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A Novel Model of Innovation Education Based on Steam+ Education Concept

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Abstract: This study proposes STEAM+ Education based on STEAM education, integrating PBL teaching method and creator education to improve the innovation education teaching system and strengthen the cultivation of students' multidisciplinary literacy. This paper mainly focuses on the core characteristics of STEAM+ education, analyzes the logic and knowledge structure of STEAM+ education, and evaluates the education model of science and technology innovation based on STEAM+ from the perspectives of college students' science and technology innovation, STEAM+ teaching philosophy and feedback evaluation. Finally, combined with this education model, we designed the science and technology education training camp under the concept of STEAM+, which includes three basic projects. Through the practical application in Longxiang Primary School, Shanghai Middle School and Shanghai Ocean University, we objectively analyzed the significance of the project in combination with the evaluation system. The integration of STEAM+ education and science and technology education promotes the deep integration of science and technology with education and teaching, cultivates innovative talents with comprehensive qualities.

1. Introduction

In order to create a more dynamic and innovative learning space for the vast number of learners, Premier Li proposed in his government work report (2015) that the Chinese government would increase STEAM Education, and at the same time provide strong policy to guarantee and support the maker education [1]. After a long period of development and integration, new teaching modes have booming in STEAM education, which aim to cultivate innovative thinking of students, stimulate their creativity, and promote interdisciplinary development [2-3]. Now is in the 14th Five-Year Plan and the beginning of the second century plan, Science and technology education's need have increased sharply. Therefore, based on the STEAM education concept, we should promote the cultivation of innovative talents and the reform of the education system.

2. The Current Situation in China

In 2017, the State Council issued the 'New Generation of Artificial Intelligence Development Plan, pointing out that programming education should be gradually promoted to cultivate composite talents; in 2017 and 2018, the Ministry of Education successively incorporated robotics programming and STEAM Education into the new assessment standards, added science classes as the basic curriculum, and committed to creating a diversified learning environment. In 2019, the Ministry of Education requested that interdisciplinary learning should be promoted comprehensively and comprehensive ability be cultivated [4]. In recent years, China's attention to STEAM education has been increasingly strengthened, and it has been popularized in developed areas such as first-tier cities. The Ministry of Education has jointly launched artificial intelligence education and other pilot work with education Research units in Beijing, Wuhan and other places, and has built artificial intelligence education ecology in Henan, Fujian and other places. Many schools have also integrated steam and guest maker education concepts to provide students with diversified environmental resources such as associations and courses. Although STEAM education in China is improving, it is still in the exploratory stage, and there are some problems such as unbalanced regional educational resources, so there is still a long way to go to promote nationwide innovative education.

3. Relevant Concepts and Core Features

In the digital era, STEAM education, maker education and PBL education, which emphasize the concept of interdisciplinary and innovative thinking, reflect their advantages and characteristics. Combined with STEAM education thought can stimulate students imagination, creativity, artistry and enthusiasm and its core is interdisciplinary [5]. In addition, STEAM education reflects five characteristics: The core of maker education for students is creativity, which focuses on improving their computational thinking ability and action power, and cultivating independent creative thinking and problem-solving ability [6]. At the same time, PBL Teaching Method emphasizes problem-solving as the core, and its main characteristics are that autonomous learning skill of learners is the main features, and learners thinking ability is trained based on practical problems [7]. The core characteristics of STEAM education, Maker Education and PBL Teaching Method have certain commonality, they all tend to cultivate innovative thinking, innovative consciousness and innovative ability [8] through design and creation by triggering independent thinking in practical problems when learning.

A novel STEAM+ Education Model was born, which focused on the interdisciplinary characteristics of STEAM education, and deeply integrate the teaching philosophy of PBL Education and Maker Education. According to the needs of practical problems, in addition to comprehensively cultivating scientific literacy, technical literacy, engineering literacy, artistic literacy and mathematical literacy, the existing materials, Internet technology and hardware resources are also used to cultivate diversified innovative thinking and practical ability. The core features are:① Deeply integrates three educational methods, establishes a new educational concept of multidisciplinary integration and multi-method integration from three aspects of innovation, problems and practice, and advocates flexibility, practicality and pluralism. ② The teaching concept of STEAM+ focuses on guiding learners to complete the design through individuals or teams in combination with practical problems, actively integrating and applying multidisciplinary knowledge, and promoting the development of students' core literacy. ③ Establishes a complete teaching system, optimizing students' knowledge structure, improving students' ability to solve problems and core competitiveness, and closely combining scientific and technological learning,

innovative thinking training and practical creation, the teaching goal of innovation, creativity and creation is promoted.

