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An Analysis of the Effectiveness of the Living Lab in the Teaching Practice of Advanced Mathematics

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Abstract: This study aims to investigate the application of experiential teaching based on the Living Lab concept in undergraduate vocational mathematics courses 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 show that experiential teaching based on Living Lab improved students' knowledge mastery level, learning attitude, innovation ability, class participation and teamwork ability. 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 universities in the future.

1. Introduction

With the continuous improvement of modern education's requirements for students' practical and innovative abilities, the traditional "indoctrination" teaching model has gradually revealed its limitations. Research has shown that placing students in practical situations can more effectively cultivate their comprehensive qualities and application skills [1]. In this context, the concept of Living Lab was developed with the aim of breaking free from the constraints of traditional teaching models and building a teaching approach that emphasises both theory and practice through real-life environments, interdisciplinary collaboration, innovative design and participatory learning. As a fundamental discipline, advanced mathematics plays a crucial supporting role in various professional fields. However, due to the highly abstract nature of mathematical knowledge, students find it difficult to understand and apply the learned content during the learning process, resulting in a lack of interest and unsatisfactory learning outcomes. To address this problem, the Living Lab concept offers new perspectives and methods for the practice of teaching advanced mathematics. By applying complex mathematical concepts in real-life scenarios and using project-based learning methods, they can be transformed into concrete practical scenarios, thereby stimulating students' enthusiasm for learning and improving teaching effectiveness [2].

The Living Lab concept, as an innovative and promising educational approach, is receiving increasing attention and application from educators and researchers, especially in the field of mathematics education. It combines the real environment with the learning process, encouraging students to deeply understand mathematical knowledge through practice and exploration, and to apply it to solve practical problems [3]. The core of the Living Lab concept is to closely link the learning environment with real life, emphasising students' active participation, practical exploration, teamwork and interdisciplinary integration, with the aim of developing students' practical application, innovative thinking and collaborative skills [4-5].

This study will focus on the application of the Living Lab concept in advanced mathematics courses, analyse how it breaks through the limitations of traditional mathematics teaching, enhances students‘ motivation and effectiveness, promotes the innovation and development of the mathematics teaching mode, improves the quality and effectiveness of students’ mathematical learning, and the research results contribute to the cultivation of excellent mathematical talents with innovative and practical abilities.

2. The Teaching Practice Path of Advanced Mathematics

2.1. Implementing the Application Method of Mathematics Curriculum Teaching

The Living Lab concept emphasises a practical and exploratory learning process through the introduction of real-life environments into teaching and learning, thereby enhancing students' comprehension and application skills. Unlike the traditional teacher-led teaching approach, this model emphasises ‘student-centredness’ and encourages students to actively explore mathematical knowledge by engaging in real-world problem-solving, and to develop their problem-solving skills and sense of innovation through practice.

Table 1: The Main Teaching Methods.

Teaching Methods	Implementation Methods	Effectiveness
On-site Investigation	Take students into real-world environments to measure and calculate real data, such as measuring area or distance within the campus	Help students integrate mathematical theory with practical scenarios to enhance their ability to apply mathematics
Case Analysis	Provide practical case studies, such as spatial planning or data analysis of community buildings, and ask students to propose solutions	Improve students' logical thinking and analytical skills, while developing their application awareness
Group Collaboration	Let students form groups, assign different tasks, and collaborate and discuss in the process of problem solving	Develop students' communication skills and team spirit through teamwork and collaborative problem solving
Modern Technological Tools	Use of virtual laboratories, simulation software and other technological means to provide rich practical resources and simulate mathematical problem-solving scenarios	Provide a more interactive learning environment to increase student motivation and autonomy

Teachers design mathematical problems based on real-life scenarios to help students apply what they have learnt in practice. For example, teachers take students out of the classroom and make full

use of the school's surroundings or community resources to design a series of mathematical exploratory activities, such as measuring distance, calculating area or analysing data. Abstract mathematical concepts become more concrete through practice, and students can not only better understand their knowledge, but also learn how to apply mathematics in their lives. This teaching method can effectively stimulate students' interest in learning and enhance their hands-on ability. In the process of implementation, teachers can adopt diversified teaching methods and tools to enhance the teaching effect. Some of the main teaching methods are given in Table 1.

The teaching methods in Table 1 allow students not only to apply abstract mathematical concepts to real life, but also to gain practical experience in an interactive learning environment, thereby improving their overall learning effectiveness. The introduction of modern technology provides students with a wider range of practical opportunities, allowing them to explore and experiment in simulated scenarios, further enhancing the depth and breadth of their learning.

2.2. Filling the Gaps in the Traditional Mathematics Curriculum

The Living Lab teaching philosophy closely integrates mathematical knowledge with real-life situations, bridging the gap between theory and practice in traditional mathematics courses. The traditional teaching model usually focuses on knowledge transfer and rarely involves the application of mathematics in reality, which often leads students to believe that mathematics is too abstract and difficult to apply in practice. Living Lab teaching significantly changes this limitation by introducing real-life scenarios that allow students to experience the practical value of mathematical knowledge in solving real-world problems.

First, Living Lab teaching can effectively stimulate students' interest in learning by designing real-life problems and cases. Traditional mathematics teaching often focuses on theoretical reasoning and practice exercises, which can easily cause students to lose interest in the learning content. Living Lab introduces practical problems such as environmental measurement and data analysis, allowing students to see the practical application of mathematical knowledge and encouraging them to actively participate in the learning process, creating a desire to explore and learn.

