Application STEM+A Teaching Philosophy To Creative Crossdisciplinary Practical Design

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ABSTRACT

The integration of STEM and ART has become an innovative STEAM teaching model, emphasizing theoretical integration and the cultivation of practical ability, and introducing this education method into design and information cross-domain related courses, so as to develop relevant teaching strategies for student adaptability. It is hoped to be curiosity-oriented, stimulate students' potential for independent learning, enhance their motivation for professional knowledge, and understand the application of what they are seeing, understand their learning goals in detail, and clarify the content of learning and future application areas through Hands-on practice deepens their learning impression, integrates majors and implements the concepts of learning by doing and learning by doing, to achieve the effect of cross-field learning. This study takes creative self-propelled vehicles and Pandora's music box as examples, combined with the 6E teaching model and its related engineering design procedures, to guide students step by step, through the combination of information technology and aesthetic design, combined with style design, The configuration and use of color styles and information perception components, together with the comparison between the pre-test prediction questionnaire and the post-test learning effectiveness questionnaire, verify that the innovative STEAM teaching model effectively enhances students' pre- and post-class review habits, and simultaneously improves their active learning ability.

Keywords: STEAM innovative teaching; cross-domain learning; independent learning.

I. INTRODUCTION

In the 1980s, Origin continued to maintain a leading crisis awareness of the country's overall competitiveness. The National Science Board (NSB) proposed the educational concept of STEM courses, integrating knowledge and skills in science, technology, engineering, and mathematics. At the same time, through the curriculum model of topic-based learning, you can cultivate talents who can solve problems in life situations and use knowledge in various fields. In the 21st century, scholars from Virginia Tech University added Art as an important element to the curriculum of STEM education, and then developed the concept of STEAM education [9] [26]. STEAM education integrates the advantages of the five disciplines. It integrates basic curriculum knowledge, operating methods, tool use, innovative production processes, creative thinking and accurate measurement, and systematically unifies and comprehensively applies them. While cultivating innovation and practical ability, students also Demonstrates cross-disciplinary integration and innovation.

In the past, teaching methods focused too much on the learning of science, information and other subjects, and lacked the ability to "practical application" of such science, information and other subject knowledge. In the traditional learning process, students tend to feel bored and frustrated, which reduces the effectiveness of learning. In the future world, the purpose of education promotion has evolved from pure knowledge transfer to allowing students to have logical concepts, design aesthetics and local cultural knowledge, implement the educational concepts of "learning by doing" and "doing while learning", and maintain a childlike innocence. Learn related courses from the perspective of playing knowledge, discover problems through the Internet, newspapers and magazines, or on-site visits, use self-exploration of knowledge as a starting point, strengthen self-learning motivation, and actively want to explore knowledge from the heart, subvert the absorption by teaching The context of professional knowledge enhances students' learning achievements.

In terms of student effectiveness, cultivate students' cross-field integration ability, autonomously solve difficulties and problems, possess the empirical spirit and the ability to integrate information, and implement the effectiveness of learning by doing, doing in learning, and cross-field learning. In terms of teaching design for teachers, the introduction of STEAM teaching mode, with the proposal of 6E teaching mode and its related engineering design procedures, is applied to the creative design of self-propelled vehicles for ultrasonic sensing and Pandora's music box for innovative teaching, and the students explore and design by themselves , If you find a problem in the process, first find the answer to the problem and inquire about related professional

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knowledge. Through repeated discussions with the teacher, you can know whether the search answer is correct. Finally, the teacher will provide an integrated explanation for the professional content of this unit, assisting no problem found The students also learn professional knowledge, and finally perform practice and evaluation. The students learn by doing, explore the questions themselves to find the answers, and finally do theoretical teaching, flip the past vertical teaching, and effectively improve students' learning memory and motivation.

Guide students in a step-by-step issue-based manner, discovering problems around their own lives and learning to understand the scope of their application, gradually learning professional knowledge from the demand side, and non-traditional vertical teaching from theory to practice, but learning while learning. Do so to expand the scope of learning and assist in the direction of diversified and cross-domain learning in the future.

II. RELATED LITERATURE AND APPLIED CULTURE

In the United States, holistic education concepts such as STEM and STEAM have long been implemented in the education scene, integrating five fields of Science, Technology, Engineering, Art and Math, and combining science, technology, engineering, art and mathematics capabilities to drive the global trend of talent education. Faced with the era of automation and artificial intelligence, future talents will not only need to be smart, but also have the ability to innovate and invent at the multiple levels of science and art, as well as a warm heart, humanity and care. The needs of the future workplace and the appearance of future careers will all undergo earth-shaking changes due to the rapid evolution of technology. At the front line of education, the only way to embrace whole-person education and build competitiveness that robots can't take away.

2.1 THE ORIGIN OF STEAM CROSS-DOMAIN LEARNING

Maeda proposed the term STEAM (Science, Technology, Engineering, Art, & Mathematics) in 2011, adding the educational theory of art on the basis of STEM education, expressing unique human emotions and creativity, and creating creativity that robots can't take away. , So the United States started STEAM education. South Korea and Singapore promoted STEAM education in 2010, the Chinese mainland listed STEAM as an important national education policy in 2015, and Taiwan decided to implement STEAM in the twelve-year state education in 2018 [1]. The World Economic Forum's 2016 "Working Future" report pointed out that in the next five years, 2 million new jobs will be created worldwide, all in STEM fields such as computer, mathematics, architecture and engineering. At the same time, 7 million jobs will be replaced by machines[2][3]. The World Economic Forum announced the "2018 Future of Jobs Report 2018" in 2018. It predicts that by 2022, the labor structure will undergo transformation due to the application of robots. 75 million jobs may be replaced. At the same time, Created 133 million new types of job opportunities. Companies will increase their demand for talents such as data analysts, computer scientists, interaction designers, robotics engineers, blockchain experts, e-commerce and social media experts. In addition, customer service, cultural experts and other fields with special "human" skills Will be more important.

