent admission of students to universities.

**4. Analysis of the current situation of mathematical literacy in secondary schools**

**4.1 Student level**

(1) Low emphasis on mathematical operations

Arithmetic exists everywhere in mathematics, and mathematical operations have always been accompanied by students' mathematical learning, but the long time of arithmetic has made both teachers and students neglect the importance and necessity of mathematical operations. In high school, a large number of mathematical methods, ideas and mathematical knowledge of the study of students just ignore mathematical operations. In the usual practice, students ignore the practice of arithmetic ability, think that as long as the memorisation of mathematical formulas can be enough, but the students actually do not master the arithmetic and ability of arithmetic.

(2) Poor reading skills

Some studies have found that many students make calculation errors because they do not examine the questions carefully, do not understand the meaning of the questions and the key information, and have poor reading skills, which leads to calculation errors. Poor reading skills are mainly reflected in ignoring hidden information and incomplete examination of the questions; the questions are too long and they cannot get useful information from the longer questions; and they cannot convert textual language into mathematical language for practical problems.

(3) Incomplete grasp of the laws of arithmetic and their application

Students are not proficient in mathematical concepts, algorithms and mathematical formulas. Due to the large number of formulas, students are easily confused in the memorisation of formulas. Students do not understand the source of formulas and only know how to memorise them by rote, while the formulas are extremely similar, which leads to students' mistakes. Secondly, students are not clear about the scope of application of the formula, when doing problems, they do not think about whether the rules of arithmetic are applicable or not, and directly apply the formula, which leads to errors.

(4) Failure to develop appropriate arithmetic ideas for specific problems

Mathematical operations literacy requires students to be able to develop appropriate mathematical ideas to solve problems. However, when students encounter more complex and integrated problems, they are confused, incomplete and illogical, and fail to formulate clear ideas for solving the problems.

(5) Poor arithmetic habits of students

It has been determined that a significant proportion of students demonstrate an aversion to utilising pencils in the context of mathematical study, preferring instead to rely on cognitive processes. This tendency is further compounded by a lack of engagement with conventional study practices, which is evidenced by the prevalence of calculation problems in examination assessments. Secondly, a considerable number of students do not pay sufficient attention to the utilisation of sketchbooks. Some students are accustomed to jotting down notes in their sketchbooks, and the calculation process is perplexing. Furthermore, some students do not possess a designated mathematics sketchbook.

**4.2 Teacher level**

(1) Traditional teaching philosophy

Under exam-oriented education, many teachers still adhere to the outdated teaching mode of teaching for the sake of grades. Almost all teachers have habitually taught all the content of high school in the first and second years of high school, and spent the rest of the time on revision, compressing three years of content into two years, and relying on a large number of exercises in the rest of the time to improve the performance of students, which has become a common teaching mode in high schools. Teachers and schools still take the performance of students as the main goal of teaching and neglect the development of students' qualities.

(2) Outdated teaching methods

In the face of different students, the teaching methods of teachers remain unchanged, and there is still a "full classroom", in which the teacher mainly gives lectures and the students are only responsible for writing and copying in the classroom. Nowadays, many schools have installed multimedia, but many teachers in the application of multimedia can not be effectively combined with the teaching, many teachers just show all the knowledge points in the multimedia, the classroom has become a PPT show class, but greatly reduces the learning efficiency.

(3) Lack of teaching demonstrations

Teachers are not only the transmitters of knowledge and concepts to students, but also influence students by their words and behaviour in class. The importance teachers attach to mathematical operations in class also affects students' attitudes towards mathematical operations. Many teachers choose to give up calculations and only explain methods in order to teach more in class. As time goes by, students will only write down the process without calculating, or develop the habit of looking at the problems, and in the long run, students' mathematical calculation ability will become lower and lower.