4. The Novel Model

Through the integration of related research [9], it is found that the innovative education model based on various teaching concepts has the following defects: incomplete teaching concepts, weak implementation and imperfect teaching system, which leads to the ineffective teaching effect. In this study, starting from three aspects: college students' science and technology innovation, STEAM+ teaching philosophy and feedback evaluation, college students with science and technology innovation projects are encouraged to go to areas with relatively backward culture to carry out popular science education, so as to guide and stimulate rural students' enthusiasm for science and technology innovation learning [28], and then repeat this process to form a virtuous circle.(Figure 1)

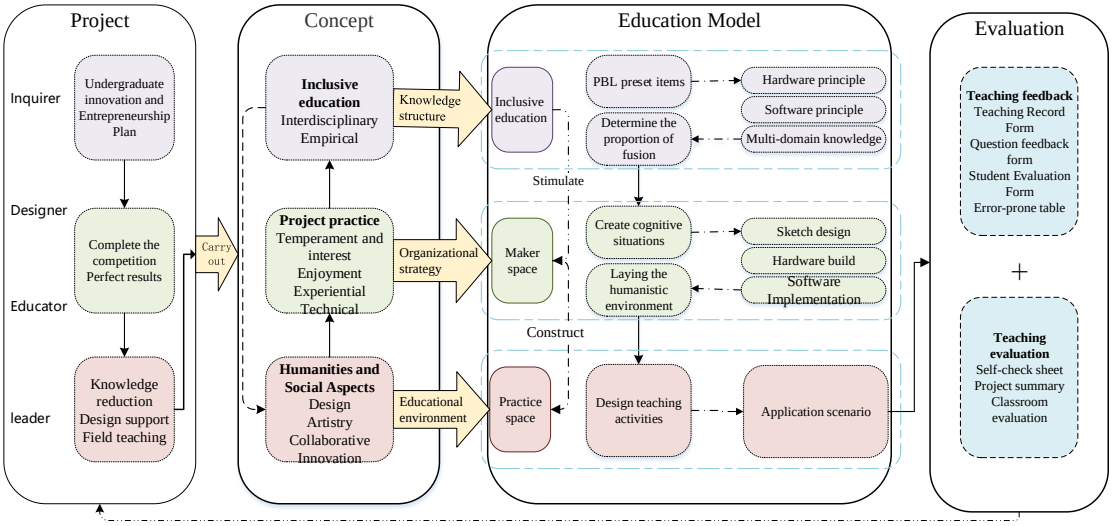


Fig.1 Design of Science and Technology Education Model Based on Steam+ Education

4.1 The Scientific Innovation Level of College Students

In recent years, China has strongly supported and encouraged college students to carry out innovation and entrepreneurship, and held competitions such as Challenge Cup, College Students' Innovation and Entrepreneurship Training Program and iCAN International Innovation and Entrepreneurship Competition to guide college students to cultivate scientific and technological innovation thinking and comprehensive quality. The model advocates that college students reduce the dimension of their professional knowledge after obtaining the results, and through the processes of preliminary screening, personnel training, secondary screening, curriculum construction, classroom design, etc., they can bring innovative practical courses to the central and western regions, rural areas, etc. In the process of implementation, we can effectively carry out science and technology education by means of existing platforms or ways and combining the characteristics of innovative models.

4.2 Steam+ Education Concept Level

The STEAM+ Education Model concept level mainly includes three aspects:

① Integration education. Project presupposition through the concept of STEAM+ is more conducive to students' understanding and solving problems, and introduces students into the real

teaching environment. It is necessary to comprehensively analyse the students‘ original environment, basic learning ability and basic knowledge, and select the most suitable integration proportion for local students and more efficient teaching.

② Project practice. It is the practical basis of the concept that students should start from practical problems and devote themselves to practical practice. The education model should pay attention to the following requirements: to create a project scene with experience and interest based on students’ cognition, to make teaching have practical significance. Guide students to become project designers, practitioners and completion. We should fully understand the basic knowledge content that students have accepted, and have the flexibility to choose methods of teaching according to students’ ability, and lay a cognitive environment.

