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A Practical Study on Teaching Experiential Mathematics Curriculum Based on Living Lab

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Abstract: This study aims to explore the application of experiential teaching based on the Living Lab in vocational mathematics curriculum and its impact on students' learning outcomes. Through comparative research between the experimental class and the control class, various data collection methods such as questionnaire surveys, classroom observations, interviews and test scores were used to comprehensively evaluate the effectiveness of experiential teaching. The research results indicate that experiential teaching based on Living Lab improved students' knowledge mastery level, learning attitude, innovation ability, class participation and teamwork ability. Specifically, students in the experimental class performed better than the control class in various evaluation indicators, especially in terms of knowledge mastery and learning attitude, which fully demonstrates the effectiveness of experiential teaching in improving students' learning outcomes. This study provides empirical support and theoretical basis for promoting the experiential teaching mode in vocational colleges in the future, and emphasises the importance of teachers combining theory and practice in teaching to improve students' learning experience and ability development.

1. Introduction

In the traditional teaching of mathematics, students often face problems of low motivation to learn and difficulty in understanding abstract concepts. Mathematics, as an abstract discipline, involves a great deal of theoretical reasoning and complex concepts. This abstraction makes it difficult for students to relate the knowledge they learn to real-life situations in the classroom, resulting in a boring and uninteresting learning process and low interest in learning. Especially in the current teaching mode, teachers mainly adopt the "indoctrination" teaching method, lacking interaction and practical activities with students. This leads to ineffective practice of students' thinking and practical skills, which in turn affects their ability to apply mathematical knowledge in solving practical problems.

Experiential teaching is a student-centred teaching method that aims to promote understanding and application of knowledge through practical experience, interaction and exploration. Compared to traditional lecture-based teaching, experiential teaching places more emphasis on students' hands-

on participation in the learning process in real-life situations. Students actively construct their understanding of knowledge through practical operation, discussion and collaboration. This teaching model not only stimulates students' interest in learning, but also enhances their participation in class, helping them to better understand and internalise abstract mathematical concepts. In addition, experiential teaching also cultivates students' critical thinking and problem-solving skills, especially their mathematical application skills when faced with complex real-world problems. Therefore, the importance of experiential education in education is becoming increasingly apparent, especially in mathematics education, which can help students to better combine theoretical knowledge with practical applications.

Living Lab is an open environment that emphasises user engagement and innovative collaboration, typically used to test and develop new methods in real-world scenarios. In the field of education, Living Lab creates real-life situations that allow students to directly participate in the process of applying knowledge [1-2]. The core concept is to place learners in real-life learning scenarios, encouraging them to solve practical problems through collaboration, interaction and practice. In mathematics education, the application of Living Lab has great potential, which can closely integrate abstract mathematical concepts with real-life problems, allowing students to master mathematical knowledge through practical activities in real-life situations, thereby enhancing learning effectiveness and problem-solving skills. This concept brings new possibilities to mathematics education and helps to bridge the gap between theory and practice.

This study aims to explore how the Living Lab concept can be combined with experiential teaching to improve students' learning outcomes in mathematics. This study designs an experiential mathematics curriculum based on Living Lab and investigates the impact of this teaching model on students' mathematical understanding, innovative thinking and practical problem-solving skills. This study not only provides theoretical basis for the reform of mathematics curriculum, but also verifies the effectiveness of the experiential teaching mode in enhancing students' mathematical application ability and learning interest through empirical research.

2. Basic Concepts and Features of the Living Lab

First proposed by William Mitchell at the Massachusetts Institute of Technology (MIT) in the 1990s and initially used in the fields of urban planning and technological innovation, the Living Lab aims to drive innovation in technologies, services and systems through experimentation and user engagement in real-life environments. In addition to emphasising technology development, Living Lab also focuses on user experience and feedback, advocating that users are active participants in the innovation process, not just beneficiaries. This open innovation ecosystem introduces various types of user participation through real-life scenarios, stimulating innovation while effectively solving practical problems. With the gradual development of this concept, Living Lab has been widely applied in various fields, including urban planning, healthcare, environmental protection, social services and more. In the field of education, the application of Living Lab focuses on creating real-life learning situations that allow students to be problem-oriented, personally involved and solve complex interdisciplinary problems [3-5].

In China, the educational application of Living Lab is gradually taking off, especially in vocational education, higher education and STEM education in primary and secondary schools. Some schools cooperate with enterprises and communities to build practical experimental projects that enable students to master theoretical knowledge and application skills through hands-on practice. The core elements of the Living Lab are user-driven, collaborative co-creation, open innovation and real-life scenarios. These elements provide learners with a comprehensive learning experience, in particular a user-driven learning model that emphasises the role of students as

'innovators' and 'problem solvers' in the learning process. This model can stimulate students' creativity, sense of responsibility and self-efficacy, enabling them to gain a deeper understanding of knowledge through independent exploration and collaborative problem solving.

