ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202408_7(8).0006

The Exploration of PBL Model based on STEAM Concept in the Teaching of "Material Foundation" Course

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Abstract

This article discusses the practical significance of combining the STEAM concept and PBL model and applying them to the teaching of the "Fundamentals of Materials" course. It mainly seeks new teaching models by analyzing the limitations of traditional teaching models. The integration of STEAM concept and PBL model into the practical teaching of "Fundamentals of Materials" mainly includes teaching project design, curriculum reform content, and curriculum reform goals. Through relevant design, it effectively improves students' interdisciplinary creative thinking and enhances their problem-solving abilities, providing effective practical teaching value and theoretical guidance for other later course reforms. It can also lead to beneficial explorations and attempts in other fields of curriculum, laying a solid foundation for improving teaching quality and talent cultivation.

Keywords

STEAM Concept; PBL Model; Material Foundation Course.

1. Introduction

The "Material Fundamentals" course, as a crucial basic course for science and engineering-related majors, its status and role cannot be underestimated. It has extremely critical significance for comprehensively cultivating students' professional qualities and shaping scientific thinking [1]. In this course, students can lay a solid professional knowledge foundation and pave the way for subsequent in-depth learning and research. However, the traditional teaching mode has exposed some limitations to a certain extent, such as restricting the initiative and creativity of students, making students often in a relatively passive receptive state and difficult to give full play to their potential and subjective initiative [2].

Different from this, the STEAM concept emphasizes the importance of multidisciplinary integration and innovative practice. It breaks disciplinary boundaries and prompts students to think and solve problems from a broader perspective. And the PBL model is problem-oriented, through specific problem situations one by one, which stimulates students' strong curiosity and exploration desire, and can thus greatly mobilize students' learning enthusiasm. Ingeniously combining these two and applying them to the teaching of the "Material Fundamentals" course undoubtedly has significant and far-reaching exploratory significance. This combination can not only enrich the teaching content and form, but also create a more open, flexible and challenging learning environment for students, allowing students to improve professional qualities and comprehensive abilities in exploration and practice, and opening up new paths and possibilities for cultivating innovative talents that meet the needs of the times [3].

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2. The Integration of the STEAM Concept and the PBL Model

The STEAM concept covers science (Science), technology (Technology), engineering (Engineering), art (Art), and mathematics (Mathematics), aiming to cultivate students' cross-disciplinary thinking and comprehensive abilities. The PBL model focuses on students' learning and growth in the process of solving practical problems. The integration of the two brings new ideas and methods to the teaching of the "Material Fundamentals" course.

STEAM represents the acronyms of science (Science), technology (Technology), engineering (Engineering), art (Arts), and mathematics (Mathematics). As an educational concept, STEAM is different from traditional educational and teaching concepts and is a concept that attaches great importance to the comprehensive application of knowledge in different disciplines. The STEAM concept attaches great importance to the integration of contents in different fields, especially the integration of the use and meaning of contents. This concept encourages students to actively acquire knowledge and seek solutions to complete classroom tasks [4].

PBL (Problem-based-Learning) is translated as "learning based on problems", which is a teaching method centered on learners. The PBL teaching model is based on the PBL theory, and this teaching model specifically includes several links such as creating a situation, discovering problems, cooperative exploration, problem-solving, summary and reflection. The teaching process attaches great importance to the learner-centered and problem-oriented, and encourages students to collaborate in groups. The teaching method usually adopts the task-driven method.

The PBL teaching model and the STEAM concept complement each other. Starting PBL teaching exploration under the STEAM concept, through cross-disciplinary learning, purposefully and meaningfully integrating the knowledge and methods in multiple disciplinary fields to solve a certain or some learning problems or projects to achieve teaching goals. The PBL teaching model provides a foothold for the theoretical practice of the STEAM concept, and the integration of the STEAM concept can optimize and enrich the theoretical basis of the PBL teaching model.

3. The Implementation of PBL Model based on STEAM Concept in the "Material Foundation" Course

3.1. Project Design

The "Material Foundation" course is one of the core professional courses in the packaging planning and design major of our school, and it is also an important way for our school to cultivate packaging and printing talents. In order to improve the teaching quality and enhance the teaching effect, our college continuously uses and innovates various teaching methods and models, and the PBL teaching model has also entered the design of our classroom reform practice.