**4.3 External factors**

The development of technology has brought many changes to the education sector as well, and the widespread use of calculators and smartphones has had a huge impact on students' ability to perform mathematical calculations. Students habitually rely on electronic devices when they are faced with complex calculations or have no ideas for solving problems. The use of calculators shortens students' practice time, which leads to students' mathematical ability to remain in simple calculations; mobile phone photo searching reduces students' thinking time, which leads to students' ability to think independently can not be exercised, and it is difficult to improve their mathematical literacy.

**5.** **Teaching Strategies for Cultivating Mathematical Operations Literacy in High School Students in CTI Teaching Model**

In order to better cultivate high school students' mathematical operations literacy with the help of CTI teaching mode, based on the teaching objectives and procedures of CTI teaching mode as well as the current situation of mathematical operations literacy in secondary schools, the following teaching strategies are given in accordance with the main procedures of the CTI teaching mode, i.e., Knowledge Exploration and Construction , Knowledge Understanding and Application, Knowledge Migration and Application, and Knowledge Innovation and Application, respectively.

**5.1 Creating Real Situations to Promote Knowledge Construction**

This strategy belongs to the teacher's teaching preparation strategy in the stage of knowledge exploration and construction in the CTI teaching mode, which requires the teacher to help students actively construct arithmetic rules and logic systems through creating real situations and problem-driven. Specifically, teachers can design real-life problems that need to be solved by arithmetic by linking them to the background of life or disciplines; guide students to independently deduce the rules of arithmetic through experiments, conjectures, verification and other modes of inquiry; and summarise the underlying logic of the steps of arithmetic, so as to help students carry out structured sorting and form a knowledge network.

Constructing knowledge through context-driven construction is consistent with the rule of moving from figurative operations to abstraction, and is equally consistent with the formative learning approach of teaching concepts and propositions in the teaching of mathematics in senior secondary schools. When students perform mathematical operations, they have problems such as poor reading skills; lack of clarity and understanding of the objects of mathematical operations; and lack of clarity in thinking about mathematical operations. Knowledge exploration and construction mainly involves learning new knowledge and new methods, and the introduction and design of new knowledge is closely related to the teaching context. A good teaching context can enable students to better understand the mathematical objects when they first come into contact with new knowledge, so that they are less prone to make mistakes when they perform arithmetic operations on the relevant mathematical objects. In addition, this strategy not only requires mathematics teachers to pay attention to the design of the teaching context, but also to pay attention to the interactivity of the classroom, and to ask more questions so that students can think more and co-operate with each other. Teachers also need to update their teaching concepts, learn more about mathematical culture, the background of mathematical knowledge and other related resources, expand their own knowledge and be creative.

For example, a teaching case of "The construction of logarithmic operation rules" is given. Create a teaching situation: archaeologists through the carbon 14 half-life determination of the age of cultural relics, known formula , how to calculate the age *t* from the measured data. Through this situation, students try to use the exponential equation deformation, and found that the direct solution to the difficulty; and then the introduction of logarithmic symbols, the derivation of logarithmic arithmetic rules; and finally, compared with the logarithmic conversion formula of the different bases, to sum up the logic of the formula for changing the bases. As a result, students understand the inevitability and instrumental value of logarithmic operations in practical problems, avoiding errors in mechanical memorisation of formulas.

Reasonable context creation can effectively enable students to take the initiative to build the rules of arithmetic and logic system, students in the process of new knowledge construction, can better understand the formation process of mathematical objects and related rules of arithmetic. At the same time in the context can also improve the ability to read mathematics, experience the formation process of mathematical cultural knowledge and the value of mathematics, improve the level of mathematical operations and literacy.

**5.2 Emphasis on basic knowledge and teaching demonstrations**

This strategy belongs to the teacher's teaching strategy at the stage of understanding and application of knowledge in the CTI teaching model, which requires teachers to pay attention to the teaching of basic knowledge and teaching demonstration to enhance students' understanding of concepts and formulas. Teachers should pay attention to the design of the board, for the derivation process of mathematical operation formulas, the connection and difference between mathematical formulas, teachers write on the blackboard will show the formation process of mathematical knowledge, which will help students understand and remember.

