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The Infiltration of Mathematical Core Literacy in Junior High School Teaching: Taking "Sharp Angle Trigonometric Functions" as an Example

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Abstract: With the continuous development and transformation of education, mathematics education, as an important component of cultivating students' comprehensive qualities and innovative abilities, has received more and more attention. In mathematics teaching, the cultivation of mathematical core literacy is the key to improving students' mathematical literacy. The infiltration and integration of mathematical core literacy can not only enhance students' understanding and mastery of mathematical knowledge, but also promote the cultivation of their mathematical thinking and problem-solving abilities. In middle school mathematics teaching, acute angle trigonometric functions are one of the important contents of mathematics, and their learning involves multiple aspects of mathematical core literacy, including understanding mathematical concepts, applying mathematical methods, and cultivating mathematical thinking. Therefore, this article takes sharp angle trigonometric functions as an example to explore the penetration of mathematical core literacy in junior high school teaching, aiming to provide theoretical and practical references for improving the quality of junior high school mathematics teaching. The experimental results indicate that students highly appreciate the teaching effectiveness of contextualized and interdisciplinary classrooms, and a score of 4.5 ± 0.89 (out of 5) is given for items that are necessary to adopt this model.

1. Introduction

With the increasing emphasis on mathematical literacy in modern society, mathematics education has gradually become one of the important issues in educational reform. In mathematics teaching, cultivating students' mathematical core literacy has become one of the main goals of education. The cultivation of mathematical core literacy not only involves the imparting of mathematical knowledge, but also includes the cultivation of students' mathematical thinking ability, problem-solving ability, and mathematical application ability. As a crucial stage for cultivating students' mathematical literacy, the quality of mathematics teaching in middle school has a crucial impact on the development of students' mathematical literacy. As one of the important contents of junior high school mathematics teaching, the study of acute angle trigonometric functions is not only related to students' understanding and mastery of mathematical knowledge, but also to the cultivation and improvement of mathematical core literacy. Therefore, exploring the penetration of mathematical core literacy in middle school mathematics teaching is of great significance for improving the quality of mathematics teaching and promoting the comprehensive development of students' mathematical literacy.

In Chapter 3, this article introduces the creation of scenarios, experiencing the charm of interdisciplinary learning, and cultivating scientific thinking through problem-solving. In Chapter 4, this article introduces the analysis of student performance and satisfaction surveys in traditional classrooms, situational and interdisciplinary classrooms. Finally, this article provides a summary of the entire article.

2. Related Works

Experts have long conducted specialized research on the penetration of mathematical core competencies in junior high school teaching. Liu S summarized the current research status of the concept of compulsory education stage models. He studied the application of pattern concepts in classroom design and infiltration strategies [1]. Most research focuses on specific mathematical topics such as equations, inequalities, and functions, and provides practical examples and instructional designs. However, there is relatively little research on curriculum style. In addition, Liu S also analyzed the implementation of model concept literacy in middle school mathematics curriculum standards in teaching. He proposed that teachers should strengthen understanding through collective lesson preparation, introduce real-life materials to students, explain the process and knowledge points of mathematical modeling, use various teaching methods to create a relaxed atmosphere, promote students to master mathematical knowledge, cultivate model concept literacy, and carry out practical teaching activities to truly implement model concepts in classroom teaching [2].

Wang H focused on the cultivation of key abilities in mathematics under the new curriculum reform, emphasizing the importance of classroom teaching in improving students' key abilities. He analyzed the necessity of improving teaching efficiency based on the current situation of middle school mathematics classroom teaching and proposed corresponding strategies to promote the cultivation and enhancement of students' key abilities [3]. Su Y expanded the problem-solving approach and cultivated students' core competencies by applying rotation transformation ideas to problems such as line segment and difference, proof angle, and common vertex problems. He reexamined the issues related to angles or line segments after graphic rotation, taking into account the students' geometric operations, reasoning, innovation, and practical abilities. Rotation transformation has become a new approach to solving complex graphic problems, promoting students' understanding of constructing auxiliary lines [4]. Sun Q aimed to explore the cognitive level of abstract ability literacy among pre service middle school mathematics teachers. Through open interviews, 11 graduates with a Master's degree in Education and 9 graduates with a Bachelor's degree in Education were surveyed. The results showed that their cognitive scope of abstract ability literacy was narrow, with over half of the content not being recognized; the cognitive breadth of Master of Education was slightly higher than that of undergraduate graduated from ordinary universities. Overall, their cognitive clarity is relatively low, and they can only recognize individual knowledge points [5].