Under the background of the development of the digital economy, new requirements have been put forward for the cultivation of packaging talents in society. As a relatively mature teaching model, the PBL teaching model also needs to make corresponding improvements and innovations in order to adapt to the cultivation of talents. At present, in the classroom application of the PBL teaching model, emphasis is placed on the selection of problems and the design of the problem situation, but not enough attention is paid to how to use the learned knowledge to solve problems. The problems or tasks emphasized by the PBL teaching model are all proposed based on actual life, and the problems in actual life are not single, and cannot be solved by a single discipline. In other words, at present, the PBL teaching model focuses on the learning and mastery of knowledge, but not enough attention is paid to the students' ability to transfer and apply knowledge.

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The STEAM education concept attaches more importance to the integration and transfer application of knowledge. It can be seen that the integration of the STEAM concept and the PBL teaching model can make the classroom teaching more perfect and the cultivation of students' abilities more comprehensive. Based on the STEAM concept, more practical problems can be designed, which can cultivate students' creative thinking of applying knowledge across disciplines, develop the habit of comprehensively using knowledge to think and handle problems, and improve the ability to solve problems.

3.2. Reform Content and Reform Goals

(1) Reform the teaching content of the "Material Foundation" course

Whether it is the STEAM teaching concept or the PBL teaching model, a key point for success lies in the richness of the teaching content, which must not only meet the needs of the interdisciplinary integrated teaching of the STEAM but also meet the learning needs of the PBL teaching mainly based on problem-oriented learning. There should not only be sufficient online teaching resources in the fields of "packaging materials" and "packaging technology" across disciplines, but also classroom software and hardware guarantees for offline participatory learning. Teaching videos, tests, course documents and other teaching contents are all indispensable, and will further enrich the teaching resource database of our "Material Foundation" course. [5-6].

(2) Construct the theory of PBL teaching model based on the STEAM concept

At present, although there have been some attempts to combine STEAM and PBL, the relevant research results really need to be further enriched. When constructing the theory of the PBL teaching model based on the STEAM concept, it is necessary to deeply think about how to skillfully integrate the rich and diverse STEAM educational concepts such as interdisciplinarity, interestingness, experientialness, situationality, cooperativeness, designability, artistry, evidentiality, and technology enhancement into the PBL model. Specifically, taking problems as the guide, let students realize the goal of "learning" in the actual process of "doing". By carefully designing problem situations with practical significance and challenges, stimulate students' interests and exploration desires, and prompt them to actively invest in learning. In the link of group cooperation, students can give full play to their respective advantages, communicate and cooperate with each other, and jointly overcome difficulties. This kind of cooperation not only helps the internalization of knowledge, but also promotes students to conduct in-depth learning and explore the depth and breadth of knowledge. At the same time, attention should be paid to the integration of artistry, so that students can feel the charm of art in the learning process and improve their aesthetic ability and creativity; evidentiality ensures the scientific and rigorous nature of learning, allowing students to verify theories through practice. And technology enhancement can make use of modern technological means to provide more resources and conveniences for teaching. By organically combining these elements to form a closely related and mutually supporting overall teaching model framework, making it fully feasible at the theoretical level and laying a solid foundation for subsequent practical applications.

(3) Carry out the practice of PBL teaching activities based on the STEAM concept

In the 2023-2024 academic year, we carefully selected one class as the object of the teaching activity research, and fully applied the constructed PBL teaching model based on the STEAM concept with the "Material Foundation" course as the starting point. In the practice process, we carefully designed each teaching link. For example, put forward practical problems related to materials, and guide students to think and analyze from multiple perspectives such as science, technology, engineering, art, and mathematics. Students conduct in-depth investigation and research through group cooperation, and use the knowledge and skills of different disciplines to find solutions. Teachers play an important guiding role throughout the process, giving students guidance and feedback in a timely manner to help them continuously improve their

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thinking and methods. At the same time, encourage students to be bold in innovating and try to use new technologies and materials to solve problems. Through such teaching activity practice, we can not only verify the feasibility and effectiveness of this teaching model in actual teaching, but also collect a large amount of feedback and data in order to further optimize and improve the model. Moreover, the achievements and experiences of this practical research will provide extremely valuable references for other courses to carry out the PBL teaching model based on the STEAM concept. It lays a solid foundation for promoting the development of interdisciplinary teaching and cultivating students with innovative spirit and comprehensive qualities. We believe that the wide application of this teaching model will have a positive and far-reaching impact on the field of education.