In the future, humans and robots will collaborate to maximize their respective advantages. Creativity, consideration, humanity, and empathy are the strengths of human beings. In order to nurture future talents, the education scene has been set out first. The whole-person education under the STEAM trend guides students to "focus on the combination of learning and life situations" and demonstrate their talents and characteristics through "practice". The five major spirits include cross-fields. , Hands-on practice, life application, problem solving and five sense learning [4].

2.2 STEM AND STEAM APPLICATIONS

The newly emerging STEAM teaching model, the most popular keyword in the American education circle is STEM, Science, Technology, Engineering, Mathematics (Science, Technology, Engineering, Mathematics, abbreviated as STEM, as shown in Figure 1, which has recently evolved into STEAM. STEM evolved into the concept of STEM+A (art/design) [4].

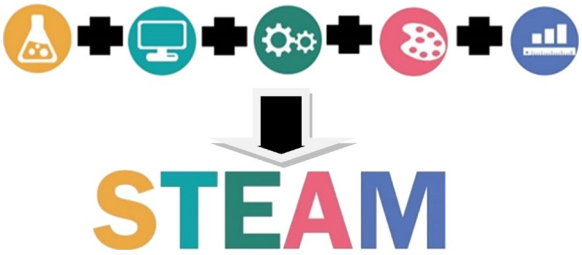

Figure 1. STEAM course

Richard L. Biffle III [5] mentioned in the article that in the course, students will:

1. In an increasingly complex and technology-driven world, develop the 21st century skills needed to become members of the global community. These skills include creativity, problem solving, critical thinking, communication, self-discipline, initiative and cooperation.
2. Able to further develop artistic and scientific skills, and have the ability to do the following:
   - Make full use of curiosity and imagination
   - Observe accurately
   - Perceive objects in different forms
   - Construct meaning and accurately express observations
   - Collaborate effectively with others
   - Spatial thinking (how do the objects appear when I rotate them in my head?)
   - Kinesthetic perception (how does it move?)
3. Through the integration of S.T.E.A.M. to provide students with practical skills to practice PBL (Basic Learning Project) to produce real artifacts or artifacts.

4. By showing the important differences between these two fields of human activity, understand how art and STEM learning support each other.

Richard L. Biffle III finally mentioned that he has been teaching this course for three years, and when thinking about and discussing the infinite opportunities related to STEAM research design and development, he is very happy to have the opportunity to let students participate in a thoughtful and thought-provoking journey. This creative and innovative method has produced a lot of ideas, dialogue and communication, knowledge, understanding and STEAM discovery and practical experience, and accepts various voices and opinions in a respectful way.

Danah Henriksen [6] mentioned in the STEAM journal published by the Clermont College in 2017 that from the broad perspective of STEAM, he proposed the value of transcending artistic integration and the potential of STEAM design thinking. Despite their interest in STEAM, many teachers still find it difficult to integrate into their school theme teaching. As an interdisciplinary crossroad, design thinking provides a natural bridge between art, science and other disciplines. In this regard, it can provide teachers with a flexible structure and path to guide the design of courses based on STEAM and serve as a comprehensive aspect of STEAM learning for students. This paper discusses an example of a Spanish elementary school teacher, as a graduate-level design thinking and education course student, using design thinking to design an interdisciplinary STEAM project for the student. This example illustrates how design thinking can guide teachers' STEAM course design and intertwined with the elements of STEAM courses to open up more interdisciplinary and creative opportunities.

2.3 STEAM COURSE CONCEPT AND APPLICATION

The concept of STEAM children's education has gradually become popular [10]. Because it advocates combining play and learning in education, more and more children's parents are paying attention to the educational value of toys. Among them, toys designed with robot assembly programming are particularly popular with consumers. Therefore, it focuses on the impact of educational design factors of robot educational toys on children's creativity. Using the "Torrance Test of Creative Thinking" (TTCT) as a research tool, the formal experiment adopts the quasi-experimental control method, and the experimental group and the control group are set up to explore the educational factors of STEAM educational children's robot toys Will have an impact on children's creativity. The experiment first screened out 25 elements that believe that robot educational toys can have an impact on children's creativity through the focus group method of STEAM education experts. The results of the study found that after a month, a total of 6 STEAM robot educational toy courses , The overall performance of the two groups of subjects before and after the total score of creativity has been significantly improved ($p<.05$), and the improvement of creativity in the experimental group is better than that of the control group, indicating that STEAM robot teaching does have an impact on the creativity of students. And the five independent variables of this research are very important to enhance children's creativity in STEAM robot teaching.

In order to cultivate design talents with aesthetics and technological literacy in the engineering field, the research proposed to develop STEAM (Science, Technology, Engineering, Arts, and Mathematics)-oriented Maker teaching courses at the high school stage. Carry out teaching experiments after developing courses with high-speed, beautiful-looking racing design activities, and compare the performance of high school students and design college students after participating in the courses to understand the differences and needs of students. The research results show that there are significant differences in the creativity and learning effectiveness of high school students and design college students. The experimental results can be used as a reference for the future development of STEAM-oriented Maker curriculum design and teaching [11].

