Research on Infiltration Strategy of Logical Reasoning Literacy in Senior High School Mathematics Solid Geometry Teaching

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Abstract: Based on the teaching of solid geometry in high school mathematics, this paper focuses on the integration of logical reasoning literacy. Under the background that current education pays attention to the cultivation of core literacy, this paper aims to explore the strategy of effectively infiltrating logical reasoning literacy into solid geometry teaching in senior high school. In this paper, the literature research method is used to sort out the relevant theoretical achievements, grasp the research status quo, analyze the teaching status quo and construct the infiltration strategy with the help of theoretical analysis and the theory of pedagogy and psychology. It is found that there are some problems in the cultivation of logical reasoning literacy in solid geometry teaching at present, such as improper teaching methods and contents, poor performance of students' literacy and so on. Based on these problems, this paper puts forward the construction strategy from three aspects: intensive teaching design, innovative teaching methods and deepening thinking tempering. These strategies can improve students' logical reasoning literacy, provide useful reference for high school mathematics teaching practice, and help improve teaching quality and students' thinking development.

1. Introduction

With the deepening of education reform, high school mathematics education pays more and more attention to the cultivation of students' core literacy. As the key component of mathematics core literacy, logical reasoning literacy plays an irreplaceable role in students' in-depth understanding of mathematics knowledge and improvement of thinking ability [1]. As an important branch of high school mathematics, solid geometry has become a high-quality carrier to cultivate students' logical reasoning literacy with its unique spatiality and logicality [2]. In this context, it is of far-reaching significance to explore the infiltration strategy of logical reasoning literacy in the teaching of solid geometry in senior high school mathematics.

In-depth study of infiltration strategy is helpful to enrich the theoretical system of mathematics education. In the past, although there were separate studies on logical reasoning literacy and solid geometry teaching, the theoretical exploration of deep integration of the two is still insufficient [3]. It is very important to improve the quality of high school mathematics teaching. At present, in the teaching of solid geometry in senior high schools, some teachers still focus on imparting knowledge, and pay insufficient attention to the cultivation of logical reasoning literacy, which leads to students' difficulty in flexibly using theorem formulas for logical deduction [4-5]. The practical infiltration strategy put forward through this study can help teachers improve teaching methods, guide students to build a logical knowledge system and enhance students' ability to solve solid geometry problems. This is of great significance to the long-term development of students. Logical reasoning literacy is not only the key to learn mathematics well, but also an indispensable ability for students to study and work in various fields in the future. Infiltrating this literacy effectively in solid geometry teaching can help students form rigorous thinking habits and lay a solid foundation for their lifelong learning.

Based on the above background, this study will comprehensively use the methods of literature research and theoretical analysis to sort out the relevant literature and deeply analyze the existing research results. On this basis, combined with the related theories of pedagogy and psychology, the

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infiltration strategy framework of logical reasoning literacy in solid geometry teaching in senior high school is constructed. It is expected that this research will provide targeted and operable guidance and suggestions for senior high school mathematics teaching practice and promote the improvement of senior high school mathematics education quality.

2. Theoretical cornerstone and conceptual interpretation

Logical reasoning literacy is closely related to solid geometry teaching, so it is necessary to explain its related concepts and theoretical basis. Logical reasoning literacy refers to the ability of students to think and demonstrate by induction, analogy and deduction according to known conditions in mathematics learning [6]. In high school mathematics, it is embodied in the process of proving theorems, analyzing and solving problems. The teaching of solid geometry is a teaching activity that takes spatial geometry as the research object and cultivates students' abilities of spatial imagination and logical thinking. Its goal is not only to let students master geometric knowledge, but also to improve their thinking quality.

Constructivist learning theory emphasizes that students actively construct new knowledge based on existing knowledge and experience. In the teaching of solid geometry, based on the original spatial cognition, students construct the thinking mode of logical reasoning through teachers' guidance and independent exploration [7]. Cognitive development theory also provides support for it, which shows that students' logical reasoning ability develops with age and in-depth study. Teachers can design appropriate teaching activities according to students' cognitive stage, and gradually improve students' logical reasoning literacy.