3.3. Project Reform Results

(1) The optimization of the combination of the STEAM teaching concept and the PBL teaching model

This research will base on the STEAM teaching concept to maximize the teaching advantage model of the PBL teaching model with problem-oriented. How to perfectly combine the two is the key point of this research. The advantage of the STEAM teaching concept lies in the integrated teaching method, emphasizing practice and process, and emphasizing solving real problems; emphasizing both knowledge and ability, and advocating "learning" in "doing". Under the guidance of the STEAM concept, teachers seize students' attention through the design of each stage of the classroom, and promote the learning stage through the seamless connection of situational introduction, new lesson explanation, group cooperation, achievement display, and summary evaluation, thereby promoting the teaching of the interdisciplinary "Material Foundation" course to achieve better results.

(2) Diversification of evaluation methods

The traditional course evaluation method for students is mainly quantified assessment based on the final exam and combined with students' usual learning situations; the evaluation method for teachers is mainly based on students' online teaching evaluation. This kind of assessment method is single and cannot mobilize the maximum enthusiasm of students' learning enthusiasm and teachers' teaching progress. This time, it is planned to focus on the three links of pre-test, problem-guided learning, and post-test, so that the evaluation content is more diverse and the evaluation means are more diverse. In terms of evaluation content, more attention is paid to formative evaluation, such as the time and frequency of students watching learning videos before class, the thinking of the questions raised, the speaking situation and teamwork situation of students when participating in problem-guided learning, the summary and reflection of the post-test, etc. will all become evaluation content. In terms of evaluation means, online and offline are combined. Online teachers score students' learning situations and students evaluate teaching materials and teachers' teaching evaluations, and offline teachers communicate with students and conduct self-evaluation and mutual evaluation.

3.4. Specific Implementation Paths and Implementation Plans for Teaching Reform

In order to carry out teaching reform with high quality, a detailed research and development idea design has been carried out around the predetermined goals, and a research plan based on the problem-based learning method has been formed, as shown in Figure 1 specifically.

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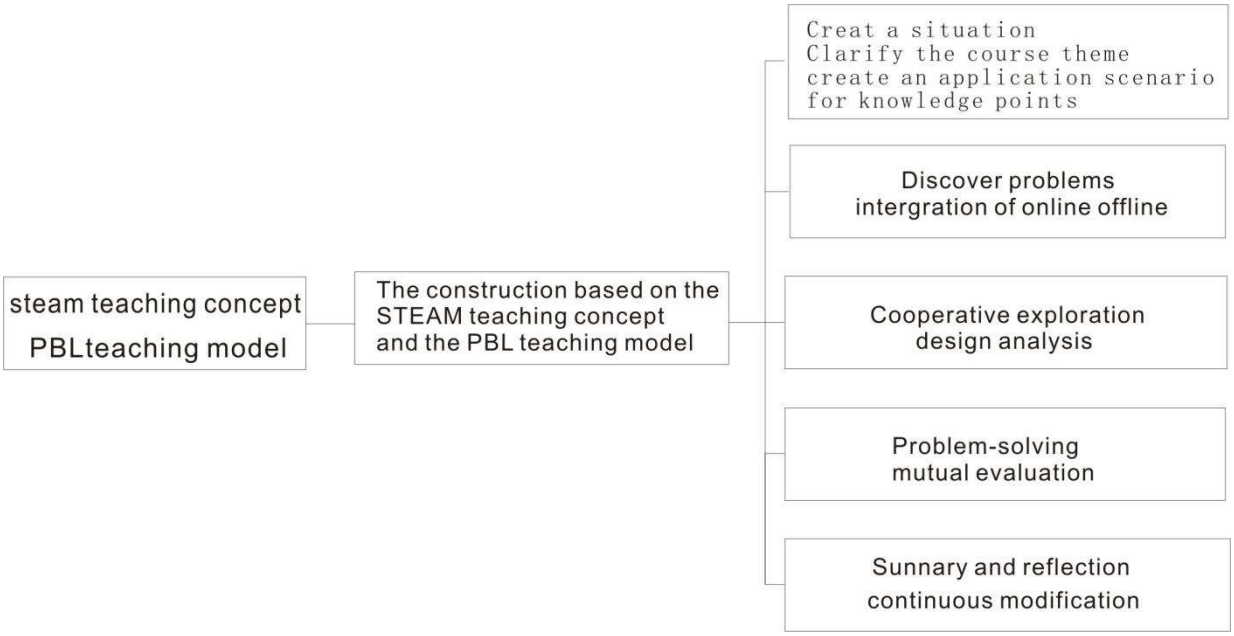

Figure 1. The research plan based on the problem-based learning method.