The twelve-year national education life and science and technology outline content precedent research said that the high school stage should cultivate the ability of students to "think"[12]. Through the process of practical activities, they can experience the process of problem solving. In STEAM teaching, By adding artistic elements, students can develop ways of self-determination and motivation. Facing problems in real life, they can use divergent thinking to solve problems. If the characteristics of STEM teaching and STEAM teaching can be integrated, the two kinds of thinking can be integrated. The advantages of it can produce cross-domain problem solving and promote the development of creativity, and cultivate competitive talents [13]. By putting forward the concept of art and adding student-centered learning, through the process of exploration and the creation of artistic works, knowledge in various fields can be learned and integrated [14], students can be trained in creativity, critical thinking and cooperative learning, and develop Lifelong skills that can solve problems [15]. In the process of making works, learners will learn to create ideas and design and produce works based on ideas. When problems are encountered in the process, they can be solved through the guidance of themselves or the teacher. The following is for mobile phone horn speakers and The contents of STEAM education are explained separately, and the details are shown in Table 1:

And through the 6E program of STEAM cross-domain aesthetic education special teaching design, the application scope of the course is explained. The learning content combines art, engineering and technology and other cross-domain categories. The core topic of the course is "preservation of historical sites" to develop STEAM cross-domain aesthetic education. Thematic courses. When thinking about the direction of the special course, the teacher team planned to use monuments and architecture as the subject of cross-domain aesthetic education, because the building itself is an artistic asset that contains rich aesthetics and aesthetic elements such as space and design style, and carries the life of the occupants. History and culture, students are also expected to cultivate the aesthetic quality of caring about the living environment by exploring the cultural preservation issues represented by the activation of historical sites, and to understand the cross-domain knowledge

connotation of the design and transformation of construction methods [1].

Table 1. STEAM education content description

Description of mobile phone horn speaker and STEAM education content	
Science	Understand the principle of sound generation, the frequency of sound, and the key points of horn shape design.
Technology	Learn the use of technological tools, including: drilling machines, wire saws, sand mills, circular hole saws, and sandpaper. Understand how to draw three-view and three-dimensional diagrams.
Engineering	Understand the principle of the horn and the recommended size of the horn drawing, and design the key structure and shape of the mobile phone speaker by yourself.
ART	In the design stage, the SCAMPER brainpower Mercedes-Benz method is introduced to help creative design thinking, and design in the face of problems and needs in life. In the finished product stage, use sand mills, colored pens and electric engraving pens to adjust and design the surface of the mobile phone speakers.
Mathematic	In the design stage, calculation and planning can be carried out with limited materials, and the drawing of the design drawing can be completed.

Table 2. STEAM cross-field aesthetic education special teaching design The 6E program description

6E program of STEAM cross-field aesthetic education special teaching design	
Engage Students can understand the process of special research and take the initiative to participate in the preparation work.	1. Discuss the research direction of aesthetic education. 2. Set research goals, objects and plan the research process. 3. Discuss group membership and division of labor. 4. Use the Internet to collect preliminary information to understand the history and characteristics of historic buildings. 5. Plan visits and survey routes and draft expert interview questions.
Explore Students can participate in field visits and work in groups to complete research and survey data.	1. Visit to historical sites, architecture and art exhibitions ("Back to 1919 Paintings on Taipei's Architectural Cultural Heritage", "Imamura Hitomi Facade Model Creation Exhibition"). 2. Visit the architectural model factory to understand the manufacturing process of the architectural model. 3. Interview with experts in related fields such as architects, artists, historic site guide teachers, etc. 4. Sharing of themed lectures by architects and heritage guide teachers.
Explain Students can interact with group members to share survey results and develop artistic creation plans.	1. Small groups work to sort out the research and survey data (photographs, videos, verbatim transcripts of interview recordings). 2. Group discussion and development of artistic activities.
Engineer Students can work in groups to complete the design and production of artistic creation actions.	1. Group discussion on the design and creation of the architectural model of the old house renovation. 2. The group discusses the content of the historical site tour and the design of the game problem.
Enrich Students can combine artistic creation with scientific and technological innovation applications.	1. Discuss the content of the guided presentation video. 2. Create guided briefings and AR applications. 3. Navigation application for panoramic photos and touch screen.
Evaluate Teachers and students make flexible adjustments to research and creation through discussion and reflection.	1. Regular group meetings are held to discuss the research progress and adjust the creation. 2. Students share research and reflection.

As shown in Table 2, the "Aesthetic Exploration Experience Period" integrates the "participation" and "exploration" processes of the 6E learning model. The teaching goal is to guide students' interest in participation by asking questions and providing information, and to explore artistic knowledge through aesthetic experience activities And perceptual aesthetic connotation. The "Aesthetic Creativity Practice Period" is a combination of "interpretation" and "planning" processes. The teaching goal is to guide students to study in groups, collect research data on special topics, discuss and exchange learning gains in order to develop artistic actions. The "Aesthetic Deepening and Innovation Period" is a combination of "deepening" and "evaluation" processes. The teaching goal is to guide students to integrate technology to further refine and innovative application of creation, and adjust the process of special research through regular discussion and reflection.

2.4 INFORMATION SENSOR APPLICATION

Sensor is a device used to detect events or changes in the environment and send this information to other electronic devices (such as a central processing unit). It is usually composed of sensitive components and conversion components. This research is expected to use Arduino development board, motor driver board module, ultrasonic sensor, Bluetooth and buzzer.