Second, Living Lab teaching emphasises practical and exploratory learning, with a particular focus on developing students' problem-solving skills, innovative thinking and teamwork. In traditional teaching, students usually receive knowledge passively and lack practical opportunities to solve complex problems. In the Living Lab teaching mode, however, students have to face challenging practical problems, stimulate their innovative potential and practice their practical skills through teamwork and interdisciplinary thinking.

In addition, the Living Lab teaching model highly values the individual learning needs of students. Traditional teaching methods often adopt a 'one size fits all' approach, with less consideration given to individual student differences. Living Lab emphasises a student-centred approach, using personalised teaching methods based on different students' learning characteristics and interests, making teaching more flexible and targeted. For example, some students may excel in mathematical theory, while others prefer practical application. Teachers can meet the needs of different students through differentiated design, significantly improving their learning outcomes.

3. The Teaching Practice Effect of Advanced Mathematics

3.1. Comparison of Academic Performance

The students in the experimental group (taught using the Living Lab approach) performed significantly better in the mid-term and final exams than the students in the control group (taught

using traditional methods). The average midterm and final scores for the experimental group were both 87 points, while the average score for the control group was only 75 points. This difference significantly reflects the improvement in students' mathematics scores in the Living Lab classroom. In addition, by testing and analysing two groups of students in different areas of mathematics, the experimental group scored 85 and 82 points respectively in algebra and geometry tests, while the control group scored only 78 and 75 points. The data shows that the Living Lab approach not only has significant benefits in terms of overall grades, but can also improve students' learning outcomes in specific areas of mathematical concepts and skills.

Table 2: Comparison of Academic Performance.

Group	Mid-term Average Score	Final Exam Average Score	Algebraic Test Average Score	Geometry Test Average Score
Experimental Group	87	87	85	82
Control Group	75	75	78	75

From the analysis in Table 2, the experimental group achieved higher scores than the control group, indicating that the Living Lab teaching method effectively improved students' learning outcomes in various mathematical areas. The main reason is that by applying mathematical knowledge to practical problems, students can better understand and master mathematical concepts, thereby achieving higher scores in exams.

3.2. Participation and Classroom Performance

During classroom teaching activities, students in the experimental group were significantly more motivated than the control group in the classroom. By observing classroom performance, students in the experimental group asked questions on average four times per class, twice as many as the control group. At the same time, students in the experimental group answered more questions in class, indicating that students were more actively involved in class discussions and thought deeply about the issues. In the group practical activities, the experimental group students' participation and performance were similarly better than that of the control group. The average participation time per student in the experimental group was 40 minutes, compared to only 20 minutes for the control group students, indicating that the experimental group students were more proactive in solving practical problems. In addition, students in the experimental group demonstrated stronger teamwork and creativity in practice, further verifying the advantages of the Living Lab concept in cultivating students' practical ability, as shown in Table 3 for the comparison of classroom participation and performance.

Table 3: Comparison of Classroom Participation and Performance.

Group	Number of questions (per class)	Number of answers to questions (per class)	Average duration of participation in practical activities (minutes)
Experimental Group	4	5	40
Control Group	2	3	20

3.3. Learning Motivation and Interest

According to a questionnaire survey of students, the experimental group showed a significant

increase in their interest in learning mathematics. 70% of the students in the experimental group reported that Living Lab teaching had increased their interest in learning mathematics, while only 40% of the students in the control group had the same feedback. In addition, the satisfaction score of the experimental group students with the Living Lab teaching method was as high as 4.5 out of 5, while the satisfaction score of the control group students with traditional teaching was 3.8. This suggests that Living Lab teaching not only increases students' interest in learning, but also improves their overall satisfaction with the teaching process.

By comparing the differences in learning interest and satisfaction between two groups of students, it can be seen that Living Lab teaching has a significant effect on stimulating students' learning motivation and improving their learning experience. The positive attitudes towards mathematics and satisfaction with the teaching methods of the students in the experimental group show that the practicality and interactivity of this teaching philosophy have a positive impact on students' deep learning.

3.4. Problem Solving Ability and Practical Application

Living Lab teaching emphasises the application of mathematical knowledge to real-life scenarios, thereby improving students' problem-solving skills. Students in the experimental group performed significantly better than the control group in mathematical modelling and practical problem solving. In the mathematical modelling project, the students in the experimental group scored an average of 90 points, while the control group scored 75 points. The students in the experimental group not only have a better understanding and mastery of mathematical concepts, but can also apply this knowledge to practical problems in everyday life, such as measuring, calculating and reasoning, thus demonstrating stronger practical skills and innovative thinking.

The performance of students in the experimental group in problem solving and practical application is better than that of the control group, indicating that Living Lab teaching helped students to develop stronger problem-solving skills through practical operation and design of real situations. This teaching model combines knowledge and practice to help students better cope with complex problems in life and work, further confirming its application value in mathematics education.

4. Conclusions

This study is based on the Living Lab concept and investigates the application effect of experiential teaching in advanced mathematics. The research results show that the experimental class using experiential teaching is significantly better than the control class in terms of exam scores, class participation and learning motivation, fully demonstrating that this teaching model can effectively improve students' mathematical knowledge mastery and overall quality. By combining practice, collaboration and innovation, the implementation of the Living Lab concept not only optimises the teaching process, but also creates a conducive learning environment for students' comprehensive development. The research results provide strong support for the teaching reform of vocational education, have broad promotion value, and can effectively promote the improvement of students' practical ability and professional qualities.

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