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Design Framework and Practice of STEM Interdisciplinary Project-based Teaching Activities Based on OBE Concept

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ABSTRACT

Interdisciplinary learning is the core feature of STEM education. Interdisciplinary course and the cultivation of comprehensive practical ability have become one of the hot spots in today's educational reform. The practical approach of STEM education points to the comprehensive application of interdisciplinary knowledge. Based on STEM, this paper adopts the teaching mode based on STEM to design the framework of STEM interdisciplinary project-based teaching activities, which is applied in the course of "Primary School Information Technology Activities and Competition Topics" to lay a foundation for cultivating interdisciplinary excellent primary school general teachers with "integration of specialties and abilities".

1. Introduction

Interdisciplinary learning is the core feature of STEM education. Interdisciplinary course teaching and the cultivation of comprehensive practical ability have become one of the hot spots in today's educational reform. In 2016, the Ministry of Education of China clearly stated in the *13th Five-Year Plan of Educational Informatization* that qualified areas should actively explore the application of information technology in new educational models such as "creating space for all", interdisciplinary learning and maker education. In 2017, the Ministry of Education issued the *Science Curriculum Standard for Compulsory Education Primary Schools*, which advocated interdisciplinary learning and suggested that teachers could try STEM education in teaching practice. In July, 2020, the Ministry of Education issued the Guiding Standards for Training Courses for Primary and Secondary School Teachers, which incorporated STEM courses and development into the theme of teachers' cultural knowledge learning and training, highlighting the important position of STEM education. *The 2022 edition of the Curriculum Standard of the Ministry of Education* strengthens the comprehensiveness and practicality of the curriculum, promotes the reform of education methods, and focuses on cultivating students' core literacy. Especially in the compulsory stage of "Information Technology" course clearly put forward the interdisciplinary teaching theme,

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and cultivating a new generation of high-quality STEM teachers is the key to practice STEM education concept and implement STEM project-based teaching design and practice. In this paper, through the construction of STEM interdisciplinary project-based teaching activities design, the application and practice of training professional courses for general normal students are analyzed, and high-quality teachers with interdisciplinary teaching ability are cultivated.

Design of STEM Interdisciplinary Project-based Teaching Framework

The current interdisciplinary mode is quite different from the previous traditional single-discipline training mode, especially the form of knowledge has gradually changed from single to integration. From the perspective of "purpose-means", interdisciplinary curriculum aims at obtaining interdisciplinary thinking, takes interdisciplinary concepts and methods as means, and takes solving real problems as intermediary.

In this study, interdisciplinary refers to the practical activities of integration, learning, practice and application of information technology and science education based on STEM and multidisciplinary in primary schools. By means of interdisciplinary concepts and methods, interdisciplinary curriculum design is carried out by using information technology and skills, and the problem of integration of training specialties and abilities of general teachers in primary education majors is solved.

The practical approach of STEM education points to the comprehensive application of interdisciplinary knowledge. In the curriculum design, the teaching mode based on STEM is adopted to design the subject curriculum, and the interdisciplinary teaching process of "learning-practice-application" is constructed from the aspects of teaching objectives, teaching contents, teaching processes and teaching evaluation, and the inquiry teaching activities are constructed in a project-driven way.

In the process of implementing knowledge transfer in practice through project-driven learning, students are progressively promoted to learn curriculum knowledge (Lego Robot, Scratch Creative Programming, etc.) at three levels of "cognition-internalization-practice", which provides support for the development of primary school mathematics, primary school Chinese, primary school English and other courses (which are determined according to students' career planning), and promotes the traditional teaching classroom to student-centered participatory teaching. After the course, the teaching effect of the course is fed back by the student evaluation form for project evaluation and feedback.

To design and implement STEM interdisciplinary course teaching, we should consider the systematicness of subject knowledge, the rationality of solving practical core-driven problems, and the integration degree between project implementation and subject knowledge penetration, so as to finally realize the mutual integration and support between the systematicness of the overall knowledge structure and the learning contents contained in various problems. This study puts forward STEM interdisciplinary project-based teaching activity design framework, around the four aspects of teaching objectives to achieve, carry out eight-step project-based teaching, from the learning layer to the application layer step by step.

2.1 Problem introduction

According to the teaching content, teachers build a situation based on real application, so that students can understand what kind of situation they will study and explore. Giving students the role or identity of future teachers is helpful to improve students' enthusiasm and initiative in learning.

2.2 Set goals

This part is designed around the three-dimensional goal of knowledge, emotion and values in order to let students know the effect to be achieved after the implementation of the project before entering the project, the setting of each project goal is set around the teaching content of this part.

2.3 Project task

Project tasks start from the teaching tasks to be achieved in the course and the scientific knowledge that students should master, and select topics from the perspective of practical application, so as to help students establish the relationship between subject knowledge and real application, focus on core-driven problems, and the core-driven problems designed by teaching should cover multiple dimensions. The problem involves the knowledge principle related to the field of study, which can stimulate students' motivation and encourage them to explore and learn. Its structure should be open and real, so as to help students produce ideas in the existing knowledge field. It is convenient for students to disassemble the core driving problems and lay the foundation for the next step of learning.

2.4 Information analysis

According to the project task, the process of students participating in project learning is actually learning

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In the process of students' independent scientific inquiry, students are guided to analyze themselves in this link, so that students can analyze the subject knowledge involved in completing the project tasks, the key technologies and experiences in solving problems, and what knowledge they have mastered and what knowledge points need to be acquired when completing the project learning.

2.5 Make a plan

The student-centered inquiry teaching activity of the project is that students form a learning team and formulate an implementation plan according to the project tasks on the basis of fully understanding the project objectives and self-learning analysis. This part is the general guidance and program of the project implementation link.

