Research on the Theoretical Framework and Practical Countermeasures of Junior Middle School Mathematics Interdisciplinary Study based on STEM

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Abstract: At present, the interdisciplinary learning ability and level of junior middle school have become an important symbol to measure the teaching level of junior middle school. As the basic theory and important tool of science learning, it is of great significance to vigorously promote the interdisciplinary learning of junior middle school mathematics with mathematics as the core subject. This paper first analyzes the research background and current situation of interdisciplinary learning of junior middle school Mathematics from the perspective of STEM (i.e. Science, Technology, Engineering, Mathematics). Then, the paper constructs the theoretical framework of junior middle school mathematics interdisciplinary learning based on the research of science subject, technology subject and engineering subject. Finally, from the three dimensions of experimental teaching, information technology and scientific spirit, this paper puts forward the practical strategy of junior middle school mathematics interdisciplinary learning.

1. Introduction

1.1. Interdisciplinary education is booming based on STEM

At present, discipline integration is becoming the trend of discipline education and development in the world, and STEM education, as a classic education model of interdisciplinary education, is booming all over the world. The US government has successively issued a series of regulations and policies such as "the K-12 Science Education Framework" [1] and "the STEM Education Act of 2015", explaining the principles, standards, methods, and systems of STEM education concepts in terms of university education model, disciplinary education integration, and educational integration policies and systems. At the same time, the domestic STEM education boom has gradually risen, and in June 2017, the "China STEM Education White Paper" was released to provide theoretical and practical guidance for exploring STEM education in China. In May 2018, the National Institute of Education Sciences released the "STEM Teacher Ability Rating Standards (Trial)", which provides guidance on cultivating teachers' STEM teaching literacy [2].

1.2. Education reform attaches great importance to cultivating students' interdisciplinary literacy

The Outline of the "National Medium - and Long-Term Education Reform and Development Plan (2010-2020)" clearly puts forward the relevant concepts of "interdisciplinary and interdisciplinary research and teaching" [3]. In 2014, the Ministry of Education issued the "Opinions on Comprehensively Deepening Curriculum Reform and Implementing the Fundamental Task of Cultivating Morality and Educating People", emphasizing the need to design a ‘core literacy system’ and carry out interdisciplinary teaching activities to improve students' comprehensive learning ability [4]. It can be seen that China's education reform has gradually begun to pay attention to cultivating students' interdisciplinary learning ability. Because of its strong interdisciplinary nature, mathematics is closely related to the fields of science, technology and engineering [5]. Therefore, in the new curriculum reform of middle and junior high schools, mathematics teachers are not only required to change the single-subject teaching concept, but also to pay more attention to students' multi-subject integrated learning, so as to further strengthen the integration of mathematics with other disciplines.

2. Research status

2.1. Abroad research status

In 1986, the National Science Foundation published the "College Science, Mathematics and Engineering Education Report", which first put forward the concept of STEM education [6]. In 2004, the teaching syllabus of the German state of Saxony emphasized the concept of 'interdisciplinary teaching' and clearly stipulated that
teachers should further strengthen their interdisciplinary teaching ability [7]. In 2011, the National Research Council of the United States issued a Framework for "K-12 Science Education: Practice, Interdisciplinary Concepts, and Core Concepts", proposing that science education should include three dimensions: ‘science and engineering practices’, ‘interdisciplinary concepts’, and ‘core discipline concepts’ [8] [9]. In 2015, the French government launched the junior middle school reform program, which clearly proposed that interdisciplinary learning practice should be set up from the fifth grade of junior middle school to achieve the effect of disciplinary knowledge integration [10]. It can be seen that foreign studies try to penetrate STEM education concepts into the four disciplines to cultivate comprehensive talents with multidisciplinary knowledge, so as to enhance comprehensive national strength [11].