■ Arduino development board

Arduino Nano is a miniature version of the Arduino USB interface. The biggest difference is that there is no power socket and the USB interface is a Mini-B socket. Arduino Nano is very small in size and can be used directly on the breadboard, as shown in Figure 2. Its processor core is [[ATmega168]] (Nano2.x) and [[ATmega328]] (Nano3.0), and it has 14 digital input/output ports (6 of which can be used as PWM output) and 8 analog inputs , A 16MHz crystal oscillator, a mini-B USB port, an ICSP header and a reset button [16].

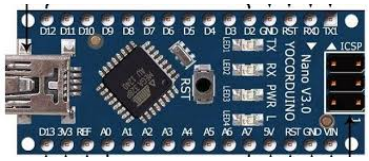

Figure 2. Arduino nano development board

The Arduino board design uses various microprocessors and controllers. These circuit boards are equipped with a set of digital and analog I/O pins, which can be connected to various expansion boards or breadboards (blocking boards) and other circuits. These circuit boards have serial ports, including Universal Serial Bus (USB) on some models, and are also used to load programs from personal computers. Microcontrollers usually use C/C++ programming language. In addition to using the traditional compilation tool chain, the Arduino project also provides an integrated development environment based on the Processing language project, as shown in Figure 3.

The Arduino project started in 2003 as a student project of the Ivrea Interactive Design Institute in Ivrea, Italy. The purpose is to provide novices and professionals with a low-cost and simple method to establish the use of sensors and Device actuator for environmental interaction. Common examples of such devices suitable for novice hobbyists include simple robots, thermostats, and motion detectors [23].

Figure 3. Arduino development board

■ L298N motor drive board module

L298N is a high-voltage, high-current motor drive chip produced by ST. The chip uses a 15-pin package. The main features are: high working voltage, the highest working voltage can reach 46V; the output current is large, the instantaneous peak current can reach 3A, the continuous working current is 2A; the rated power is 25W. A high-voltage and high-current full-bridge driver with two H-bridges, which can be used to drive inductive loads such as DC motors, stepping motors, relay coils, etc.; standard logic level signal control; with two enable control terminals, Allow or prohibit the device to work without being affected by the input signal. There is a logic power input terminal to make the internal logic circuit work at low voltage; it can be connected with an external detection resistor to feed back the change to the control circuit. Using the L298N chip drive motor, the chip can drive a two-phase stepper motor or a four-phase stepper motor, or two DC motors, as shown in Figure 4.

1. As the main driving chip, L298N has the characteristics of strong driving ability, low heat generation and strong anti-interference ability.
2. The built-in 78M05 is partially powered by the drive power supply, but in order to avoid damage to the voltage regulator chip, when using a drive voltage greater than 12V, please use an external 5V logic power supply.
3. Using large-capacity filter capacitors and freewheeling protection diodes can improve reliability [17].

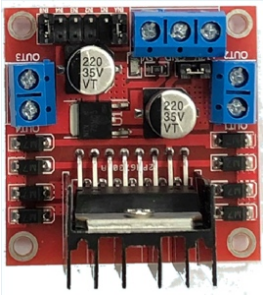

Figure 4. L298N motor drive board module

■ HC-05 Bluetooth

The hardware of HC-05 and HC-06 are the same. Both use the BC417143 chip of CSR (Cambridge Silicon Radio) of Cambridge, UK. It supports Bluetooth 2.1+EDR specification, but the firmware inside the chip is different. CSR is the Bluetooth communication chip factory with the highest market share in the world. In mid-October 2014, Qualcomm, the global leader in mobile phone chips, agreed to acquire CSR for US$2.5 billion in cash to strengthen the company's Internet of Things (Internet of Things) layout. South Korea's Samsung also spent US$310 million in 2012 to obtain technology patents for CSR's Bluetooth, WiFi, and GPS positioning. The appearance and main pins of the HC-05 module are shown in Figure 5:

Figure 5. The appearance of the HC-05 module

The basic Bluetooth serial communication module does not lead out pins, but leaves stamp-like perforations around the printed circuit board for easy soldering. If you don't want to do soldering, you can buy a module with a bottom plate. This board comes with a DC voltage conversion IC, which is convenient to connect to a 3.6V~6V power supply. Bluetooth devices on the market usually belong to "slave" devices, such as Bluetooth mouse/keyboard, Bluetooth GPS, Bluetooth remote control toys, etc. General Arduino Bluetooth remote control and communication experiments are also in the "slave" mode. No matter it is HC-05, HC-06 or Bluetooth 4.0, it has no effect on the Arduino. The control program is the same. The actual wiring only uses 4 Lines: power, ground, transmission (TxD) and reception (RxD) [18].

■ Ultrasonic sensor

The ultrasonic sensor is a sensor developed using the characteristics of ultrasonic waves, as shown in Figure [6]. Ultrasonic wave is a kind of mechanical wave with higher vibration frequency than sound wave. It is generated by the vibration of the transducer chip under the excitation of voltage. It has high frequency, short wavelength, small diffraction phenomenon, especially good directivity, which can become ray. Features such as directional communication. Ultrasonic waves have a great ability to penetrate liquids and solids, especially in solids that are opaque to sunlight. It can penetrate to a depth of tens of meters. When ultrasonic waves encounter impurities or sub-interfaces, they will produce significant reflections and form echoes, and they can produce Doppler effects when they encounter moving objects. Sensors developed based on ultrasonic characteristics are called ultrasonic sensors and are widely used in industry, national defense, and biomedicine.