3. Insight into the cultivation of logical reasoning literacy in solid geometry teaching in senior high school

In the high school mathematics teaching system, solid geometry occupies an important position, which plays a key role in cultivating students' logical reasoning literacy [8]. At present, there are many points worthy of attention in the cultivation of logical reasoning literacy in solid geometry teaching. Judging from the current situation of teaching practice, the infiltration of teaching methods into logical reasoning literacy is insufficient. Some teachers still rely too much on traditional teaching methods, leading the one-way transmission of knowledge in the classroom, and students passively accept it. For example, when explaining the theorem proof of solid geometry, teachers often give the proof steps directly, and students lack the process of independent thinking and reasoning. Although this teaching method can ensure the efficiency of imparting knowledge to a certain extent, it is difficult for students to really understand the logical thinking behind the proof, which is not conducive to the improvement of logical reasoning literacy. In terms of teaching content, some teachers pay too much attention to the memory of knowledge points, while ignoring the logical connection between knowledge and the training of logical reasoning ability [9]. For example, when teaching the properties and judging theorems of space geometry, students are not guided to establish the relationship between them through logical deduction, which leads to students' inability to accurately choose the appropriate theorem for reasoning when applying theorems to solve problems.

In order to clearly understand the performance of students' logical reasoning literacy in solid geometry learning, this paper conducted a questionnaire survey and test on 300 students from three high schools in a certain area, and sorted out the data as shown in Table 1.

As can be seen from Table 1, students have problems in many aspects of solid geometry logical reasoning literacy. In the understanding of spatial concepts, nearly half of the students are familiar with the basic geometry, but they lack the ability of spatial perception and analysis when facing complex combinations, which affects the subsequent logical reasoning. In the application of theorem, most students can't use knowledge flexibly for logical deduction, which reflects that the logic training of knowledge application is not enough in teaching. In the process of logical deduction, up to 70% of students are not rigorous in reasoning, which shows that students lack

rigorous logical thinking habits. The weak combination of spatial imagination and logic also makes students limited in solving practical problems of solid geometry.

Table 1 Statistics on the Performance of High School Students' Logical Reasoning Literacy in Solid Geometry

Examination Dimension	Specific Performance	Proportion of Students	Causes	Impact on Subsequent Learning
Understanding of Spatial Concepts	Able to identify common geometric solids, but struggles to understand spatial relationships in complex composite solids	45%	Weak spatial perception, insufficient decomposition training	Hindered in deriving properties of complex figures and solving problems
Application of Theorems	Can apply theorems to simple problems, but finds it difficult to use them flexibly in comprehensive problems	60%	Insufficient comprehensive training, lack of a knowledge network	Difficulty in developing ideas for comprehensive problems
Logical Deduction Process	Reasoning is not rigorous, misses key steps, lacks overall grasp	70%	Poor reasoning habits, shallow understanding of justifications	Prone to errors in proofs, difficult to reach correct conclusions
Combination of Spatial Imagination and Logic	Struggles to combine figures with reasoning, performs poorly in spatial transformation problems	55%	Insufficient operations and guidance, disconnection between imagination and reasoning	Limited in solving dynamic and transformation problems

There are many factors that affect the development of students' logical reasoning literacy [10]. On the one hand, students' own basic knowledge reserve and learning attitude have an important influence on the improvement of logical reasoning literacy. If students do not have a solid grasp of the basic concepts and theorems of solid geometry, it will be difficult for them to make effective logical reasoning. On the other hand, the teaching environment and resources can not be ignored. The completeness of school teaching facilities, teachers' professional quality and teaching concept are all directly related to the effectiveness of cultivating logical reasoning quality.

4. Strategy construction of integrating logical reasoning literacy into solid geometry teaching in senior high school

In order to effectively improve students' logical reasoning literacy in solid geometry learning in senior high school, it is necessary to construct scientific and reasonable teaching strategies. This will not only help students better master the knowledge of solid geometry, but also promote the all-round development of their logical thinking ability.

4.1. Intensive teaching design

Teachers should carefully plan the teaching content according to the training goal of logical reasoning literacy. For example, when designing the teaching content of "the positional relationship between points, lines and planes in space", we can introduce simple life examples to gradually guide students to abstract the geometric elements of space and their relationships, so that students can get in touch with logical reasoning in the process of establishing the concept of space. Teachers should pay attention to the logic and consistency of content and design well-defined teaching activities. Taking the teaching of "Judgment Theorem of Vertical Line and Plane" as an example, let students first observe the phenomenon of vertical line and plane in life, put forward conjectures, then verify them through experimental operations, and finally guide students to make rigorous

logical proofs. Through this kind of activity design, students can improve their logical reasoning ability in step-by-step and in-depth inquiry.