2.6 Project implementation

Project implementation is a process in which students are the mainstay and teachers guide students to practice. This part is a link in which theory and practice are combined and real hands-on operation is carried out.

2.7 Outcome evaluation

Results evaluation is mainly carried out from multiple angles, such as students' self-satisfaction in completing projects, mutual evaluation among group members and groups, and teacher evaluation. Through multiple evaluations, students can be helped to improve their awareness and feedback on self-learning and enhance their sense of self-efficacy.

2.8 Effectst

The setting of this link allows students to summarize and reflect on the contents that need to be improved in the project itself, so as to make corrections and feedback and iterate through the curriculum development project.

3. Practice of STEM Interdisciplinary Project-based Teaching Activities

3.1 Basic situation of activity practice

In practice, STEM interdisciplinary project-based teaching activity design framework is applied to the teaching of *Information Technology Activities and Competition in Primary Schools,* which involves 181 students in 6 classes of 19 grades. Through the method of questionnaires to students before and after class survey, the current situation and needs of students survey and analysis, targeted to carry out teaching work.

Taking interdisciplinary as the breakthrough point, taking scientific and technological knowledge as the means (scientific skills include scratch programming technology, Lego robot, Misch, Maker, etc.), setting curriculum content, carrying out skill knowledge teaching in the form of project-driven, carrying out practical drills with interdisciplinary comprehensive teaching application, and combining with students' career planning needs, finally completing STEM-based interdisciplinary teaching case development of primary school mathematics, Chinese, English, science, art, sound and other related courses, enhancing students' interdisciplinary innovative teaching ability.

3.2 Activity implementation process

The implementation process of the activity starts with solving the problem of fixed-point parking, completes the learning of programming knowledge of Lego robot knowledge, and completes the project learning by using the comprehensive application of mathematics, engineering, science and technology in STEM, which is transferred to the teaching of primary school mathematics curriculum and develops interdisciplinary teaching cases. As shown in Table 1:

3.3 Activity effect and reflection

In order to test the effect of STEM interdisciplinary project-based teaching activities, in the research process, the classroom effect is evaluated by the learners' learning and feeling as the evaluation lever, and the pre-class and after-class questionnaires are used to evaluate and test. The pre-class questionnaires are arranged after the first class, and the learners have an initial comprehensive understanding of the curriculum objectives, contents, requirements and introduction. After-class questionnaires are conducted after the students finish this course. By comparing the data of the questionnaires before and after class, STEM interdisciplinary project-based teaching activities have better improved the students' effect. Do you know anything about this course? Are you afraid of difficulties in this course? The results of 181 students who participated in the survey are shown in Figure 4. At first, the students did not know much about this course and were afraid of learning difficulties.

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Table 1. Design of fixed-point parking project and teaching case

Project: fixed-point parking project and teaching case design	
(1) Introduce problems and constructing project scenarios	Introduce fixed-point parking from life, and work with students to determine the practical problems to be solved in the project. Interdisciplinary knowledge: Mathematics, learn to use mathematical thinking and tools (ruler) to solve problems in engineering; Engineering, building a fixed-point parking project for cars, and carrying out practice with reasonable division of labor; Technology, using LEGO technology to solve core problems, complete the production and testing of the project.
(2) Determine the goal and explore the effectiveness of the project	Knowledge: Learn the basic theoretical knowledge of Lego and apply it to practice; Learn the interdisciplinary teaching design of STEM and master the significance of the application of measurement in the project Skills: Able to build the car structure according to the requirements to ensure normal operation; Be able to program and control the operation and parking of the car, transform and transfer what you have learned, and design teaching cases Literacy: Comprehensive application and interdisciplinary innovation ability
(3) Project tasks, focusing on core-driven issues	How to use STEM interdisciplinary knowledge to complete the project of solving fixed-point parking and develop and write teaching cases? LEGO hardware and programming environment and meter ruler, which need to stop at fixed points and transform into STEM interdisciplinary teaching cases
(4) Information analysis	Known question: How to measure? What are the functions of the circumference of wheels? Knowledge about the distance of primary school mathematics Question to know: How to apply Lego programming software? How to construct the structure of the car. How to use what you have learned to develop STEM interdisciplinary teaching projects.
(5) Make a plan of autonomous learning, that is, what should I do	Make overall design methods; Build car hardware; Write software; Test project; Evaluate intergroup; Improvement and promotion
(6) Project implementation	Guide the students to decide the fixed-point parking scheme of the car by using mathematical knowledge without sensors Build the hardware structure of the car according to the scheme Write a program, which mainly sets the driving mode and power of the motor, and determines the running parameters of the electrical connection by calculating the circumference of the wheel and dividing the total distance by the circumference of the wheel Complete the whole design by testing and correcting the parameters Transform the results and develop teaching cases
(7) Achievement evaluation, multi-evaluation of the project	By demonstrating my own project achievements and teaching cases, make personal evaluation * 25% + group mutual evaluation * 25% + teacher evaluation * 20% + user evaluation * 30%, and make overall evaluation on the project effect.
(8) Summarize and reflect on the problems encountered in the project and the improvement methods	After completing the practical project application, it is transformed into STEM interdisciplinary project-based teaching case design

4. Conclusion

"STEM interdisciplinary project-based teaching activity framework, combine subject teaching with professional development, improve students' ability to solve problems and comprehensive application of interdisciplinary knowledge, and truly apply what they have learned. Exploratory teaching activities are being implemented in a project-driven way, and the progressive learning of subject knowledge is realized, which is applied in the course

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of" *Primary School Information Technology Activities and Competition Topics* ", laying a foundation for cultivating interdisciplinary excellent primary school general teachers with" integration of specialties and abilities ".

Fund Project

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