Chen Z selected different versions of mathematics textbooks from the United States and China to compare the impact of their exercises on core mathematical literacy. He found that different versions focused on different types of literacy, but all emphasized mathematical operations, and the literacy reflected in each version was at the basic stage [6]. Misu L used qualitative methods to explore the use of mathematical learning media among high school mathematics teachers in Kentucky. He collected data through interview methods and used Miles, Huberman, and Saldana analysis models for data processing. The results showed that teachers mainly used traditional media such as PowerPoint, textbooks, zoom apps, and WhatsApp, rather than learning media from Android systems. The teaching focuses on preliminary tests and gradually increasing difficulty exercises, but the improvement of students' computational ability is limited and there is less connection with practical problems [7].

Zhang H systematically reviewed the current situation and existing problems of integrating the history of mathematics into high school mathematics teaching based on domestic and foreign literature in the past decade. He analyzed the obstacles that affected integration and proposed corresponding strategies aimed at providing assistance to teachers and educators. Finally, he reviewed, anticipated, and summarized the current research [8]. Based on the new version of the Jiangsu Education Press textbook, Wang Y proposed suggestions for cultivating high school students' geometric intuition ability from three aspects: pre class introduction, new knowledge teaching, and example consolidation and expansion, aiming to provide practical teaching references for teachers and promote an intuitive understanding of geometry [9]. Meng Y conducted a survey on 51 pre service high school mathematics teachers and found that their understanding of intuitive imagination literacy was limited, and most of the content was not recognized or the cognitive level was not deep enough [10]. Putri CK investigated the types of errors and their effects in solving statistical literacy tests among five 11th grade high school students in Banjabaru, South Borneo. He used a case study method to collect data through testing and interviews, and found that student errors include conceptual, procedural, and technical aspects. These errors may affect their daily data processing and may indicate early signals of learning disabilities [11].

Sang H elaborated on the overall development of education in the field of information technology from both domestic and international perspectives. Then he analyzed the existing problems, explored new exploration models and implementation suggestions, and proposed prospects at the end of the article [12]. Sun H summarized the current status and shortcomings of research on logical reasoning literacy. His research mainly focused on connotation, level, influencing factors, and cultivation strategies, but there were problems such as single methods, lack of empirical research, and lack of systematicity. In the future, research methods should be improved, influencing factors should be thoroughly and systematically studied, and more actionable cultivation strategies should be proposed [13].

Esti I used the Spradley qualitative model to analyze the issue of low scores in Indonesia's participation in the International Student Assessment Program (PISA) in China. He collected data such as PISA results and course documents, and observed and interviewed teachers. He found that teachers did not fully utilize higher-order thinking skills and complained about frequent course changes. The distribution of education quality is uneven, especially due to the geographical dispersion of Indonesia. Therefore, he suggested that the government develop long-term plans, increase PISA exercises, and use purposive sampling to select participants [14]. Ma X aimed to explore how to better cultivate students' mathematical application awareness and literacy in middle school mathematics classrooms. He analyzed the characteristics of literacy and teaching status through theoretical research methods, and proposed cultivation strategies: adopting diversified teaching methods, expanding the connection between mathematics and reality, interdisciplinary teaching, and creating practical situations. These strategies aim to stimulate students' interest, expand their mathematical perspective, and promote a learning approach that combines theory with practice [15].

Shongwe B compared the common content knowledge of spatial visualization between two groups of pre service primary school mathematics teachers using the modified mathematical teaching knowledge framework. The results showed that teachers with a pure school mathematics background performed poorly in spatial visualization and may be influenced by misconceptions. Future research directions will explore ways to solve this problem [16]. Zhu M discussed the importance of interdisciplinary thinking in middle school grammar teaching, using English tenses as an example. By combining numerical and geometric thinking in mathematics, he explored the application of single mathematical models and multiple mathematical models in grammar teaching, aiming to enhance students' interest in grammar learning and promote the development of multiple intelligences [17]. There are several shortcomings in the research on the penetration of existing mathematical core competencies in junior high school teaching. Firstly, existing research mainly focuses on the theoretical nature of mathematical core competencies, but lacks in-depth exploration and guidance on specific operational methods for practical teaching scenarios. Secondly, research on the integration and intersection of teaching content across different disciplines is still relatively limited, lacking a comprehensive interdisciplinary perspective. In addition, there is a lack of systematic exploration of teaching strategies and methodologies on how teachers can effectively cultivate students' mathematical core competencies in actual teaching, which makes it difficult to translate research results into effective practical teaching.