Ultrasonic waves have a great ability to penetrate liquids and solids, especially in solids that are opaque to sunlight. It can penetrate to a depth of tens of meters. When ultrasonic waves encounter impurities or sub-interfaces, they will produce significant reflections and form echoes, and they can produce Doppler effects when they encounter moving objects. To use ultrasound as a detection method, ultrasound must be generated and received. The device that accomplishes this function is an ultrasonic sensor, which is habitually called an ultrasonic transducer, or an ultrasonic probe. The ultrasonic probe is mainly composed of piezoelectric wafers, which can transmit and receive ultrasonic waves. Low-power ultrasound probes are mostly used for detection. It has many different structures, which can be divided into straight probe (longitudinal wave), oblique probe (transverse wave), surface wave probe (surface wave), lamb wave probe (lamb wave), double probe (probe reflection, probe reception), etc.[24].

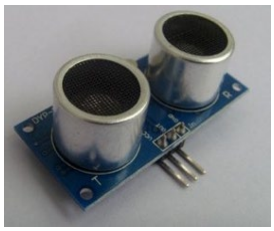

Figure 6. Ultrasonic sensor

■ Buzzer

The buzzer is a device that can generate sound signals. It uses DC power supply, as shown in Figure [7]. After connecting the communication signal source, the audio signal current passes through the electromagnetic coil, causing the electromagnetic coil to generate a magnetic field, causing the diaphragm to vibrate periodically. Vibration sounds, and Webduino can even fill in the note code through HTML5 Attribute. Each code corresponds to a value, which corresponds to the frequency of the buzzer sound, so you can edit the music with pure HTML5 or javascript. Sound through the buzzer. The buzzer is near the circuit board and has symbols marked "+" and "-". The "-" is connected to the GND of the development board, and the "+" is connected to the pin 11 (in fact, it doesn't matter if you connect it backwards), you can use it Connect the Dupont line, if it is Mark 1, you can also directly plug it into it [25].

Figure 7. Buzzer

The buzzer is near the circuit board and has symbols marked "+" and "-". The "-" is connected to the GND of the development board, and the "+" is connected to the pin 11 (in fact, it doesn't matter if you connect it backwards), you can use it Connect the Dupont line, if it is Mark 1, you can also directly plug it into it.

■ Summary

This research will apply the innovative STEAM teaching model, combined with the 6E engineering program to assist the course units in the logical and progressive learning, and

make good use of different sensing components for creative ideas, and to understand the principle characteristics and application scope of different sensors in the process.

III. APPLICATION OF STEAM CROSS-DOMAIN INTEGRATION PRACTICAL CREATION

This research uses creative self-propelled vehicle practical design and Pandora's music box as the theme unit of STEAM innovation teaching. Through the theme unit creation, students are encouraged to understand the results of the cross-disciplinary combination of information and design in the process of hands-on production.

3.1 STEAM AND CREATIVE SELF-PROPELLED CAR COURSE APPLICATION

In the information age, the production of many products has moved towards automation. The same is true for vehicles. Self-propelled vehicles are a kind of car that adds chips, program control, etc. to the general car model to allow the car to perform specific actions. Therefore, if the self-propelled vehicle is used properly, it can be a production line that can be automated in a factory. It comes in handy. The self-propelled car is a basic wheeled robot, which uses Arduino Nano to control the core and supports Arduino Open Source resources. The car body is equipped with a variety of sensors, and the program is designed to be a tracking self-propelled car, a light-energy-driven car, etc., to meet the basic functions of a self-propelled car, and an ultrasonic ranging module can also be installed to become an obstacle avoidance self-propelled car , Install a bluetooth module, with a mobile phone App to become a mobile control self-propelled car[19].

In addition, because it will act according to the rules of the program, it can also be used as an alternative robot in our daily life to make our actions more convenient. For example, self-propelled vehicles can provide disabled people with more convenient movement in barrier-free spaces, and can use self-propelled vehicles to reach the places they want to go. The future application range is very wide [20].

3.2 INTEGRATED DESIGN CREATION OF CREATIVE SELF-PROPELLED VEHICLES

This research introduces information-related majors and design innovations across different fields. Through the brainstorming and creativity of the course team, the practical and innovative design of self-propelled vehicles is developed, and the easy-to-obtain Arduino board is combined with the road tracking module, HC-05 bluetooth module, and motor. The driver board module and other simple maker kits, learn to edit the building block program, plan obstacle avoidance paths, and at the same time come up with the theme style through the group creativity. This time the creative direction with food as the theme, try different materials by hand After calculating the size of the elements, the actual works are produced. Students develop curiosity and self-confidence in the process, which enhances their interest in learning. This research is aimed at junior students in unit innovation teaching.

Table 3. Self-propelled vehicle practical innovation design unit course 6E program