2.2. Domestic research status

Compared with the west, STEM education in our country started late, but gradually received attention. In 2012, "Shanghai Education Global Education News" firstly introduced STEM education, pointing out that China's STEM education research mainly focuses on theoretical exploration, environmental construction and technology application, and mostly draws on the STEM education model of the United States. In 2017, the "White Paper on STEM Education in China" elaborated on the basic situation, development status and future planning of STEM education in China, and clearly proposed to promote teachers' interdisciplinary learning literacy. Chen (2006) emphasized that middle school mathematics should pay attention to interdisciplinary learning, and analyzed the future development trend of interdisciplinary learning of mathematics [12]. Pan (2009) proposed the integrated teaching of mathematical thought and method in science curriculum, and expounded the problem of integrated application of science teaching and mathematical thought and method [13]. Bai (2019) made a comparative analysis of the new curriculum standards of middle school mathematics in China and STEM concepts, and carried out thoughts and practices on the cultivation of interdisciplinary learning literacy in mathematics [14].

To sum up, although research on the theory and practice of interdisciplinary learning has appeared frequently in domestic and foreign literature, research on interdisciplinary learning in junior middle school mathematics based on STEM is not involved much. The new round of teaching reform requires the improvement of students' comprehensive learning literacy. Mathematics, as the basic theory and learning basis of natural science, is bound to be inseparable from interdisciplinary learning, and cultivating students' interdisciplinary learning literacy is an inevitable requirement of the development of The Times. Therefore, the interdisciplinary study of junior middle school mathematics based on STEM meets the requirements of The Times and has far-reaching significance.

3. Theoretical framework

3.1. Concept definition

STEM: The concept of STEM education is not to mechanically superimpose science, technology, engineering and mathematics, but to take the strengths of each discipline, organically integrate the relative advantages of each discipline, and further stimulate students' interest in learning. (STEM relationship of junior middle school mathematics is shown in Fig. 1)

Junior middle school mathematics discipline literacy: Junior middle school mathematics discipline literacy is the ability to effectively use junior middle school mathematics knowledge literacy, which is the basic mathematical knowledge to promote scientific development, promote technological innovation, and ensure the project implementation.

Interdisciplinary learning: As the name implies, it means cross-integration, taking the advantages of various disciplines to make up for the shortcomings of conventional education, which is to organically integrate the theories, methods and ways of thinking of multiple disciplines, so that students can have interdisciplinary understanding, effectively master multidisciplinary knowledge and effectively integrate.

3.2. Construction and analysis of theoretical framework

With junior middle school mathematics knowledge as the center, practical activities are processed and designed by applying the knowledge and methods of technology, science and engineering disciplines, so that students can widely explore multidisciplinary knowledge through mathematical tools and cultivate their wisdom and ability in various aspects (theoretical framework is shown in Fig. 2).
3.2.1. Interdisciplinary study based on science subjects and junior middle school mathematics

On the one hand, the eighth grade students are guided to carry out physics and mathematics interest learning activities, integrating physics and mathematics related knowledge, students use mathematical tools to carry out mathematical modeling, logical deduction, numerical transformation and other mathematical applications of physical phenomena, motion laws and classical theories; On the other hand, it guides the ninth grade students to carry out the interest learning activities of chemical mathematics, integrates the relevant knowledge of chemistry and mathematics, and enables the students to use mathematical tools to carry out mathematical modeling, logical deduction, numerical operation and other mathematical applications on the nature, composition, structure and change law of matter.

3.2.2. Interdisciplinary study based on technical subjects and junior middle school mathematics

On the one hand, the school makes full use of the community programming course for seventh grade students, guides students to solve math problems through independent programming, inspires students’ thinking and interest in information programming, and organically integrates information technology into math practice; On the other hand, make full use of the multimedia resources of the school, carry out digital teaching activities of information multimedia, break the traditional learning mode of "blackboard + chalk", and use multimedia tools to display and transmit mathematical knowledge to students in an image.

