Application Research on Enhancing the Learning Effectiveness Level of Engineering College Students Based on STEM Education

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Abstract. This study aims to explore the STEAM threshold, form a set of more perfect engineering class vocational classroom teaching mode, which greatly stimulate the engineering class vocational students classroom vitality, improve engineering quality, and improve the social competitiveness, engineering class vocational employment to provide a big boost.Research has found that in the educational and teaching environment created under the STEM education concept, the learning effectiveness level of engineering college students has significantly improved, mainly reflected in a significant increase in interdisciplinary awareness, specifically reflected in innovative ideas and exploratory awareness.Under the wave of "new engineering", vocational higher education needs to emphasize the course to solve the problem of real situation review and continuous development, on the basis of interdisciplinary STEAM education concept and connotation of systematic higher vocational curriculum design, targeted to improve vocational higher education engineering discipline original teaching idea, subject structure and organization form, construction and STEAM education concept of innovative, hybrid engineering higher vocational curriculum system.

Keywords: STEAM Education; engineering college students; Learning results;

1 Introduction

With the homogenization of education, skill oriented education is an essential type of education in developing countries. For high-quality labor, engineering college students are the foothold of high-quality labor[1]. The development of STEM education originated in the 1980s in the United States. Initially, it was aimed at cultivating interdisciplinary and high-quality blue collar workers, providing an indispensable labor force for the rapid economic development of the United States in the 20th century. To this day, interdisciplinary education remains a reference and training method for skilled and high-quality talents. Even today, interdisciplinary education still exudes the charm of life for engineering education[2]. In creating different contexts, interdisciplinary education can improve the learning effectiveness and engineering literacy of engineering college students[3].If we can learn effective STEAM education concept, and the integration of national conditions of education environment, promote interdisciplinary, the integration of science and society, thus can really achieve training professional applied, the goal of talent[4]. At present, despise engineering education in higher vocational colleges, by learning from STEAM education concept can make students

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in the solid basic knowledge at the same time break the barriers between disciplines, improve vocational students engineering thinking, for the development of the society to cultivate more applied talents, to meet the challenge of the future society[5].

2 Division of learning achievement level of engineering students

The key to cultivating the ability of engineering students is to improve the ability of engineering students. The ability level of engineering vocational students not only reflects the professional quality of engineering vocational students, but also reflects the teaching level of cultivating engineering vocational students. Therefore, engineering quality in engineering vocational students professional quality is particularly important, good engineering quality in vocational students in the face of various engineering problems or actual production problems, not only help engineering vocational students based on the understanding of the practical problems, also can complete the engineering model logic assumptions and preliminary build engineering model to solve practical problems.There are various classifications of learning effectiveness levels. Based on the model of classical learning theory, this article proposes a brief model for the learning effectiveness level of engineering college students, etc[6-8].

This study comprehensive literature, referring to the other researchers of engineering literacy level, transforming learning effectiveness into innovation, exploration, reading, and divergent thinking abilities, and compiled the engineering literacy level division scale used in this study, as shown in Table 1.

Table 1. Learning effectiveness level classification scale

horizontal	Description of the relevant levels
Level 1	Students can not understand the engineering problem, and completely have no way to start to the problem, or answer the blank.
Level 2	Engineering college students can understand the problem, but can not construct the problem solving model correctly.
Level 3	Students can understand the problem correctly, but they can only build a preliminary model to solve the problem.
Level 4	Engineering students can accurately understand the problem and put forward the correct problem-solving model, but they cannot completely remove the model.
Level 5	Engineering students can accurately understand the problem, put forward the correct problem solving model, and solve the model, but cannot apply and analyze the solved model.
Level 6	Engineering students can accurately understand the problem accurately, build the correct model to solve the practical problems, and analyze and popularize the application of the model.

3 Teaching design of engineering higher vocational courses under STEAM vision

This study is based on the classification of the learning effectiveness level of engineering college students mentioned above, and guided by the practical problem-solving approach of project-based learning cases, to explore the improvement level of learning effectiveness of engineering college students in interdisciplinary education[9]. Based on the scenario creation of interdisciplinary education and the engineering background of actual scientific problems, engineering system solutions run through the entire process of problem-solving, with mathematics as a tool and as a solution reflected in the entire process of problem-solving and analysis[10].Engineering students solving practical problems in interdisciplinary contexts can enhance their learning effectiveness and gain more connection and exercise in the coupling of engineering thinking. Ultimately, through interdisciplinary education, the learning effectiveness and literacy level of engineering students can be improved and developed.