STEAM Innovation Experience Course	
6E program	Engineering design program
Innovative design of self-propelled vehicles	
Engage	● Define the problem or goal
1. Understand what a self-propelled car is? Related origin allusions 2. What are the materials of the self-propelled vehicle? 3. Introduction to the tracking types and functions of self-propelled vehicles 4. Define the style and shape of appearance creation	
Explore	● Find the problem ● Develop solutions
1. What is a "self-propelled car"? Explore the principles used by self-propelled vehicles to avoid obstacles 2. What are the information components needed to understand the self-propelled vehicle? 3. How to make a self-propelled vehicle obstacle avoidance effect? 4. How to write the obstacle avoidance program into the information development board? 5. How to design the appearance and style of themed self-propelled vehicle? What are the material elements implemented? 6. Collect relevant success stories and learn relevant skills	
Explain	● Choose the right plan under restricted conditions
1. Select relevant themes, integrate their cultural elements, define the style and creative design, make a slideshow to share with everyone 2. Convert obstacle avoidance trajectory planning into programming language 3. The students first find out the answers to the questions, sum up their cultural characteristic elements and the way to avoid obstacles, and analyze them 4. The teacher integrates relevant professional background knowledge and introduces case videos to assist students in choosing a suitable method for creative thinking and program linking	
Engineer	● Prototype ● Test evaluation ● Communication and discussion
1. Under the restriction of never creating a self-propelled car by hand, first think about and collect the composite media that can be made, and experience the style, mystery and characteristics of different media. 2. Evaluate the characteristics of each medium, whether it is suitable for the style and touch of your design? Can the product form of thematic self-propelled vehicle be concretely presented? 3. Explore the production methods and processes of different media, and communicate the feasibility of using them in practical creation of self-propelled vehicles 4. Carefully estimate the size, color and style image of the work	
Enrich	● Redesign ● Complete
1. The adjustment of the size of the work and the materials used for the first time, the production failed, and the reasons for the failure are discussed 2. Debug the link between the code and the information sensor 3. Go deep into various fields, learn about other self-propelled vehicle presentation methods, accumulate your own aesthetic experience, and enrich design creativity	
Evaluate	● Check whether to solve the problem or achieve the goal
Presenting personal works in the form of small final results, allowing other students to observe each other. The teacher also gives suggestions and understands whether the design of self-propelled vehicles meets the expected goal effect, and presents the integrated mode of STEAM innovation teaching through thematic work. , To enhance students' motivation for cross-field learning.	

The teaching directions are as follows:

- While teaching professional theories, the student groups are encouraged to discuss on the Internet and collect cultural backgrounds in Neighboring fields.
- By collecting and analyzing data, discussing with the instructor, and combining programming and technology-related knowledge, we can make relevant products that meet the cultural background.
- In the process, I tried to use different media to create. There were many failures in the process, but the students benefited a lot.
- Understand the cross-domain knowledge, and apply the practice to the product, implement the learning policy of learning by doing and learning by doing. In the learning process, the innovative STEAM teaching method is introduced to stimulate the motivation of students to learn independently to find answers to questions and increase the sense of learning achievement.

After innovative teaching through STEAM, the practical and innovative design of self-propelled vehicles is carried out. The 6E innovative teaching procedures are shown in Table 3.

Through the 6E program creative design of the STEAM innovation experience course, students produce concrete results. In the process, they experience how to write obstacle avoidance code and learn the process of debugging, as shown in Figure 8:

```
void loop() {
  // put your main code here, to run repeatedly:
  for(int i=0;i<10;i++)
  {
    moveTo(0,speed);delay(1000);
    moveTo(2,speed);delay(300);
  }
  for(int i=0;i<10;i++)
  {
    moveTo(1,speed);delay(1000);
    moveTo(3,speed);delay(300);
  }
}
```

Figure 8. Self-propelled car code

While learning the coding and debugging of self-propelled vehicle tracking and obstacle avoidance programs, design its appearance through thematic planning, and combine information components after hand-made styling, including Arduino development board, road tracking module and motor drive board module And other sensing elements, as shown in Figure 9:

Figure 9. Self-propelled vehicle sensing element

Taking the Soap Speed car as the prototype theme of self-propelled vehicles, various foods, geometric shapes... and other shapes are designed, hand-made by composite media such as styrofoam, PU, cardboard, airplane wood, clay, etc., and assembled. Test whether the size is correct. Through color changes, each self-propelled vehicle is filled with personal style, color and creative concept. The completed work of the innovative design part of the highly distinctive self-propelled vehicle is shown in Figure 10:

Figure 10. Creative self-propelled vehicle practical design

3.3 STEAM AND PANDORA'S MUSIC BOX COURSE APPLICATION

For many people, music is an indispensable and beautiful thing in life. When we were young, each of us may have a music box, or it may not be big but it accompanied each of us through a different childhood. Familiar melody is often remembered by people, playing around in memory over and over again. A small box accompanies us throughout our childhood. Every note played is beating our familiar memory and time, and the music box is the object that carries this memory. The history of the music box can be traced back to the Middle Ages in Europe. At that time, the church used a bell tower to tell the time, using a wooden cylinder with needles to move the mechanical structure, and using the principle of lever to drive the bell hammer to strike different The clock face formed the earliest prototype of the music box "Carillon", as shown in Figure 11 [21].

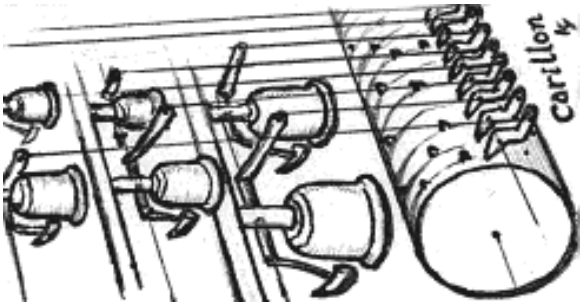

Figure 11. The earliest prototype of a music box"Carillon"

The bells and bells are assembled in the clock, and the sound is used to inform the time, and then several devices are juxtaposed to adjust the pitch, to rotate the metal cylinder and the needle attached to the cylinder drives the hammer to play a beautiful melody. It is music Conception of the box development process [22].

According to the type and application of music boxes, music boxes can be divided into three types: the first type is traditional music boxes, which are mainly composed of mechanical movement and outer box, and the second type is electronic music boxes, which use circuits and chips. The structure is mainly used to play music files of storage devices

such as ROM, Flash, and USB. It can usually be carried with you and often has multiple functions for users to use. The third category is the software music box, which runs on the operating system and is composed of programs. It mainly plays music files in the database. Most of them are equipped with a cable search function so that users can receive and use the latest music information. The interactive music box in this research is a kind of electronic music box. Through the Arduino UNO development board, combined with multiple sensors, the syllable music score is converted into a programming language at the same time, and it is embedded in the development board. A shaped music box that can make sounds through distance changes.