3.2.3. Interdisciplinary study based on engineering subjects and junior middle school mathematics

On the one hand, through the experiment and practical operation learning, let students hands-on experience and use knowledge to solve practical problems; On the other hand, comprehensive social practice learning activities are set up, with personal exploration as the main line, and students are guided to use mathematical tools to cooperatively solve problems, so as to improve their hands-on ability while acquiring mathematical knowledge.

4. Practical strategy

4.1. Taking the scientific spirit as the purpose, promote innovative logical thinking

STEM education philosophy adheres to science as the first purpose, and the interdisciplinary study of mathematics in junior middle school based on STEM should aim at exploring scientific truth, abandon the bad learning atmosphere of exam-oriented education, and cultivate middle school students with innovative logical thinking in a new era for the society.

4.1.1. Cultivate students' scientific thinking

Create a ‘classroom + peacetime’ linkage learning model, encourage students to use mathematical tools to conduct mathematical analysis and logical deduction of scientific phenomena, material properties and motion laws, and cultivate students’ scientific inertia thinking of ‘logical correlation’.

4.1.2. Stimulate students' creative ability

Build a scientific teaching model of ‘books + life’, encourage students to use the mathematical theory tools of books to find problems from multiple angles in life, share your problems in multiple dimensions, and solve problems in multiple ways, and cultivate students’ scientific innovative thinking of ‘thinking by comparison’.

4.2. Taking information technology as the carrier, create the immersive learning model

STEM education concept advocates student-centered, the use of existing advanced multimedia information technology, to provide learners with information learning situations and Spaces, set up immersive learning classrooms, and further stimulate students' active learning interests.

4.2.1. Make full use of school club programming classes

Through appropriate reward mechanisms (such as setting ‘programming talent’ to love that image), guide and encourage students to solve math problems through independent or cooperative programming, inspire students’ thinking and interest in information programming, and organically integrate information technology into math learning practice.

4.2.2. Make full use of school multimedia resources

Carry out information multimedia digital teaching activities (such as ‘online tutoring’, ‘mutual learning’ and other activities in spare time), break the traditional teaching mode of ‘blackboard + chalk’, and use...
multimedia tools to visually show and transmit mathematical knowledge to students.

4.3. Taking experimental teaching as the starting point, construct the grid knowledge structure

STEM education concept focuses on students' hands-on learning experience, gives students immersive learning experience, and encourages students to develop learning habits of spontaneous exploration and willingness to share. STEM based interdisciplinary learning of junior middle school mathematics emphasizes knowledge construction rather than mechanical acceptance. Carrying out experimental teaching can fully integrate mathematical knowledge and enable students to form a grid knowledge structure.

4.3.1. Carry out classroom experiment teaching

With physics and chemistry classes as the carrier, students are encouraged to operate experiments themselves, participate in experimental ideas, and innovate experimental methods. Students are encouraged to comprehensively use mathematical logic and mathematical knowledge to analyze natural physical phenomena and improve their ability to solve practical problems.

4.3.2. Carry out Social experiment teaching

With extracurricular practice activities as the carrier and exploration as the goal, the school should guide students to use mathematical thinking to discover mathematical laws in social phenomena and activities, and encourage students to use mathematical methods to cooperatively solve social practice problems, so that students can improve their hands-on ability while acquiring mathematical knowledge.

5. Conclusion

To some extent, the article enriches and deepens the learning content of junior middle school mathematics, expands and extends the learning mode of junior middle school mathematics, and has important theoretical and practical significance.

On the one hand, mathematics STEM learning in junior high school combines mathematics with science, technology and engineering, and integrates new learning modes into junior high school mathematics learning modes, which theoretically provides effective support for further enriching and deepening students' learning content, expanding and extending learning modes, and exploring and improving learning effects.

On the other hand, STEM-based interdisciplinary study of junior middle school mathematics can not only effectively improve teachers' interdisciplinary teaching literacy in practice, but also further innovate the teaching mode and provide students with a deep, multi-disciplinary and efficient learning mode and environment.

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References


