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Research on the Development of Practical Activities Based on the Integration of Physics, Chemistry, and Biology in Junior High School

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Abstract: Based on the teaching mode of subject integration, fusion-based subject activities are developed and practiced in the classroom. On the foundation of basic knowledge and methods, students are cultivated to understand science, conduct scientific experiments, observe scientifically, and measure scientifically. By adopting scientific methods to explore unknown problems, students can uncover the truth or analyze and explain experimental phenomena. Combined with daily inquiry activities around them, it is revealed that inquiry is not mysterious and inquiry activities are everywhere. Fusion-based subject activities select specific themes and guide students to understand and experience the basic significance, methods, and spirit of inquiry in a progressive and in-depth manner. This approach cultivates students' abilities to comprehensively solve problems and conduct inquiries.

Keywords: Subject Integration; Thematic Activities; Development and Practice

In recent years, China's compulsory education curriculum standards have been continuously updated, emphasizing the importance of interdisciplinary integration and practical teaching. Documents such as the "Opinions of the CPC Central Committee and The State Council on Deepening Education and Teaching Reform to Comprehensively Improve the Quality of Compulsory Education" [1] and the "Compulsory Education Curriculum Plan" explicitly propose requirements for interdisciplinary practice, highlighting the connections between physics, chemistry, biology, and other disciplines with daily life, engineering practice, and social development. Meanwhile, the curriculum standards for various disciplines issued by the Ministry of Education also emphasize comprehensive and practical teaching.

This study aims to address the following two major bottlenecks: Firstly, the issue of improving students' scientific literacy, including the emphasis on knowledge learning over practical experience and the preponderance of passive learning over active construction. Secondly, the problem of curriculum construction across disciplines, including the isolation of disciplines, the lack of systematicness in fused practical activities, and teaching objectives are confined within disciplines, with inadequate integration of science, technology, society, engineering, and other dimensions. Additionally, there is also a lack of basic pathways and strategies for the development and implementation of practical activities.

1. Research Design

1.1 Research on Discipline Integration [2]

Discipline integration has undergone three stages: emergence, development, innovation and prosperity. At the end of the 20th century, discipline integration began to attract attention. The German educator Johann Friedrich Herbart introduced the principle of correlation in curriculum, which was gradually developed into a teaching trend by educators such as Jacobs in Canada. In the 1960s, the United States attempted to introduce the STS (Science, Technology, Society) curriculum model, which interconnected science, technology, and society. In the 1980s, the STEM (Science, Technology, Engineering, Mathematics) educational concept was proposed in the United States and implemented in primary and secondary schools starting in the 1990s. By the early 21st century, STEM education became a focal point, and Germany also introduced MINT (Management of Innovation and New Technology) education. Finland and the United Kingdom subsequently launched educational reforms centered on discipline integration. Although these countries differ in their implementation methods, they all focus on students, cultivating their comprehensive qualities through thematic or related courses.

Discipline integration aims to resolve problems, achieve teaching objectives, and comprehensively cultivate students' learning abilities and overall qualities through the intervention of multiple disciplinary resources. Although it involves elements from different disciplines, there is integration, prioritization, and a dominance of the unique characteristics and traits of the leading discipline. Discipline integration is not a simple embellishment of disciplines, but rather a practical leveraging of the effectiveness and roles of different disciplinary resources.

Discipline-integrated teaching can be applied to various aspects of junior high school physics, chemistry, and biology courses, helping students better understand physical phenomena and principles, and improving their overall quality and innovation abilities. For example, by introducing natural experiments and technological production activities, combining knowledge points from chemistry and biology disciplines, and organizing interdisciplinary competitions, students are encouraged to explore knowledge and applications in different disciplines.

Discipline integration possesses educational, practical, and theoretical values [2]. It contributes to enhancing students' comprehensive qualities, such as teamwork ability, innovation capability, interdisciplinary thinking skills, and cultivating their ability to solve comprehensive problems. It facilitates the formation of standardized strategies and paths, leading to the radiation and guidance of disciplines within schools and the expansion of other disciplines. Furthermore, it strengthens theoretical understanding, as discipline integration not only involves the fusion of individual disciplines but also the interaction and integration of two or more disciplines. This embodies the integration of scientific literacy and humanistic literacy.

1.2 Research on Practical Activities

Practical activities[3], Originating from the background of quality education, constitute an essential part of the national basic education curriculum system. The "Guidance Outline for Comprehensive Practical Activity Courses in Primary and Secondary Schools" explicitly designates them as mandatory courses for national compulsory education and regular high schools, emphasizing interdisciplinary inquiry-based learning and social practice. Centered around problems, practical activities advance through interconnected learning tasks, characterized by a broad extension without distinct boundaries.

Taking the physics discipline as an example, by guiding students to solve real-life physics problems, understand the relationship between physics, the history of science, and societal development, and reflect on the knowledge framework connections between physics and other disciplines, we can innovate teaching modes. A five-step problem-inquiry efficient teaching model is constructed: "Create a scenario - Identify problems - Collaborative inquiry - Reflective evaluation - Consolidation and elevation". Simultaneously, there is an exploration of cross-disciplinary core competency integration through practical activities.