3. Methods

3.1 Creating Scenarios and Feeling the Charm of Interdisciplinary Learning

The traditional teaching method of mathematics overly relies on textbooks and neglects the integration with practical life. This approach has a negative impact on students' learning and growth, hindering the cultivation of their core competencies and learning abilities. Therefore, teachers should start from the subject status of students, change their teaching philosophy from their own perspective, and make appropriate adjustments to teaching methods, focusing on cultivating students' comprehensive abilities. Interest is the internal driving force for students to learn, and middle school students are very interested in interesting teaching activities. The construction of situations can intuitively present mathematical knowledge to students, and the simplest and most effective way to stimulate interest in mathematics classrooms is to construct interesting and intuitive situations. Let the teacher use "acute angle trigonometric function" as an example to construct a vivid teaching scenario. Imagining in math class, the teacher guides students to explore the angle of solar panels together. Outside the classroom window, there is a bright sunshine. The teacher placed a solar panel on the windowsill and asked the students to observe the tilt angle of the solar panel. Subsequently, the teacher posed a question: What angle should we choose if we want to maximize the reception of solar energy by solar panels? The students began to think, some suggested how much angle the solar panels should be at with the ground, while others considered the influence of the position and time of the sun on the angle. Through this scenario, students intuitively felt the connection between angles and real life, which stimulated their interest and curiosity in acute angle trigonometric functions. This interdisciplinary teaching context not only makes mathematical knowledge more concrete and practical, but also allows students to experience the practical application value of mathematics in solving practical problems.

3.2 Solving Problems and Cultivating Scientific Thinking

In daily teaching, middle school mathematics teachers need to pay attention to the cultivation of students' mathematical problem-solving abilities in order to comprehensively enhance their core literacy. This ensures that students can flexibly apply their learned knowledge to solve related problems, highlight the value of the mathematics subject itself, and make their mathematical learning activities more relaxed and convenient. In classroom teaching, teachers should combine the cognitive status of students, construct corresponding problem-solving situations, do a good job in cultivating students' mathematical thinking, and guide students to sort out their concepts of applying mathematical knowledge.

The new curriculum standard emphasizes that in mathematics teaching, teachers also need to fully consider the living conditions of students, explain knowledge based on their lives, so that students can use theoretical knowledge to solve practical problems, set problems based on life, strengthen students' mathematical thinking, and also cultivate their scientific responsibility. Let the teacher use "sharp angle trigonometric function" as an example to design a problem scenario to cultivate students' scientific thinking. Assuming students are asked to design a Ferris wheel in an amusement park, they need to consider factors such as the height, tilt angle, and carriage design of the Ferris wheel. The teacher guides students to think: How to determine the height and tilt angle of the Ferris wheel to ensure that passengers have the best viewing experience at the top? Students need to use sharp angle trigonometric functions to calculate the field of view at different heights and angles, as well as design the position and structure of the carriage within a safe range. Through this scenario, students not only need to apply mathematical knowledge to solve practical problems, but also need to consider factors such as safety and passenger experience, thereby cultivating their scientific thinking abilities. The design of this problem scenario not only stimulates students' interest in learning, but also allows them to experience the fun and challenges of scientific thinking in the process of solving problems.

4. Results and Discussion

4.1 Experimental Preparation

This survey focuses on questionnaires and uses the QuestionStar platform as a tool to conduct targeted surveys on students in a middle school. Because the school's infrastructure is relatively good, online learning resources and offline academic conferences are relatively complete, students can use various related equipment well, and they are all engaged in or have just completed classroom teaching mode learning. In this study, we used 43 questionnaires and conducted relevant reliability tests to correct the content and indicators of the questionnaires. A total of 62 questionnaires were distributed, and 2 invalid ones were removed, resulting in 60 valid ones with a response rate of approximately 97%. The experimental group is a scenario based and interdisciplinary classroom, while the control group is a traditional classroom.

4.2 Experimental Results

The experimental data in Figure 1 provides a comparison of the evaluation scores of learning processes between situational and interdisciplinary classrooms and traditional classrooms. From the data, it can be seen that there are significant differences between the experimental group and the control group in several key indicators. In terms of the basic characteristics of the teaching mode, the experimental group scored significantly higher than the control group, indicating that students have a higher acceptance of situational and interdisciplinary teaching modes. Secondly, in terms of the degree of self-directed learning before class, the experimental group scored much higher than the control group, which means that situational and interdisciplinary classrooms can better stimulate students' learning interest and self-directed learning ability.

