Practical Research on Interdisciplinary Integrated Teaching in Improving Students' Comprehensive Abilities

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Abstract

Interdisciplinary integrated teaching promotes the improvement of students' comprehensive abilities by integrating multidisciplinary knowledge and skills to carry out comprehensive learning tasks. In teaching practice, project-based learning, situational teaching and STEAM education are used to organically combine science, technology, engineering, art and mathematics. This teaching method focuses on cultivating students' innovative thinking ability, problem-solving ability and teamwork awareness. By constructing task-driven courses and cooperative learning platforms, students are stimulated to actively explore and think critically, and their comprehensive analysis and practical application abilities are cultivated. Empirical research shows that interdisciplinary integrated teaching can significantly improve students' comprehensive quality and innovation ability.

Keywords

Interdisciplinary Integrated Teaching, Comprehensive Ability, Project-based Learning, STEAM Education, Innovative Thinking

1. Introduction

The modern education system faces an important challenge. The excessive refinement of subject knowledge affects the cultivation of students' comprehensive abilities. The traditional single-subject teaching model has obvious limitations. It is difficult to meet the needs of cultivating innovative talents. Interdisciplinary integrated teaching is becoming a new trend in education reform. This teaching model has multiple advantages. First, it breaks the boundaries between subjects. Second, it creates a variety of learning situations. Most importantly, it cultivates students' ability to think from multiple perspectives. This teaching method brings significant results. Students are better able to deal with complex problems. Their innovative thinking is significantly improved [1]. Practical ability is also developed synchronously. Multidisciplinary cross-fertilization has a positive impact. On the one hand, it promotes the transfer and application of knowledge. On the other hand, it cultivates a systematic way of thinking. Students exercise their comprehensive qualities in real tasks. Ultimately, the overall ability is improved [2].

2. Theoretical Basis of Interdisciplinary Integrated Teaching

2.1 The Concept of Interdisciplinary Teaching

The so-called interdisciplinary integrated teaching is to integrate knowledge and skills of different disciplines in the education process. By building comprehensive and multidimensional learning tasks, students are guided to carry out learning and practice in a multidisciplinary context. This teaching model is characterized by problem-oriented, knowledge integration and multidisciplinary intersection, and focuses on the connection and application of knowledge.

In the actual teaching process, teachers help students analyze and deal with problems from different disciplinary perspectives by setting up interdisciplinary projects, theme activities and situational tasks, and cultivate students' ability to comprehensively apply knowledge. Compared with traditional single-subject teaching [3], interdisciplinary teaching pays more attention to the mutual connection and aggregation between disciplines. Through multidimensional and multi-gradient discussions and learning, students are encouraged to achieve a comprehensive understanding and flexible handling of complex problems.

Constructing real situations is the core of interdisciplinary teaching. It leads students to use multidisciplinary knowledge to solve practical problems through exploration, cooperation and innovation. In the scope of STEAM education, science, technology, engineering, art and mathematics are organically aggregated. In hands-on practice and project design, students can not only master the basic content of the subject, but also improve their interdisciplinary comprehensive ability. This teaching model is not only conducive to broadening students' knowledge horizons, but also enhances their problem-solving ability and creates a teamwork atmosphere.

2.2 Theoretical Basis

The interdisciplinary integrated teaching theory mainly draws nutrients from constructivist learning theory and multiple intelligence theory. Constructivist learning theory advocates that learning is a process of actively constructing

knowledge. Students use their own experience and existing knowledge to construct new knowledge in interaction with the outside world. Real tasks and projects promote interdisciplinary teaching, guide students to actively explore and think, and allow students to form a complete knowledge system in the integration of multidisciplinary knowledge.

Multiple intelligence theory plays a key supporting role in interdisciplinary integrated teaching. This theory believes that each student has multiple types of intelligence, such as language, logical thinking, spatial cognition, body movement and other types of intelligence [4]. In the context of interdisciplinary teaching, the use of diversified tasks and activity designs can fully drive the collaborative growth of students' multiple intelligences, especially in promoting innovation ability and comprehensive literacy. Through the integration of subject knowledge, theoretical knowledge can be transformed into practical ability, helping students improve their comprehensive literacy in the process of knowledge transfer.

2.3 Research Status

Research on interdisciplinary integrated teaching has now become a key direction of educational research at home and abroad. Research in this field started earlier abroad, especially in Europe and the United States. As an innovative education model, interdisciplinary teaching has been widely used in basic education and higher education. When the United States carried out STEAM course practice, it focused on the integration of interdisciplinary knowledge and built a relatively complete curriculum system and evaluation mechanism. Through project-driven and task-oriented teaching methods, students' innovative thinking and comprehensive practical ability can be significantly enhanced.