3.4 INTEGRATED DESIGN AND CREATION OF PANDORA'S MUSIC BOX

This research introduces information-related majors across fields, combined with design innovation, and designed an interactive music box, using the Arduino board combined with the buzzer and ultrasonic sensor to integrate it into an interactive sensor. Learn to edit the block program. Sing Christmas music. At the same time, through computer drawing techniques and other related courses, after designing the shape of the music box, calculating the size, and producing works through the method of laser engraving, students have developed curiosity and self-confidence in the process, which enhances their interest in learning. The research carried out unit innovative teaching for freshmen, and carried out the design of interactive music box in animal shape, and named this interactive music box Pandora's music box. The 6E innovative teaching program is shown in Table 4.

Through the 6E program creative design of the STEAM innovation experience course, students produce concrete results, experience how to transform the existing music rhythm into code editing, and learn the process of debugging. Create and design the appearance of Pandora's music box through drawing software, and put electronic music box information components inside, including Arduino development board, ultrasonic sensor, buzzer and other sensing components, as shown in Figure 12:

Figure 12. Arduino and multiple sensors connection diagram

Table 4. Pandora's music box innovation unit course 6E program

STEAM Innovation Experience Course	
6E program	Engineering design program
Applied to Pandora's music box innovative design teaching	
Engage	● Define the problem or goal
1. Know what is a music box? Related origin allusions and types introduction 2. The manufacturing method of the music box and its positioning in everyone's mind 3. Confirm the direction of making music box for the theme of this unit 4. Define the style and shape of appearance creation	
Explore	● Find the problem ● Develop solutions
1. What is an "electronic music box"? Explore the principles used by electronic music boxes 2. What are the information components needed to understand the electronic music box? 3. How to make an electronic music box of your own style? How to transform music rhythm and programming language? 4. How to put the music rhythm into the information development board? 5. How to design the appearance and style of the theme music box? Overall design of appearance and music style 6. Collect relevant success stories and learn relevant skills	
Explain	● Choose the right plan under restricted conditions
1. Select a unique festival, integrate the Christmas atmosphere and cultural elements, define the style and creative design of the shape, and collect its Christmas cultural materials, and make a slideshow to share with everyone 2. Convert the music rhythm of Christmas songs into programming language 3. The students first find out the answers to the questions, summarize their cultural characteristic elements and music conversion methods, and analyze them 4. Understand the cultural characteristics of festivals, re-plan and design interactive music boxes, and discuss how to make them through design aesthetics combined with cultural and information and technical capabilities 5. The teacher integrates relevant professional background knowledge and introduces case videos to assist students in choosing a suitable method for creative thinking and program linking	
Engineer	● Prototype ● Test evaluation ● Communication and discussion
1. Under the limitation of never creating a music box by hand, first think about and collect the composite media that can be made, and experience the style, mystery and characteristics of different media. 2. Evaluate the characteristics of each medium, whether it is suitable for the style and touch of your design? Can the product form of the interactive music box be concretely presented? 3. Explore the production methods and processes of different media, communicate and match the feasibility of using Christmas-style music boxes 4. Carefully estimate the size, color and style image of the work 5. Is the imported music code correct? 6. How to combine the development board with the sensor and the music box	
Enrich	● Redesign ● Complete
1. The adjustment of the size of the work and the materials used for the first time, the production failed, and the reasons for the failure are discussed 2. Debug the link between music code and information sensor 3. Go deep into various fields, learn more about other music box presentation methods, accumulate your own aesthetic experience, and enrich design creativity	
Evaluate	● Check whether to solve the problem or achieve the goal
In the form of a small final publication, show personal works, let other students observe each other, the teacher also gives suggestions, and understand whether the designed interactive music box meets the expected target effect, and named this interactive music box Pandora Dangdang box , To present the integrated mode of STEAM innovative teaching through thematic assignments, and to enhance students' motivation for cross-field learning.	

Created with the theme of Christmas atmosphere and doll design, designed Christmas elk, rabbit and Santa Claus and other shapes, made the building block puzzle through the method of laser carving, and assembled it, and tested whether the size is correct. As shown in Figure 13, the assembly is completed and has not been painted works.

Figure 13. Assembled and unpainted works

Through color changes, each Pandora's music box is filled with personal style, color and creative concept. It is designed to sing Christmas music when you take the music box away from the desktop, and you can stop singing when the desktop is flat. Part of the unique Pandora's music box is completed. The work is shown in Figure 14:

Figure 14. Final partial works presented

In addition to using the laser engraving method, I also tried to use mini-bricks for composite media creation. The same way, the information method of music and sensors combined with the subject direction of the decoration on the desk was used for thinking. The preliminary creation results are shown in Figure 15. , And more media STEAM lesson plans will be extended in the future.

Figure 15. Mini brick works

IV. STUDENT'S COURSE STUDY SATISFACTION EVALUATION

This research is based on the creation of Pandora's music box. The course learning satisfaction survey of this research is divided into three aspects: pre-test and post-test, investigation of learning interest and exploration, active and active extended learning, and self-learning efforts for the course. At the beginning of course learning Let the students fill out the prediction questionnaire. After the results of the course are displayed, perform a post-test questionnaire on the learning effectiveness. The results of the comparison between the prediction questionnaire and the learning effectiveness questionnaire are shown in Figure 16. In the prediction questionnaire for exploring learning interests, 50 % Of the students felt interested in the course arrangement, 37% of the students felt very interested, and 94% of the students who got the results of the post-test questionnaire on the learning effectiveness found this unit course to be interesting.Overall, through course learning, 7% of the students became interested in the course.