Living Lab has great applicability in mathematics curriculum. Although mathematics itself is abstract, its applications are extensive and closely related to real life. By combining mathematical problems with real-life situations, students can understand and master abstract mathematical concepts while solving practical problems. For example, when studying functions or probabilities, students can apply mathematical theories to real-world problems by studying practical projects such as urban traffic flow, meteorological forecasting or financial risk management, thereby deepening their understanding and improving their application skills.

In addition, Living Lab can also cultivate students' collaborative spirit and communication skills. In real-life situations, students need to work with others to solve complex problems, learn how to share work and work together, share knowledge and tackle challenges together. This process not only increases the effectiveness of mathematics learning, but also strengthens students' social and teamwork skills. Through this innovative teaching method, mathematics curriculum can become more interesting and challenging, and students' sense of participation and achievement is enhanced.

3. Comparison between Experiential Teaching and Traditional Teaching Models

The traditional model of teaching mathematics focuses mainly on teacher lectures, and students acquire knowledge by listening and doing exercises. Although this "indoctrination style" of teaching is more efficient in imparting knowledge, it overemphasises the memorisation and repetition of knowledge, leaving students with little opportunity for independent exploration and difficulty in forming a deep understanding of knowledge. In addition, traditional teaching methods often use a single assessment system to measure students' grades, ignoring their individual learning needs and the development of diverse skills. Due to limited classroom interaction, students' enthusiasm for learning is low and their learning outcomes are often limited to exam scores rather than practical application and innovation of knowledge.

In contrast, experiential teaching emphasises the promotion of learning through students' personal experiences and practical operations. This student-centred teaching model allows students to learn in real or simulated situations and to actively participate in the construction of knowledge. Students experience the learning process through exploration, reflection and collaboration, thereby deepening their understanding of knowledge. The advantage of experiential teaching is that it can significantly increase students' interest and initiative in learning, especially in solving practical problems, and it also develops students' critical thinking and innovation skills. In addition, experiential teaching can help students transform theoretical knowledge into practical skills and cultivate their ability to apply knowledge in different contexts.

Existing research has shown that experiential teaching can enhance students' learning motivation, deep understanding and innovative ability. In various courses, experiential teaching can effectively improve learning outcomes by constructing situational tasks that allow students to actively participate and solve problems. Especially in STEM (Science, Technology, Engineering, and Mathematics) education, experiential teaching has been widely applied, and research has proven its effectiveness in improving students' practical skills and problem-solving abilities.

In mathematics curriculum, although some scholars and educators have attempted to apply experiential teaching, research on the systematic introduction of the Living Lab concept into mathematics education is relatively rare. The innovation of this study lies in combining Living Lab with mathematics curriculum for the first time, and exploring the impact of experiential teaching on students' mathematical understanding, practical skills and innovative thinking through the design of

mathematics projects based on real-life situations. Unlike traditional mathematics classrooms, this study empirically verifies whether experiential teaching based on Living Lab can help students better apply mathematical knowledge in practical problem solving and improve their performance in interdisciplinary problems. This not only provides a new way to reform mathematics education, but also opens up new research areas for the application of experiential teaching models in different disciplines.

4. Curriculum Design of Experiential Teaching

4.1. The Integration Path of Mathematics Curriculum Teaching

The key to combining the Living Lab concept with mathematics teaching is to place mathematics teaching in real-life situations, thereby enhancing students' practical experience and problem-solving skills. First, teachers can choose mathematical application scenarios that are close to everyday life, based on students' interests or future career directions, and combine mathematical concepts with practical activities. For example, problems such as traffic flow optimisation, financial data analysis and statistical models in environmental protection can enable students to apply mathematical tools in real-life situations, thus enhancing the practical effectiveness of learning.

In addition, teachers can break down complex mathematical problems into multiple subtasks, and students can solve problems through individual exploration or team collaboration. This approach allows students to move from being passive receivers of knowledge to being continuous learners and improvers through practical application. By assigning different roles (such as modeller, analyst, coordinator, etc.), students can take on tasks independently in collaboration and achieve overall goals by working together. Teachers play a guiding role in this process, helping students to understand problems from different perspectives and stimulating interdisciplinary, holistic thinking.

4.2. Teaching Objectives and Implementation Plan

The design of a mathematics curriculum based on the Living Lab requires clear teaching objectives and the development of specific implementation plans. First, the teaching objectives can include three core aspects: enhancing abstract thinking skills, strengthening practical problem-solving skills, and cultivating collaboration and innovation skills. By decomposing and modelling complex problems, students are able to extract abstract mathematical concepts from real-life problems and apply them to problem solving. By introducing practical scenarios, students not only master mathematical knowledge but also improve their ability to apply it in real-life situations. Teamwork and interdisciplinary task design also provide students with opportunities to foster collaboration and innovation, thereby developing their multidimensional skills.