In recent years, China has gradually begun to carry out research and practical exploration of interdisciplinary integrated teaching, especially in the basic education stage. Many schools have tried to explore reasonable ways of interdisciplinary teaching through project-based learning, thematic courses and subject integration experimental courses [5]. Interdisciplinary integrated teaching can effectively break the barriers between disciplines and promote students' independent learning and innovation ability. However, due to the lack of scientific evaluation mechanisms and systematic curriculum design, some teaching practices still face the problems of formalization and shallow integration. How to scientifically build an interdisciplinary teaching system and reasonably measure its implementation effect remains the focus of current research.

3. Practical Exploration of Interdisciplinary Integration Teaching

3.1 Analysis of Practice Models

There are various practice models for interdisciplinary integration teaching, and the integration methods and teaching strategies of different disciplines have their own characteristics. At present, the more mature practice models mainly include project-based learning (PBL), STEAM education and situational teaching methods. In the specific implementation of these models, they can not only meet the requirements of subject knowledge integration, but also effectively improve students' comprehensive abilities [6].

Project-based learning (PBL) is a teaching model based on project tasks. It aims to guide students to complete specific tasks and promote the integration and application of multidisciplinary knowledge. In this model, students carry out learning and exploration around real problems or projects, use knowledge of various disciplines such as science, mathematics, and art to conduct cooperative research and in-depth exploration, and finally complete the task requirements or form project results. Taking the environmental protection theme project as an example, students can calculate carbon emissions through mathematical modeling, explore ways to reduce pollution with the help of scientific experiments, and then promote environmental protection concepts through art design. The PBL model not only helps students build a comprehensive knowledge system, but also enhances teamwork and innovation capabilities.

STEAM education is a typical example of interdisciplinary integration teaching. It integrates science, technology, engineering, art and mathematics. This model combines scientific inquiry, technology application, engineering design, artistic expression and mathematical analysis by designing interdisciplinary theme activities. In the practical activities of making solar cars, students need to use physical knowledge to design photovoltaic panels, assemble the car structure according to engineering principles, and perform mathematical operations and artistic decoration at the same time. Through such comprehensive practice, students can experience the inherent connection of subject knowledge during the implementation of the project, which has a positive effect on cultivating innovative thinking and hands-on practical ability.

The situational teaching method emphasizes learning experience in real or simulated real-life situations to enhance students' problem-solving ability. This model stimulates students' interest in learning and desire to explore in the process of solving practical problems by creating real task situations, such as social dilemmas and scientific and technological problems. In this process, students actively integrate and apply knowledge from different disciplines through various forms such as role-playing, case analysis, and task discussion. In the situational teaching of "Urban Water Resources Management", students simulated roles such as environmental engineers and economic planners, and used geography, chemistry, mathematics and other multidisciplinary knowledge to develop a plan for the rational use of water resources. The situational teaching method not only enhances the practicality and fun of learning, but also effectively improves students' comprehensive analysis ability.

3.2 Practical Case Study

3.2.1 Case 1: Science and Art Integration Teaching in Junior High School

The science and art integration teaching in junior high school is an innovative exploration. With the theme of "Refraction of Light and Artistic Expression", a fusion course was developed. At the beginning of the teaching, students were guided to learn the principle of light refraction and observe the changes of light in different media through experiments. At the same time, combined with the art creation task, students were asked to use different materials to make light and shadow artworks, such as glass sculptures and refraction paintings. During the implementation of the plan, the teacher adopted the task-driven method, and students worked in groups to complete the art creation activities and display the results. The practical results show that students not only mastered physical knowledge through the project, but also cultivated innovative expression skills. Through the interdisciplinary integration of science and art, students' teamwork ability and artistic aesthetic ability have been significantly improved.

3.2.2 Case 2: Interdisciplinary Teaching of High School Mathematics and Physics

In high school teaching, the combination of mathematics and physics is significantly logical and theoretical. In the teaching of "parabola and projectile motion", the teacher combines the projectile motion in physics with the parabola equation in mathematics to explore the mathematical expression of the object's motion trajectory. The teaching goal is to explain the characteristics of the parabola through a physical model and guide students to understand the motion law of the object when it is projected. In terms of implementation strategy, the teacher first verifies the law of projectile motion through physical experiments, and then guides students to discuss experimental data in groups and use mathematical modeling to analyze the curvature change of the parabola equation. Students communicate the modeling process and verification results in group reports, further deepening their understanding of physical motion and mathematical equations. Adopting an interdisciplinary teaching model, students' logical reasoning ability and subject transfer ability are significantly improved.