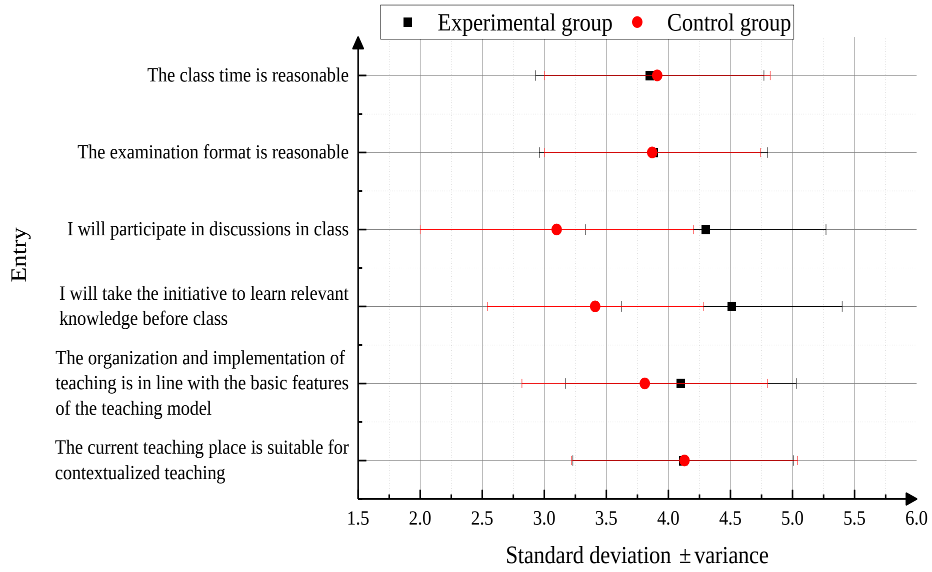

Figure 1: Learning process evaluation score

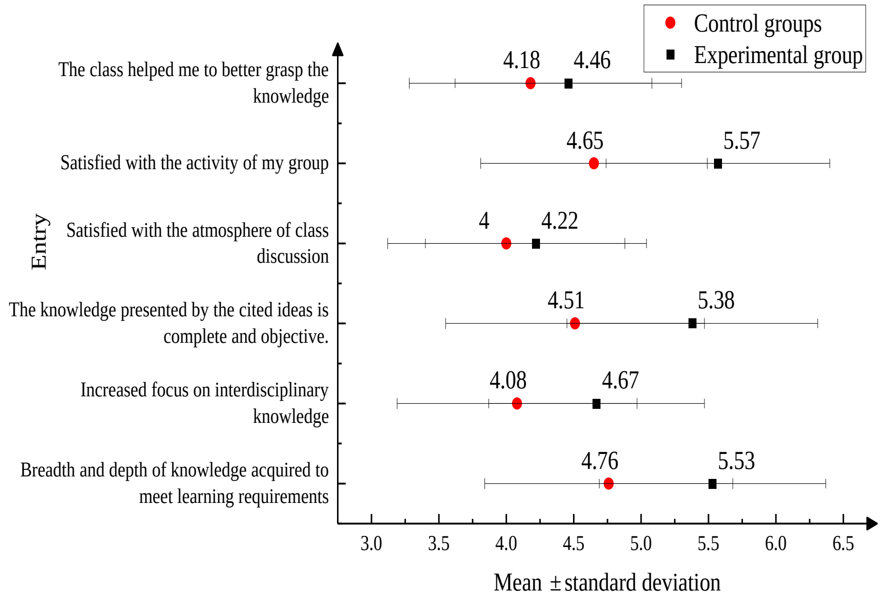

Figure 2: Satisfaction with teaching quality

The experimental data in Figure 2 provides a comparison of evaluation scores for learning outcomes between situational and interdisciplinary classrooms and traditional classrooms. The data shows significant differences between the experimental group and the control group in multiple key indicators. Firstly, in terms of the breadth and depth of learning knowledge, the experimental group scored slightly higher (5.53) than the control group (4.76), indicating that situational and interdisciplinary classrooms may better meet students' learning needs and provide broader and deeper knowledge. Secondly, regarding the issue of whether to pay more attention to interdisciplinary knowledge, the experimental group's score (4.67) was slightly higher than the control group's score (4.08). This indicates that situational and interdisciplinary classrooms may place more emphasis on the integration of interdisciplinary knowledge, helping students acquire more comprehensive knowledge. In terms of knowledge completeness and objectivity guided by viewpoints, the experimental group scored significantly higher (5.38) than the control group (4.51).