As shown in Figure 2 [2], using cross-disciplinary thinking based on real-world problems to link cross-disciplinary core competencies, we explore the integration of cross-disciplinary like moral education, science, art, humanities, and technology in practical activities. Through investigation, analysis, reasoning, etc., we select interrelated cross-disciplinary concepts and summarize cross-disciplinary fusion models based on core competencies, embodying the learning of cross-disciplinary concepts in specific learning processes and integrated courses.

Practical activities face challenges in practice, such as improper control of teacher-student relationships and difficulties in selecting and integrating curriculum resources. Researchers need to redefine the teacher-student relationship and conduct research on school resource development tailored to different educational stages and subjects.

2. Definition of Core Concepts

Subject integration is a cross-boundary education or interdisciplinary teaching concept proposed in response to isolated academic disciplines and monolithic teaching modes. The crux lies in identifying and discovering content that can be integrated, encompassing the integration of subject knowledge, subject thinking, subject methodologies, subject ethics, and subject spirit.

Practical activities[4] primarily adopt three major methodologies and processes: research-oriented methodologies and processes, methodologies and processes focused on social practice and community service activities, and methodologies and processes centered on project design and technical practice. The objectives of these activities are to stimulate students' interest in exploration and cultivate their sense of social responsibility and mission.

3. Research Objectives and Contents as follows

Through this research project, we aim to establish a well-structured, detailed, easily operable, and high-quality resource library for integrated practical inquiry activities in junior high school physics, chemistry, and biology. Additionally, we seek to optimize these integrated practical inquiry activities by developing activity themes, implementation pathways, and strategic methods based on the concept of deep experiential learning. The specific objectives include constructing subject knowledge, cultivating scientific thinking, fostering a sense of scientific inquiry, enhancing understanding of the nature of science, and forming teaching strategies and resource libraries for practical inquiry activities.

The research contents encompass an investigation into the current status of integrated practical inquiry activities in junior high school physics, chemistry, and biology, a literature review of the current situation and theories, research on theme development, exploration and practice of single-subject and interdisciplinary inquiry activities, as well as research on project development, implementation pathways, and methodological strategies.

4. Innovation Points

The uniqueness of this study lies in the development of a systematic set of practical activity cases for integrating physics, chemistry, and biology in junior high schools, proposing implementation methods, measures, and strategies to break down disciplinary barriers and cultivate students' comprehensive practical abilities. Additionally, it explores the integration points of these three subjects, filling the existing gaps.

5. Research Achievements

5.1 Cognitive Achievements

Understanding of the Essence of "Subject Integration": Subject-integrated learning aims to cultivate students' core competencies by integrating knowledge and methods from different subjects using comprehensive approaches, leading to a holistic understanding.

Characteristics of Thematic Inquiry Activities for Integrating Physics, Chemistry, and Biology in Junior High Schools: Practicality, constructivism, comprehensiveness, and openness.

Functional Understanding of Thematic Inquiry Activities for Subject Integration in Junior High Schools: These activities transform learning towards solving real-world problems, stimulate learning interest and develop scientific inquiry skills, help students construct core knowledge and concepts, and enhance subject literacy.

5.2 Operational Achievements

Development and Application Process of Thematic Inquiry Activities for Subject Integration in Junior High Schools: Deep exploration of themes, discussion on activity implementation methods, teacher tracking and support, and summary and reflection.

Implementation Strategies: Cultivate teachers' development capabilities and develop activity projects based on real-world problem scenarios.

5.3 Tangible Achievements

Sub-topics of thematic inquiry activities for subject integration.A collection of research papers, including studies based on subject literacy, exploration of PBL (Problem-Based Learning) activities, and inquiries promoting students' deep learning.

A case study collection and a scheme collection, showcasing the specific practices and applications of thematic inquiry activities for subject integration.

Through systematic research approaches and innovative points, this study has achieved rich cognitive, operational, and tangible results, providing strong support for the further promotion and application of thematic inquiry activities for integrating physics, chemistry, and biology in junior high schools.

References:

[1] CPC Central Committee and State Council: Issuing the "Opinions on Deepening Educational and Teaching Reform to Comprehensively Improve the Quality of Compulsory Education" [J]. Basic Education Curriculum, 2019(15): 4.

[2]Xu Aiqun. Design and Case Appreciation of Interdisciplinary Core Competency Integration Paths in Junior High School Physics. Middle School Physics, 2003(10): 32-33.

[3] Tian Huisheng. The Nature, Characteristics, and Curriculum Orientation of Comprehensive Practical Activities [J]. People's Education, 2001(10): 34-36.

[4] Zhang Hua. On the Essence of the "Inquiry-Based Learning" Curriculum [J]. Research in Educational Development, 2001(5): 14-18.