③ Humanistic and social aspects. Guiding students to dialectically and rationally contact and understand the influence of science and technology on economy, life and society in practice, and training students' innovative thinking, critical thinking and practical ability are the “implementation goals” of the educational concept of “STEAM+”.

4.3 Feedback Evaluation Level

The feedback evaluation level is an important basis to prove the practical significance of the new model based on STEAM+ education concept. Teachers can make teaching records, question feedback forms, student evaluation forms, error-prone forms and other auxiliary teaching. In addition, parents and project experts will be invited to evaluate, find problems and make further improvements.

The education mode mainly revolves around the STEAM+ Education concept. Through the professional dimension reduction of the scientific and creative achievements completed by college students, the teaching behaviours cantered on cultivating students is exported to the science and technology training courses of supporting education service. Through integrated education, the maker space and practice space are stimulated and constructed, leading students to use basic knowledge to build models, deduce and calculate, independently or cooperatively use teaching resources to complete projects, and learn multidisciplinary knowledge and understand the thoughts behind them in the process of problem solving. Finally, feedback on teaching satisfaction and teaching effect through the complete teaching evaluation system.

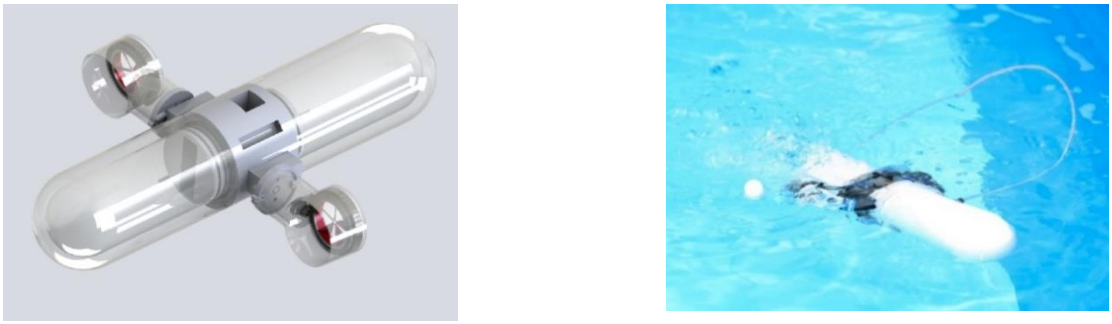
5. A Steam+ Training Camp

STEAM+ Training camps are simplified and adapted from college students' science and technology projects, including the design and construction examples of three engineering projects: warning cars, underwater robot and Quad-rotor UAV. The purpose is to carry out the cultivation of hands-on practice ability to every design link, and take this opportunity to help students in knowledge-poor areas to understand the application prospects in the society, and establish a correct and positive concept of scientific innovation. The following Course: Design and Construction of Underwater Robot is taken as an example to introduce a series of courses.

5.1 Course Introduction

Using the National University student Innovation Project ShuiBao [10](G202010264045), as shown in Figure 2, it is simplified and constructed into the Course: Design and Construction of Underwater Robot. The purpose is to guide primary and secondary school students to complete the design of simple underwater robot by hand through data collection, circuit construction and programming, to improve students' ability of thinking, finding and solving problems, and to

improve their practical ability and comprehensive quality in welding, assembly and programming practice.



(a) ROV rendering (b) Underwater robot

Fig. 2 Demonstration of design and construction of Underwater Robot

5.2 Curriculum Structure

The framework of the Course: Design and Construction of Underwater Robot starts with collecting data. As shown in Figure 3, the relevant data of underwater robots are collected through the Internet platform to understand what related materials and circuit components are needed for the construction of underwater robots. After collecting relevant information, set out to build the circuit, combine the corresponding circuit knowledge and electronic technology knowledge, use the sensors and control modules needed to realize the corresponding functions, draw the PCB board and complete the welding of the corresponding parts. The most difficult part lies in programming to realize the whole motion control and simulation. Programming puts forward higher requirements on Mathematics and Technology for students, and compiles the motion algorithm program based on the library function of the core board, which greatly exercises the practical ability, programming ability and thinking ability. Finally, the underwater robot obtained after the appearance design and the overall debugging is the final course result, and can help middle school students achieve the expansion goal in the cognitive fields such as water quality monitoring, fishery breeding and the like.