The implementation plan can include design experience activities, case studies and team collaboration. For example, experiential activities can be based on practical problems such as optimising urban traffic signals and managing corporate inventory. Students can work in groups to design and optimise solutions using mathematical tools such as linear programming or probability statistics. Case teaching introduces real-life mathematical application scenarios (such as corporate financial analysis or climate data modelling), allowing students to analyse and discuss solutions with practical value. The teamwork phase emphasises role allocation, where each student is responsible for different tasks (such as data collection, modelling, analysis of results, etc.) and works together to solve complex problems. This multi-level instructional design can help students learn mathematics in real-life situations and improve their practical application skills.

4.3. Teaching Case Analysis

In the linear algebra course, the topic "Traffic Flow Prediction" is designed to enable students to solve traffic optimisation problems at different intersections in cities using matrix operations and linear equation systems. Students collect traffic data, build mathematical models, analyse data and propose optimisation solutions. In the process, students can not only apply their knowledge of linear algebra, but also improve their ability to solve practical problems by completing complex tasks through group collaboration. In the calculus courses, experiential teaching is combined with the topic of "Population Change Models in Ecosystems", which allows students to use differential equations to predict population changes in a given ecosystem. By setting different parameters, students discuss how these parameters affect the growth or decline of the population, and model and validate them with data. This real-world problem-based approach to teaching can help students gain a deeper understanding of mathematical concepts and improve their practical skills.

In designing teaching cases, key elements include setting tasks, assigning student roles and establishing collaborative mechanisms. By setting clear tasks, students can clearly understand the learning objectives and actively think about how to solve problems. Different students play different roles and share tasks through teamwork, which not only improves the efficiency of collaboration but also gives each student a sense of responsibility. Teachers act as guides, helping students to reflect and improve through timely feedback and guidance. Through these instructional designs, mathematics curriculum can not only increase students' interest and sense of achievement in learning, but also strengthen their problem-solving skills.

5. Evaluation of the Effectiveness of Experiential Teaching

5.1. Research Design and Data Collection

In order to comprehensively evaluate the impact of experiential teaching based on Living Lab on students' learning outcomes, this study adopts an experimental research design. Firstly, 100 students were selected from the experimental class and the control class of vocational colleges. The experimental class adopted an experiential teaching model based on Living Lab, while the control class implemented a traditional lecture-based teaching model.

In terms of teaching design, the experimental class designed a series of practical activities and interactive scenarios to enhance students' sense of participation and practical ability, while the control class was taught according to the conventional curriculum structure, mainly through lectures and homework. A variety of data collection methods were used, including questionnaires, classroom observations, interviews and test scores, to ensure the comprehensiveness of the evaluation.

5.2. Data Analysis and Discussion

In order to evaluate the effectiveness of experiential teaching based on Living Lab, relevant data was collected from students in the experimental and control classes. The evaluation results of the students' learning effectiveness are shown in Table 1.

According to the evaluation results in Table 1, the experiential teaching model based on Living Lab has shown excellent performance in improving students' knowledge mastery, learning attitude, innovation ability, class participation and teamwork ability. The evaluation results not only support the original intention of this study, but also provide an empirical basis for the implementation of experiential teaching in mathematics education in the future. In addition, student feedback and interview results show that students highly recognise this teaching model and believe that practical

activities and interactive cooperation can effectively promote their learning and growth.

Table 1: Results of Student Learning Assessment

Evaluation Indicators	Average Score of Experimental Class	Average Score of Control Class	Difference	Evaluate
Knowledge Mastery (test score)	85.3	78.1	7.2	Experimental class performed better, and experiential teaching enhanced students' understanding of concepts
Learning Attitude (out of 10 points)	8.7	7.5	1.2	Experiential teaching increases student interest and enthusiasm for learning
Innovation Ability (out of 10 points)	8.2	6.8	1.4	Experimental class is more innovative and experiential teaching encourages students to think innovatively.
Classroom Participation (out of 10 points)	9	7.2	1.8	Pupils in the experimental class have significantly increased their participation in lessons.
Teamwork Ability (out of 10 points)	8.9	7.4	1.5	The cooperative effect of the experimental class is better, and experiential teaching encourages teamwork

6. Conclusions

This study explores the application of experiential teaching based on Living Lab in mathematics curriculum and makes several findings that reveal the positive impact of the experiential teaching mode on students' learning outcomes.

Firstly, experiential teaching based on Living Lab improved students' level of knowledge mastery. Students in the experimental class outperformed the control class in the test, indicating that students can better understand and apply mathematical knowledge through practical activities and interactive scenarios. This indicates the importance of combining theory with practice, enabling students not only to learn in the classroom but also to apply what they have learned to practical problems.

Second, experiential teaching also has a significant impact on improving students' attitudes to learning. Survey data show that students in the experimental class have significantly higher enthusiasm and interest in learning than those in the control class. This suggests that experiential teaching effectively stimulates students' intrinsic motivation and promotes a positive learning atmosphere by increasing classroom interaction and participation.

In addition, research has shown that experiential education can help to improve students' innovation and teamwork skills. The experimental class outperformed the control class in both indicators, reflecting that the experiential teaching model can effectively cultivate students' creative thinking and cooperative spirit.

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