The teaching strategy of this session is similar to the traditional teaching pattern, which is based on the initial understanding of new knowledge, the teacher explains the application of knowledge through detailed teaching demonstrations, and students understand and consolidate knowledge through basic exercises. The application of knowledge mainly focuses on the development of the "four fundamentals" , i.e. understanding the basics, mastering the basic skills, appreciating mathematics, thinking and methodology, accumulating experience in mathematical activities, and developing the core mathematical literacy of students in mathematical abstraction, logical reasoning, mathematical operations and intuitive imagery, while infiltrating the education of character and values. Teachers present important and critical teaching content in the form of board books, which can draw students' attention and deepen their understanding and memory of mathematical formulae or mathematical algorithms. For example, for the teaching of mathematical formulae, teachers can help students understand and master them in the way of derivation of formulae - understanding and memorisation - mnemonic memorisation - intensive training.

The development of the Four Fundamentals determines the development of various mathematical skills, and the laying of a good foundation helps students to develop their core mathematical literacy. When teachers pay attention to the teaching and demonstration of the fundamentals, learners will also pay attention to them and put their learning into practice, which is particularly important for mathematical operations. In addition, teachers can pay more attention to students' mathematical operation habits, for example, whether they write carefully during the operation process, whether they value the use of sketchbooks, and whether they have the process of calculation rather than using electronic products to arrive at the answer directly.

**5.3 Designing variant problems to drive migration applications**

This strategy belongs to the teacher's teaching implementation strategy in the stage of transferring and applying knowledge in the CTI teaching model, which serves as a bridge between the previous and the next stage in the teaching and learning process. The strategy requires teachers to teach internal transfer of mathematics by designing similar problem situations, by designing reduction problems between different relational structures, and by designing integrated problems that require the application of a variety of knowledge; and external transfer of mathematics by highlighting the notion of modelling or mathematical modelling, and by adopting project-based learning where appropriate.

The transfer of knowledge can be defined in two distinct ways. Firstly, it is the process of transferring knowledge outside the discipline of mathematics. This involves the ability to transfer knowledge or methods from the discipline of mathematics to other contexts in order to solve problems. These problems may arise in real-life situations or in other subject areas. Secondly, it is the process of transferring knowledge within the discipline of mathematics. This involves the use of knowledge or methods in one knowledge structure to solve problems in another knowledge structure. For example, this may involve the use of algebraic knowledge to solve geometry problems. For instance, the solution of geometry problems is possible through the utilisation of algebraic knowledge. Designing similar problem situations helps students to establish connections between knowledge, for example, comparing "the general formula of the equidistant series" and "the equation of a straight line", which belong to different structures but can be seen to be connected. A good transfer will enable students to better understand the mathematical objects, so that they will be able to solve problems and perform mathematical operations without problems. Designing reduction problems between different relational structures means that the two structures, algebra and geometry, can be related so that problems under the two structures can be transformed into each other, and geometric problems can be transformed into algebraic problems for solving. Designing comprehensive problems that require the application of multiple knowledge requires the use of multiple pieces of knowledge, acquired at different stages and possibly from different bodies of knowledge in mathematics, which are used simultaneously to solve the same problem. These problems may also contain hidden conditions or questions that require the addition of supporting elements to answer, and involve the examination of core mathematical literacy at Level 3. For the teaching of extra-disciplinary migration contexts, mainly including real-life contexts and scientific contexts, extra-disciplinary problem discovery and problem solving can best reflect the "Three Ways", i.e., observing the real world with mathematical vision, analysing the real world with mathematical thinking, and expressing the real world with mathematical language, and the migration of such problems can help students to further improve the level of their Mathematical Core Literacy. The transfer of such problems helps students to further improve their core mathematical literacy.