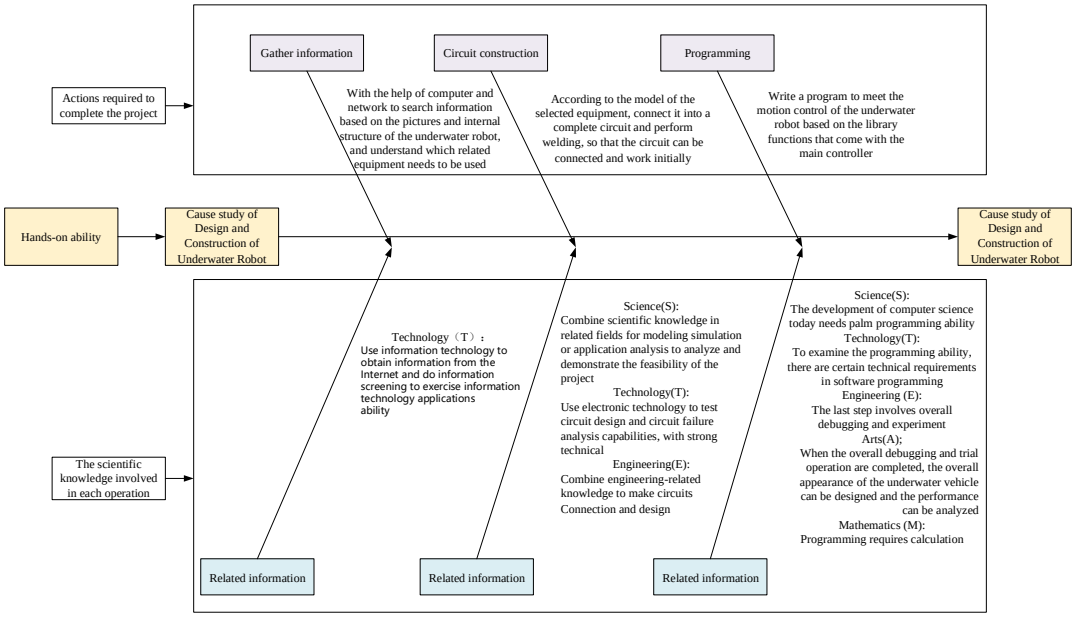


Fig.3 The Structure of the Course: Design and Construction of Underwater Robot

Through the establishment and realization of underwater robot, it realizes the functions of water quality monitoring and adjustment, and thoroughly implements the basic national policy of protecting the environment, laying a foundation for primary and secondary school students to cultivate the concept of technology protection of the environment. (Figure 4)

(a) ROV 3D printing

(b) ROV fabrication of physical objects

(c) ROV 3D fabrication

Fig.4 Example of Rov Design and Fabrication

5.3 Design Teaching Activity

The Course: Design and Construction of Underwater Robot reflects the teaching idea of structuring project links and decomposing learning objectives layer by layer. Considering that the learning situations of students are different, their cognitive starting point and experience basis will also be different, so around the three cognitive objectives of emphasizing knowledge, practice and thinking, the Course: Design and Construction of Underwater Robot is reconstructed. Table 1 for specific ideas:

Table 1 Differential Teaching Treatment of Design and Construction of Underwater Robot

Focus	Emphasis on knowledge	Re-practice	Heavy thinking
Applicable learning situation	Students who have not taken innovative courses, but love innovation.	Have solid software and hardware design programming Foundation.	Have steam education and learning experience, have a certain Foundation.
Project link	Link 1, link 2, Link 3	Link 4	Link 5
Teaching processing	As an introductory course of theory, STEAM teaching theory is popularized on the basis of interest, focusing on understanding and learning the basic knowledge of science creation, and emphasizing the growth of computational thinking from the basic disciplines.	Focus on the practical operation of software and hardware design, reduce the number of practice with reference cases, and experience the complete process from modeling, training, verification to application.	Focus on the ability to analyze problems and solve them; Reinforce the information society responsibility of applied technology and the humanistic understanding of technology.