4.2. Innovative teaching methods

The problem-oriented teaching method can effectively stimulate students' logical thinking. Teachers set a series of enlightening questions around the key points and difficulties in teaching. For example, when explaining the "property theorem of plane-to-plane parallelism", they can ask the question: "If two planes are parallel, what is the positional relationship between the straight line in one plane and the straight line in the other plane? How to prove it? " Guide students to solve problems through thinking, discussion and reasoning. With the help of intuitive teaching tools and modern information technology, logical reasoning teaching can also be helped. Teachers can use the solid geometric model to let students intuitively feel the structure of spatial graphics, and dynamically display the changing process of graphics through geometric sketchpad and other software to help students understand the spatial geometric relationship, so as to better carry out logical reasoning.

4.3. Deepening thinking and tempering

Strengthen students' reasoning ability through diversified topic training. Proving questions can cultivate students' deductive reasoning ability, while exploring questions can exercise reasonable reasoning ability. Table 2 below shows the training objectives of different types of questions on students' logical reasoning literacy.

Table 2 Types and Objectives of Training Questions for Logical Reasoning in High School Solid Geometry

Question Type	Specific Question Example	Training Objective	Difficulty Level	Recommended Stage
Proof Questions	In the cube ABCD-$A_1B_1C_1D_1$, prove that plane A_1BD is parallel to plane B_1D_1C	Cultivate deductive reasoning, standardize reasoning processes and formats	Medium	Knowledge consolidation
Exploratory Questions	In the triangular pyramid P-ABC, where PA = PB = PC, explore the position of the projection of P onto the base and prove the conclusion	Guide plausible reasoning and argumentation, enhance comprehensive reasoning ability	Medium-High	Knowledge deepening
Open-Ended Questions	Given line segment conditions, construct a geometric solid and explain the thought process	Stimulate innovation and spatial imagination, use reasoning to determine the structure of geometric solids	High	Ability expansion
Analogical Questions	Based on the judgment of similarity in plane triangles, analogize and prove the judgment of volume ratios in triangular pyramids	Strengthen analogical reasoning, understand geometric relationships in different dimensions	Medium	Knowledge transfer

As can be seen from Table 2, different types of topics have their own emphasis and complement each other, which comprehensively exercises students' logical reasoning ability. At the same time, teachers should pay attention to cultivating students' ability of coordinated development of spatial imagination and logical reasoning. Teachers can make students draw spatial graphics and transform spatial graphics, so that students can make logical reasoning on the basis of spatial imagination and deepen spatial imagination in the process of logical reasoning, thus realizing the organic integration of the two and effectively improving students' logical reasoning literacy.

5. Conclusions

This study focuses on the infiltration strategy of logical reasoning literacy in senior high school mathematics solid geometry teaching. After combing the relevant theories and analyzing the current teaching situation, the effective path to improve students' logical reasoning literacy is clarified. The research shows that the present situation of cultivating logical reasoning literacy in solid geometry teaching in senior high school is not optimistic. In teaching practice, some teachers' teaching methods are traditional, relying too much on teaching and ignoring students' independent reasoning; The teaching content focuses on knowledge memory and pays little attention to logical association and reasoning training. From the performance of students' literacy, there are defects in the understanding of spatial concepts, the application of theorems, logical deduction and the combination of spatial imagination and logic. In view of these problems, the constructed infiltration strategy is of great significance and feasibility. Carefully study teaching design, plan content according to literacy goals, design activities with distinct levels, and build a logical reasoning ladder for students. Innovative teaching methods, using problem-oriented method to stimulate thinking, using intuitive tools and information technology to help understanding, and creating a good reasoning environment. Deepen thinking training, promote the coordinated development of spatial imagination and logical reasoning through targeted training of different types of topics, and comprehensively improve students' reasoning ability.

Through the implementation of these strategies, it is expected to change the current teaching dilemma and improve students' logical reasoning literacy in solid geometry learning. It can not only help students master solid geometry knowledge and solve practical problems, but also cultivate their rigorous thinking habits and lay the foundation for lifelong learning. This study also provides reference for senior high school mathematics teachers to improve their teaching and promote the quality of mathematics education. In the future, we expect these strategies to be widely used and further improved in teaching practice, and continue to explore the path of integration and development of logical reasoning literacy and other mathematical literacy, so as to inject new vitality into senior high school mathematics education.

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