Appropriate mathematical transfer problems can enable students to improve their ability to identify, formulate, analyse and solve problems, and better master mathematical concepts, laws and formulas. The transfer of mathematical problems can establish relationships between mathematical knowledge and penetrate mathematical ideas and methods, which is helpful for students' mathematical arithmetic thinking, speed of arithmetic, and multi-solution of problems. Especially when transferring problems outside the subject, it helps students to further improve their core mathematical literacy.

**5.4 Designing innovative questions to stimulate creative thinking**

This strategy belongs to the instructional implementation strategy for teachers in the innovative application of knowledge phase of the CTI instructional model, which requires teachers to design Knowledge Innovative Problems and related instructional design in order to solve ill-structured problems. Innovative knowledge problems include open-ended problems, variational problems, generalisation problems, and new definition problems. Targeted at enhancing students' higher levels of core maths literacy.

"Creative application of knowledge" is the last part of the CTI teaching model, and it is a key step in teaching and learning to achieve a high level of core literacy development. In solving the problem of poor structure, students may give up easily when encountering difficult problems, their thinking may be blocked, and they may rely too much on electronic products and lack of thinking, etc. On the part of teachers, there are problems such as teachers' adherence to traditional teaching concepts, no or little involvement in innovative topics, and the lack of ability of some teachers themselves. In order to solve the above problems more effectively, it is suggested that teachers apply the CTI teaching mode for teaching. By designing innovative questions such as open-ended questions, variational questions, generalisation questions, new definition questions, etc., they can break through students' thinking and enhance their higher level of core mathematical literacy. Taking the design of open-ended problems as an example, when designing open-ended problems, teachers can make appropriate processing and transformation of well-structured problems. There are two primary approaches to this issue. Firstly, the conditions of the original question can be strengthened or weakened, resulting in the goal becoming unclear or the conclusion becoming non-unique. Secondly, the number of conditions of the original question can be increased appropriately, thereby transforming the question into a conditional redundancy question. This approach enables students to reason through the selection of conditions. Thirdly, it is recommended that the conclusions of the original question be deleted. This will ensure that the goal is not clear, and the students can obtain the conclusions through the reasoning process. Alternatively, the conclusions can be added to the question to ensure that it is well-structured before answering.

The solution of deep mathematical problems and ill-structured problems helps to expand students' thinking, develop their ability to apply arithmetic in innovative ways to solve complex problems, and enhance their sense of innovation. This strategy pays more attention to the level and ability of teachers, and requires them to have the courage to change their traditional teaching concepts and make efforts to further enhance students' literacy at a better level. In the process of solving innovative problems, students can learn to be flexible, understand the objects of mathematical operations from multiple perspectives, and pay more attention to the flexible adaptation and innovative application of knowledge.

**6. CONCLUSION**

Cultivating students' mathematical core literacy is the focus of attention of the domestic and international mathematics education circles. With the exploration and reform of the education model, with the help of the CTI teaching mode, appropriate teaching strategies can be used to develop students' mathematical operation literacy effectively in teaching. This paper posits that, in order to cultivate students' mathematical operation core literacy under the CTI teaching mode, teachers should create a real situation to promote the construction of knowledge. They should emphasise basic knowledge, pay attention to the teaching demonstration, design variant problems to drive the transfer of application, and design innovative problems to stimulate innovative thinking. This argument is based on the analysis of CTI teaching mode and the definition and requirements of mathematical operation core literacy, combined with the current situation of mathematical operation literacy in secondary schools. It is hoped that teachers will take construction as the basis, migration as the bridge and innovation as the sublimation, and finally realise the core mathematical operation from "mechanical calculation" to "strategic operation" through contextualised knowledge construction, focused teaching demonstration, step-by-step migration training and open innovation tasks, combined with reflections and evaluations. The core literacy of mathematical operations can be improved from "mechanical computation" to "strategic computation" through reflection and evaluation. However, the enhancement of mathematical literacy is a long-term and arduous task in senior secondary mathematics teaching, and future research can further explore the in-depth integration of the CTI model and information technology, as well as the longitudinal tracking of the development of literacy across academic periods.

**Disclaimer (Artificial intelligence)**

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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