6. Steam Education Practice

6.1 Practical Project Development

At present, many educational organizations and pioneers have put the STEAM+ education into

practice. Member Zhang went to Longxiang school, Huaiyuan County, Bengbu City, Anhui Province in July 2019 to carry out the practice of supporting education. She brought the project topics to rural classrooms and carried out a series of STEAM courses for junior high school students, as shown in Figure 5:

(a) display of teaching activities in longing school

(b) site of supporting education activities

Fig. 5 Science and Technology creation and activities of supporting education around STEAM+

In addition, teacher Wu, the project instructor, once carried out the course: design and construction of Quad-rotor UAV in Shanghai middle school to popularize and publicize the STEAM+ education, carry out interdisciplinary combination to integrate science, technology, engineering and mathematics across disciplines, and cultivate their hands-on ability and problem solving ability through Project Exploration and hands-on practice creation, as shown in Figure 6:

Fig.6 Shanghai Middle School Students Participate in the Steam+ Classroom Display

Under the guidance of the Science and Technology Department of Shanghai Ocean University, member Xie (President of Azure Innovation Club) launched a five-week Azure innovation training camp of Shanghai Ocean University (October-November 2020). As shown in Figure 7, through three cases of STEAM+ education, the aim is to bring initial experience to students who have no knowledge with or have little knowledge about STEAM and gradually cultivate their comprehensive quality of disciplines. The activities enable students of different majors to come together and jointly plan and complete the project.

Fig.7 Azure Innovation Training Camp under the Concept of Steam+ Education

6.2 Practice Effect and Feedback Evaluation Analysis

Based on the teaching evaluation system and literature review, the project team conducted teaching feedback and evaluation to relevant groups through interviews and questionnaires after the STEAM+ practice, as shown in Table 2:

Table 2 Students' Attitude Towards Steam+ Education and Curriculum Questionnaire Survey

Target	Question
Attitude	Have you attended a similar innovation training course?
	Do you wish to continue participating in the STEAM+ Education activities?
	Do you think this kind of course deserves further promotion?
	Would you like to recommend the STEAM+ training course to your friends?
Effect	Does the STEAM+ training course enhance your creativity?
	Has the STEAM+ Education course given you multidisciplinary knowledge?
	Does the STEAM+ Education help you better understand knowledge?
	Does the STEAM+ Education model enhance your learning enthusiasm?

Among the 108 valid samples, only 24.07% of the students have participated in similar innovative training courses; 85.19% of students hope to continue to participate in such activities. In terms of effect, 72.22% and 79.62% of the students thought that the course was helpful to creativity and multidisciplinary cognition, respectively. In addition, the junior and senior high school students who have not received the education of science and innovation courses show higher enthusiasm and exercise innovative thinking and practical ability under the guidance of teachers, obtaining a sense of accomplishment. The STEAM+ Education Model has strengthened the integration of disciplines and the exercise of comprehensive quality, and has gained high recognition.

7. Summary

The STEAM+ Education Model is a major reform and innovation of the original education model, which has important practical significance in the new era. The STEAM+ Education Model aims to cultivate high-end talents with more innovative quality for the country, and deeply integrate Maker Education and PBL Education related concepts. Based on the concept of STEAM+, the model of science and technology supporting education effectively constructs a complete curriculum system, and provides corresponding science and technology education courses for each school section in combination with the reduced-dimension National University student Innovation and Entrepreneurship Project. It also brings cutting-edge science and technology projects to rural students, inspires more rural students to love science and technology, and gets a good response in university extracurricular scientific and technological academic works and supporting education; Under the STEAM+ Education Model, a STEAM+ Education Camp for university students guides students to love science and technology innovation and helps them find projects suitable for their own development path. STEAM+ education model attaches importance to the cultivation and development of comprehensive ability and scientific literacy. It is a new and advanced education model which is suitable for all ages and meets the basic requirements of SanQuan Education (All-round education in the whole process with all-staff). However, there are also problems that need to be solved urgently, such as the difficulty in setting up curriculum gradient and the difficulty in maintaining the interest of students. With the support of the 14th Five-Year Plan Policy, the STEAM+ Education Model will gradually enter the classrooms of primary and secondary schools, and will carry out extensive publicity and education in combination with the new pattern of Internet+ to help rural revitalization strategy and provide high-quality education supporting education services. The concept of STEAM+ Education plays an extremely critical role in cultivating the scientific and creative quality and personal development of students. It will further

affect the reform of quality education and promote the arrival of the next round of educational revolution.

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