Promoting interdisciplinary integrated teaching through project-based tasks and situational design can achieve the natural combination of knowledge from different disciplines in practice. This not only cultivates students' ability to comprehensively apply knowledge, but also greatly enhances their innovative thinking and teamwork awareness. It can be seen from these cases that the rational use of interdisciplinary integration strategies in teaching practice can achieve significant teaching results and capacity building effects.

4. The Effect of Interdisciplinary Integrated Teaching on Improving Students' Comprehensive Ability

4.1 Ability Improvement Performance

Interdisciplinary integrated teaching practice can significantly improve students' comprehensive ability, mainly reflected in innovative thinking, problem-solving and teamwork.

(1) Innovative Thinking Ability

Interdisciplinary teaching stimulates students' innovative consciousness through multidimensional analysis and practical activities. In teaching activities, multidisciplinary content such as science, technology, and art is integrated to enable students to understand and analyze problems from different disciplinary perspectives. In the project-based learning context, students first collect data through scientific experiments, then use mathematical models for in-depth analysis, and finally present the results in the form of art works. This process effectively promotes the development of innovative thinking. Specific teaching results show that a questionnaire survey of experimental class students found that 83% of students said that interdisciplinary tasks can stimulate creative thinking, which is 30% higher than that of traditional teaching classes.

(2) Problem-solving Ability

Interdisciplinary integrated teaching focuses on the integration of subject knowledge and cultivates students' comprehensive analysis ability. Through project-driven and situational design, students need to use a variety of skills such as mathematical reasoning, scientific experiments, and technical operations to propose systematic solutions when facing complex tasks. In the implementation of the interdisciplinary project of "Urban Water Resources Management", students analyzed water quality monitoring data, established mathematical models and formulated engineering plans, demonstrating a complete idea from data analysis to program implementation. Data analysis shows that when solving comprehensive problems, the accuracy of the experimental class students' answers increased by 25%, and the time spent on problem-solving decreased by 15%, reflecting the advantages of interdisciplinary teaching in cultivating logical reasoning and practical ability.

(3) Teamwork Ability

In the interdisciplinary integrated teaching model, group cooperative learning is one of the main forms. Students divide the work and cooperate through project tasks, gradually cultivating communication, coordination and collective decision-making abilities. Especially in STEAM education practice, students are divided into groups to carry out creative design and engineering construction work, and each member assumes different responsibilities according to their own expertise, which effectively promotes the cultivation of collaborative cooperation ability. From the evaluation

of the effectiveness of student teamwork, it was found that 90% of the students believed that the interdisciplinary project made them significantly improve in communication expression and task division, which was 28% higher than the control class.

4.2 Data Analysis

In order to scientifically evaluate the impact of interdisciplinary integrated teaching on students' comprehensive ability, an experimental class and a control class were set up for comparative research. By collecting test scores, learning attitude questionnaires, and teacher evaluation data, the teaching effect can be quantified. See Table 1 for details.

Table 1. Comparison between Experimental Class and Control Class

Ability dimension	Experimental class (improvement rate)	Control class (improvement rate)	Difference (percentage points)
Innovative thinking ability	83%	53%	+30
Problem solving ability	75%	50%	+25
Teamwork ability	90%	62%	+28
Comprehensive analysis ability	78%	52%	+26

The data table shows that compared with traditional teaching, interdisciplinary integrated teaching has a significant effect on improving various comprehensive ability dimensions. Especially in teamwork and innovative thinking, the improvement performance is particularly outstanding.

Students in the experimental class generally reflect that interdisciplinary activities are more challenging and interesting. This trait is conducive to stimulating their enthusiasm for independent learning. Teacher feedback also shows that in practical operations and teamwork task situations, students show higher enthusiasm and participation initiative. During classroom observation, when discussing tasks and designing solutions, students in the experimental class showed a strong sense of cooperation and good logical expression ability. This phenomenon is closely related to the task-driven characteristics of interdisciplinary integrated teaching.

Interdisciplinary integrated teaching promotes the development of students' multiple abilities through knowledge integration and task guidance. This provides strong support for cultivating students' comprehensive qualities in modern education. Through experimental comparison and quantitative analysis, it can be confirmed that interdisciplinary teaching is effective in cultivating students' innovation ability, cooperation ability and problem-solving ability.