In the teaching design of STEAM subthreshold engineering vocational courses, improving engineering literacy is the core of teaching design, and the purpose is to cultivate the engineering literacy ability level of engineering vocational students. In the face of practical problems, the first thing that engineering vocational students face is how to model the practical problems. Engineering modeling of practical problems is the key to solve problems. Therefore, the application of engineering model to solve practical problems in the teaching of STEAM subthreshold engineering higher vocational courses is the key focus of course teaching. Using the teaching design of STEAM interdisciplinary higher vocational course, we split the engineering model of practical problems and assume the engineering model for the whole process of each split. Through the teaching of sub-threshold engineering higher vocational courses in STEAM, the church engineering higher vocational students make a preliminary engineering model assumption on the actual problems, so as to carry out the next stage of engineering design, and finally explore the optimal solution of the engineering model according to the engineering design. In the whole engineering modeling process of practical problems, the application of engineering knowledge runs through the whole process of solving practical problems. Based on the scientific concept and principles, the engineering thinking and problem solving ability of the engineering vocational students through the idea and method of engineering design, and the choice and strategy of the technical methods by exploring the solution of the engineering model. Next, it is necessary to explore whether the engineering model is the optimal solution to solve practical problems. At this time, it is also necessary to carry out hypothesis testing and logical analysis of the engineering model, and to carry out the logic and testing of the engineering model through mathematics and engineering knowledge. Finally, the engineering model is applied through the system of engineering thinking, to solve such practical problems and apply and popularize the engineering model.Therefore, the research team proposed that STEAM Teaching design of threshold engineering higher vocational courses as shown in Fig.1.

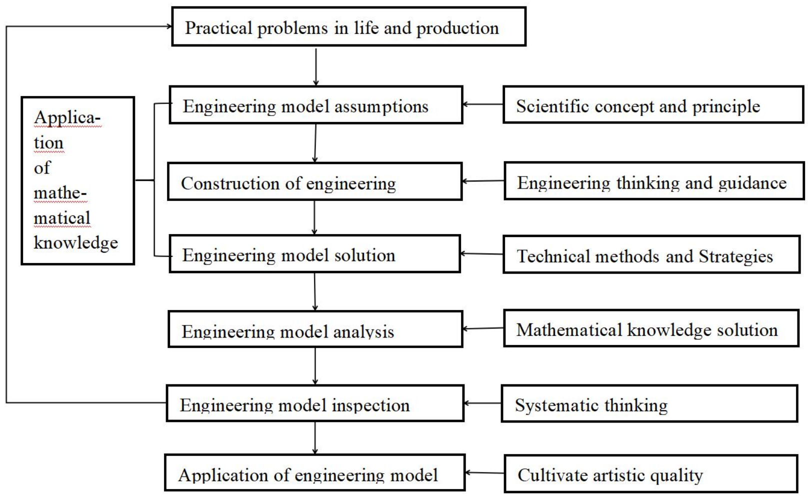

Fig. 1. STEAM Teaching design of threshold engineering higher vocational courses.

4 Analysis and research on engineering literacy level of STEAM

The subjects of this experiment are 2 classes of turbine engineering technology major randomly assigned by a vocational college before grade 2022 in Quanzhou city, Fujian Province, including class 1 of turbine engineering technology, experimental class class 2,45 students in class 1 of turbine engineering technology and 42 students in turbine engineering technology class 2. After the college entrance examination, the students' engineering literacy level has been improved and tends to be stable. In order to ensure that the math scores do not cause errors in the engineering literacy test of the students in the two classes, the average score of the experimental test was about 79.32 points before enrollment, and the average score of the college entrance examination was about 77.23 points. The experimental class adopts the educational concept of integrating STEAM, and the control class adopts the traditional teaching method for teaching,as shown in Table 2.

Table 2. Test of independent samples

		Levin variance equivalence test		Mean-value equivalence t-test						
		F	conspicuousness	t	free degree	Sig.(Double tail)	Mean difference	Standard error difference	Difference value with 95% confidence interval lower limit	superior limit
mark	Assume equal variance	.012	.876	.382	110	.692	1.8496	3.76410	-5.98265	8.94754
	Equal variance is not assumed			.382	104.972	.692	1.8496	3.76400	-5.98211	8.94798

Based on the above experimental results, we can conclude that there is no significant difference in the pre test results between the control group and the experimental group. The average score of the experimental group is only 1.85 points lower than the average score of the control group, with Sig=0.876>0.05. There is no significant difference between the two types of results.