This indicates that contextualized and interdisciplinary classrooms may better guide students to access more complete and objective knowledge, improving their overall thinking ability. In addition, regarding satisfaction with the classroom discussion atmosphere and group activity, the experimental group's scores (4.22 and 5.57) were also higher than those of the control group (4.00 and 4.65). This indicates that contextualized and interdisciplinary classrooms may create a more positive learning atmosphere, stimulating more participation and discussion among students.

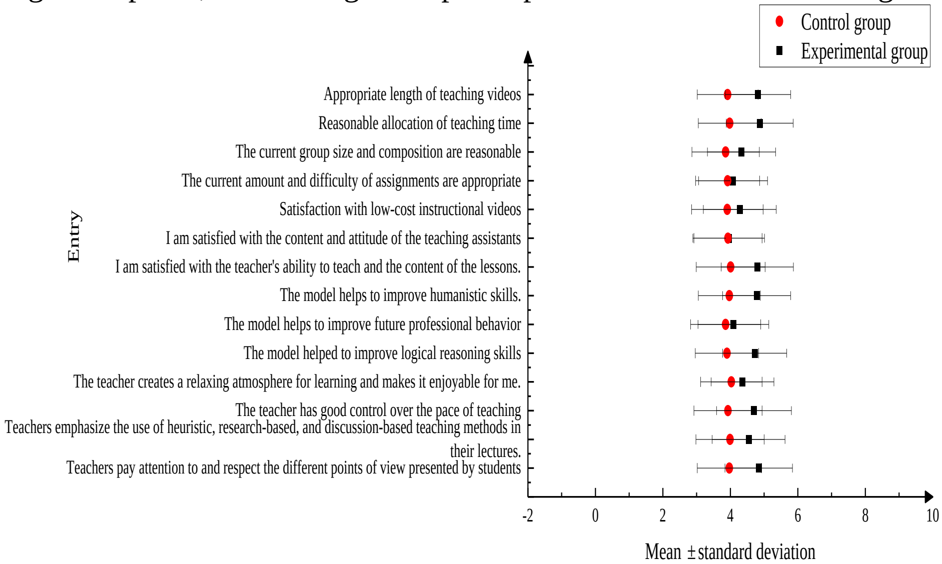

Figure 3: Student's Teaching Evaluation

The experimental data in Figure 3 shows the comparative evaluation of situational and interdisciplinary classrooms with traditional classrooms in multiple aspects. It is worth noting that the experimental group scored significantly higher than the control group in terms of teachers paying attention to and respecting student perspectives, emphasizing heuristic research-based teaching methods, controlling teaching progress, and creating a learning atmosphere. This indicates that contextualized and interdisciplinary classrooms may better stimulate student engagement, cultivate their logical reasoning ability and humanistic literacy, and better meet their learning needs. In addition, the experimental group showed significantly higher satisfaction with the teaching ability and content of the teachers compared to the control group. However, there are relatively small differences between the two groups in terms of teaching assistant work content, homework volume and difficulty, and group composition. In summary, situational and interdisciplinary classrooms may have certain advantages in teaching methods, learning atmosphere, and teaching quality, but further optimization is still needed in other aspects.

Table 1: Teaching effectiveness of situational and interdisciplinary classrooms (full score: 5 points)

Entry	$\bar{x}+s$
Learning results meet expectations	4.1 ±0.89
The model is more effective than the traditional model	3.9 ±0.56
It is necessary to adopt this mode	4.5 ±0.89
The mode is conducive to the understanding and mastery of knowledge	4.1 ±0.78
The mode is conducive to improving comprehensive ability	3.92 ±0.87

From Table 1, it can be seen that students highly appreciate the teaching effectiveness of contextualized and interdisciplinary classrooms, and the score for items that are necessary to adopt this model is 4.5 ±0.89.

5. Conclusion

The penetration of mathematical core literacy in junior high school teaching is crucial. This article uses "acute angle trigonometric functions" as an example to demonstrate core mathematical literacy. In the process of learning acute angle trigonometric functions, students not only need to master basic concepts and formulas, but also need to cultivate logical reasoning ability, problem-solving ability, and mathematical modeling ability. The cultivation of these abilities not only helps students achieve better grades in the field of mathematics, but more importantly, lays a solid foundation for their future learning and work. Therefore, teachers should pay attention to cultivating students' mathematical core literacy in teaching, guiding them to flexibly apply the knowledge they have learned to solve practical problems, thereby improving their comprehensive quality and innovative ability.

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