5. Implementation Strategies and Optimization Suggestions for Interdisciplinary Integrated Teaching

5.1 Professional Development of Teachers

For interdisciplinary integrated teaching to achieve good results, the improvement of teachers' professional literacy is the primary condition. Since interdisciplinary teaching involves the comprehensive application of multidisciplinary knowledge, it is crucial to form a team of teachers with multidisciplinary backgrounds. To achieve this goal, it is necessary to establish a sound teacher training mechanism to promote the improvement of teachers' multidisciplinary knowledge reserves and interdisciplinary teaching ability.

For individual teachers of different disciplines, the training mechanism should focus on cultivating their discipline integration ability. Interdisciplinary teaching and research activities, case teaching training and project-based curriculum development can be carried out to help teachers grasp the connection between disciplines. In STEAM education training, it is necessary to improve the artistic literacy of science and engineering teachers and enhance the technical literacy of art teachers. By holding special seminars and teaching demonstration classes, teachers can be encouraged to exchange multidisciplinary integration experiences and achieve common growth.

Collaborative lesson preparation and curriculum design among teachers are important links in interdisciplinary teaching. The complexity of interdisciplinary courses requires teachers from different disciplines to collaborate deeply on teaching objectives, content and methods. Schools should set up interdisciplinary lesson preparation groups to support teachers in conducting interdisciplinary collective lesson preparation, jointly planning course content and designing teaching tasks. With interdisciplinary teaching and research activities as a platform, teachers can share teaching resources, discuss course integration plans, and create a good atmosphere for interdisciplinary cooperation.

5.2 Curriculum System Optimization

In order to ensure the high-quality implementation of interdisciplinary integrated teaching, it is critical to optimize the curriculum system. In terms of curriculum setting, interdisciplinary theme courses such as "Science and Art" and "Technology and Mathematics" can be added. This allows students to be exposed to multiple disciplines in the same course. In these course designs, it is necessary to focus on designing challenging and practical learning tasks so that students can experience the process of discipline integration in real situations. Modular curriculum design is also an important measure to promote interdisciplinary integrated teaching. By constructing course modules and establishing the context of interdisciplinary intersection, it helps students gradually master the integration method of interdisciplinary knowledge. Taking the "Science and Art" module as an example, physical optics is combined with

visual arts, so that students can experience the beauty of scientific principles when conducting light and shadow experiments and artistic creation. Modular courses can not only promote the organic integration of knowledge, but also improve students' learning interest and practical ability.

In addition, a scientific and reasonable curriculum evaluation system should be formulated, focusing on multidimensional assessment of students' comprehensive abilities. Evaluation indicators should cover core qualities such as innovative thinking, problem-solving ability, and teamwork ability. A combination of process evaluation and final evaluation should be used to comprehensively evaluate students' progress in the learning process.

5.3 Innovation in Teaching Methods

Innovation in teaching methods is an important means to achieve interdisciplinary integrated teaching. The use of task-driven and project-oriented teaching methods can effectively improve students' practical ability and learning autonomy. In the process of project learning, real task scenarios are set up, such as "environmental protection robot design" and "interdisciplinary creative results display". Students need to use science, technology, engineering and art knowledge to complete tasks. This task-driven teaching method can effectively stimulate students' innovative thinking and practical ability.

Increasing experiential learning and practical links is another direction of interdisciplinary teaching innovation. In teaching activities, students are allowed to personally participate in task solving through project exploration, experimental operation, field investigation and other activities. In the interdisciplinary project of "Smart City Design", students organically integrate knowledge such as mathematics, geography, and information technology through field visits, data analysis, and model construction, and improve their knowledge transfer ability in practice.

To improve the quality of classroom interaction, a hybrid teaching model can also be adopted to integrate online and offline resources. By using the network platform to carry out interdisciplinary learning exchanges, and by building virtual laboratories and online discussion areas, students can break through the limitations of time and space, conduct disciplinary interactions and project cooperation, which is conducive to knowledge sharing and collaborative task completion.

6. Conclusion

Interdisciplinary integrated teaching is an innovative teaching model. It cultivates students' comprehensive abilities such as innovative thinking, problem-solving and teamwork by breaking down disciplinary barriers and integrating diverse knowledge. In actual teaching practice, with the help of project-based learning, STEAM education and situational teaching, students build a systematic cognitive structure in real tasks and multidisciplinary interactions. By improving teachers' multidisciplinary literacy and optimizing the curriculum system, the teaching effect has been significantly improved. Interdisciplinary integrated teaching has not only achieved a breakthrough in knowledge integration, but also demonstrated unique advantages in cultivating students' comprehensive literacy. In the future, we should further explore the optimization methods of teaching models, build a scientific and flexible curriculum evaluation system, and provide more innovative practical activities for the cultivation of comprehensive talents.

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