4. Evaluation of the Implementation Effect of the PBL Mode based on the STEAM Concept in the Teaching of the "Fundamentals of Materials" Course

4.1. Knowledge Mastery

Evaluate students' mastery of the basic theoretical knowledge of materials through methods such as tests and assignments. Tests can include regular small tests of knowledge points and comprehensive tests after the end of chapters, comprehensively detecting students' understanding and memory of theoretical knowledge such as various characteristics, processing techniques, and performance of materials. Assignments can be designed as the analysis and solution of some practical problems, requiring students to use the learned theoretical knowledge for in-depth thinking and calculation. For example, asking students to analyze the performance of a certain material in a specific environment, or designing a simple material application plan. In this way, not only can the students' mastery of knowledge be inspected, but also whether they can flexibly apply knowledge. Through the comprehensive application of these methods, we can relatively accurately assess the students' mastery of the basic theoretical knowledge of materials and provide an important basis for subsequent teaching adjustments.

4.2. Improvement of Comprehensive Abilities

Observe the progress of students in teamwork, problem-solving, and innovative thinking. In terms of teamwork, pay attention to observing how students carry out division of labor, communication and coordination, and mutual support in group projects. See if they can clarify their respective responsibilities, actively share views and resources, and work together to solve problems. In terms of problem-solving, focus on students' analysis ideas, strategy selection, and implementation effects when facing complex problems. See if they can use multi-disciplinary knowledge and methods to gradually analyze problems and find effective solutions. For innovative thinking, it can be considered from aspects such as the new ideas and methods proposed by students and the questioning of traditional views. Observe whether they dare to break through the routine and try to think about problems from different angles, showing unique innovative consciousness and ability. Through long-term and detailed observation and

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analysis, it is possible to accurately understand the improvement situation of students in these key comprehensive abilities.

4.3. Learning Interest and Initiative

Investigate the changes in students' interest and participation in the course. It can be in the form of a questionnaire survey to ask students about their feelings and evaluations of the course content, teaching methods, and project settings. Understand whether they find the course interesting and challenging, and whether they are willing to actively participate in classroom discussions and group activities. At the same time, the degree of students' participation can also be directly observed through classroom performance, such as students' attendance, the eagerness of classroom speeches, and the state of engagement during group discussions. In addition, students' feedback opinions and suggestions can also be collected to understand their expectations and needs for the course, so as to better adjust the teaching strategy and stimulate greater learning interest and initiative of students. Through these multiple survey methods, comprehensively grasp the dynamic changes of students in terms of learning interest and initiative to provide strong support for optimizing course teaching.

5. Conclusion and Outlook

The application of the PBL mode based on the STEAM concept in the teaching of the "Fundamentals of Materials" course has indeed achieved certain results. Students have made relatively obvious progress in knowledge mastery, improvement of comprehensive abilities, and cultivation of innovative thinking. However, the application of this model is still in the process of continuous development and improvement.

In future practices, we can further optimize the project design. More carefully select and construct project themes to make them more closely fit the actual needs and disciplinary frontiers, and enhance the attractiveness and challenge of the projects. At the same time, continuously improve the evaluation system of the projects to more comprehensively and objectively evaluate students' learning achievements and ability development.

Strengthening teacher training is also a crucial link. Teachers need to continuously improve their understanding and application ability of the STEAM concept and the PBL mode, and master the methods and techniques of cross-disciplinary teaching in order to better guide students in project-based learning. Through training, teachers can be more proficient in integrating multi-disciplinary resources and providing students with more targeted and professional guidance.

In addition, we can also actively explore cooperation with enterprises, scientific research institutions, etc., introduce more external resources and practical opportunities, and broaden students' horizons and practical fields. And encourage students to actively participate in various disciplinary competitions and innovation activities to apply the learned knowledge to a wider range of scenarios. Through these efforts, we expect to better play the advantages of this model, lay a solid foundation for cultivating high-quality talents with innovative spirit and practical ability, promote the continuous progress and development of education and teaching, and deliver more excellent professional talents to society, and contribute to scientific and technological progress and social development.

Acknowledgments

Fund project: 2024 School-level Teaching Reform Research Project of Zhejiang DongFang Polytechnic (DF2024JGYB12).

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202408_7(8).0006

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