From the experimental results, it can be seen that in the interdisciplinary educational context, the learning effectiveness level of engineering students has been improved to varying degrees. Taking the experimental class as an example, the level one decreased from 13.21% to 1.89%, while compared to the control group, the difference in the level meter was not significant. The control group level four increased from 9.43% to 18.87%. Overall, under the experimental data of the control group, there was no significant difference between levels 1 and 6. Under the data from the experimental class, low-level learning outcomes significantly decreased, while high-level learning outcomes significantly increased, indicating that interdisciplinary educational and teaching contexts can better promote the plasticity and scalability of learning outcomes for engineering students,and there are significant differences on the whole,as shown in Table 3.

Table 3. Statistical Table of Engineering Literacy Level (before and after experiment comparison)

Engineering literacy level	A percentage of the total population of (%)			
	Control class		experimental class	
	Before the experiment	After the experiment	Before the experiment	After the experiment
Level 1	9.61	5.77	13.21	1.89
Level 2	36.54	40.38	33.96	30.19
Level 3	22.31	22.31	23.4	24.23
Level 4	11.54	11.54	9.43	18.87
Level 5	15.32	16.21	16.27	10.73
Level 6	4.68	3.79	3.73	9.54

From the pre-test observation, it shows that the reading comprehension of most higher vocational students is relatively general, and from the perspective of standard deviation, the reading ability of higher vocational students is general; From the perspective of simplified representation, it is similar to the maximum value and the minimum value, but the mean value is biased to the minimum value. The core of the engineering modeling and innovation divergent thinking, the two data can reflect the vocational students ability of engineering literacy, engineering modeling and innovation divergent thinking, the two score minimum and maximum difference is nearly three times, but its average are close to the minimum, control class vocational students in engineering modeling and innovative divergent thinking distance the requirement of high level engineering literacy gap is larger. Therefore, we can conclude that improve higher vocational students engineering literacy, the enlightenment of teaching, higher vocational stage of the course path, not only to strengthen the higher vocational student reading comprehension and simplified representation and the ability of model construction, more important is in engineering modeling and innovative divergent thinking two angles to higher requirements, so as to improve the higher vocational student engineering literacy ability level. Engineering literacy has gradually become the observation point and detection point of the quality of vocational education. Through the front and back measurement between the control group and the experimental group, we can see that the engineering vocational classroom teaching under STEAM has an effect on improving the engineering literacy of engineering vocational students.

5 Conclusion

5.1 Improve the engineering thinking ability of engineering students and enhance their practical application ability level

In the comparison of the post-experimental test, There are significant differences between the test scores of the experimental class and those of the control class, This difference is reflected in the significant differences in the characterization simplification of engineering literacy, engineering modelling and divergent innovative thinking, However, there was no significant difference between the results of the experimental class and the results of the control class, Two classes have similar scores, And the comparison class is slightly higher, This shows that the STEAM has played a role, Show that this teaching method promotes students' engineering thinking, To improve students' vocational application ability.Through the above experiments, the interdisciplinary teaching context created can help improve the learning literacy level of engineering students, and significantly enhance their exploration and innovation abilities.

5.2 Diversified learning methods to promote the process of students' cognitive structure

The STEAM threshold engineering vocational program enhances students' interest in the field of engineering, and improves their cognitive structure. The interdisciplinary integrated teaching method of STEAM greatly promotes the diversification of curriculum learning methods of higher vocational students, and adds new elements to the traditional teaching methods, thus promoting the process of optimizing students' cognitive structure. On the basis of the actual problem situation of life and production, the STEAM education concept is combined with the engineering higher vocational course design teaching, so that students can find the essence and connotation of the problems, and promote the improvement of students' cognitive structure.The diversification of teaching contexts brought about by interdisciplinary education helps students break through a single teaching context. Through the use of mathematics as a tool throughout the entire process of problem-solving, we aim to better enhance and promote the development of learning outcomes among students in the field of science.

5.3 Enhancing the Output and Improvement of Engineering Products for Engineering Students in Cross disciplinary Education Context

For students, engineering model construction is a clear goal but difficult to solve the engineering problems, students have clear engineering mind mapping is particularly important, teachers can use interdisciplinary STEAM teaching concept to guide students to attach importance to and learning problem situation of engineering thinking, and through mathematics and technology the two tools to optimize students' engineering thinking, on the other hand, high connectivity of engineering mind mapping at the same time can better help students learn the core knowledge of mathematics and technology, and establish between engineering thinking and engineering products.The core literacy of engineering students lies in the extensibility and connectivity of engineering thinking. Through the creation of interdisciplinary learning environments, it promotes the development of engineering thinking and literacy among engineering students, thereby better creating products that meet production standards in actual engineering environments.

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