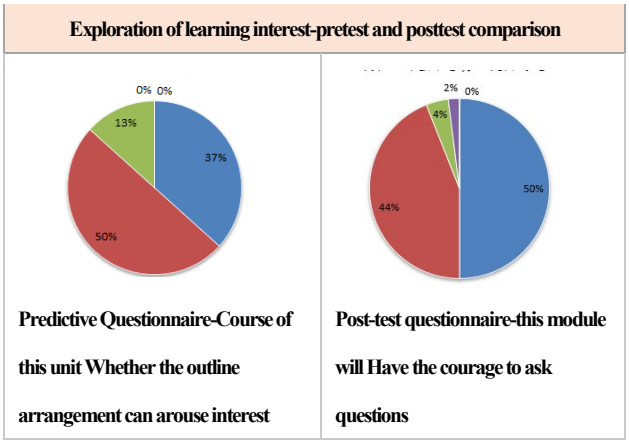

Figure 16. Learning interest exploration

The main axis of this research hopes to guide students to increase their interest in cross-field learning through STEAM's innovative teaching model. It also hopes to strengthen students' willingness to actively engage in extended learning related to the curriculum, through hands-on methods, and at the same time integrate the concepts of theory and practice. In the prediction questionnaire, 17% of the students strongly agreed with the initiative and extended learning, and 50% agreed with it. When the results were shown, the effectiveness questionnaire found that 52% of the students agreed with the autonomous extended learning, while 48% agreed with it. Of students agree to independent learning. In terms of overall performance, the proportion of students who strongly agree has been greatly increased, increasing by 35%, which verifies that the STEAM innovative teaching model has an excellent effect of autonomous extended learning, as shown in Figure 17:

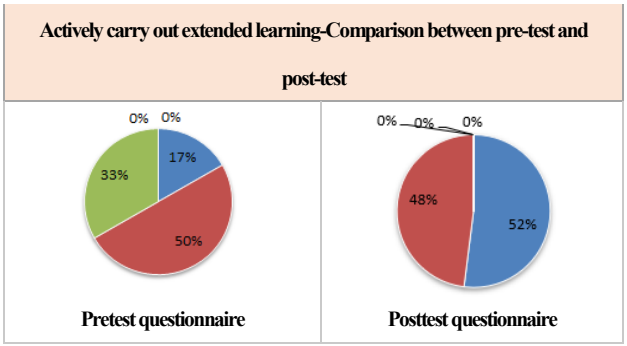

Figure 17. Active extended learning attitude

This unit combines the cross-domain integrated learning model of STEAM innovative teaching to encourage students to change their passive habits in learning. Only 17% of the students agreed to put in a lot of effort in this course at the beginning of the unit. After the course results are displayed, there are 64% of the students think that they have put in a lot of effort in this course. As shown in Figure 18, it has proved that they have improved their passive and easy learning attitude in the past, and they are willing to make more efforts for classroom learning and cross-field work.

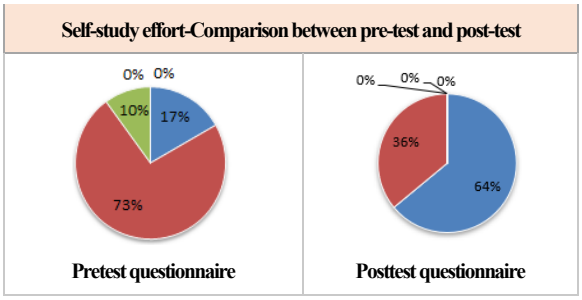

Figure 18. Self-study effort

V. CONCLUSIONS

In the innovative teaching of STEAM, students are given more opportunities to observe daily life and social context, to find problems around their lives, to create ideas through problem-solving methods, and to learn independently, find information, understand the ins and outs of affairs, and past history. Background, find the problem and solve the problem, and introduce the cultural background, aesthetic design and information technology and other cross-domain expertise to combine in the same unit exercise, through repeated revisions, exercises, data retrieval, testing, from which a sense of accomplishment and cross-domain learning and Motivation of application, this STEAM innovation mode helps to achieve the goal of cross-domain teaching, enhance students' learning motivation and accumulate experience in teamwork and expression skills.

During the learning process, students often feel flustered due to the subject's brainstorming process, production methods, integrated sensors, or not knowing how to correct them. They can make corrections through constant teacher-student discussions and observe peers' works to increase their self-energy. Strengthen learning confidence and find specific learning and application directions. There are frustrations in the process, but when I see the results, I feel a sense of accomplishment.

In response to the different theme units of each design, you need to learn and understand the professional knowledge of each aspect, and at the same time in-depth exploration of the field. In the creative process, you can also try composite media and materials for design, and find answers to questions in the process of hand-made models. , To implement the concept of learning by doing and learning by doing. Students who learn through the innovative STEAM teaching model have the ability to integrate and cross-domain, and are also keen on observing things, and can actively explore and answer and get used to the teamwork atmosphere, which helps Talent characteristics and creative practical ability requirements in future employment.

In the future, the unit results of this course will be gradually introduced into other related experience courses, and more diverse materials and sensing devices will be added, which will help students have the motivation to explore problems independently in their learning, and at the same time, they will simulate the way the project is carried out. Subject exploration, problem-solving, finding answers, learning cross-domain knowledge, applying it to works, and finally appraising works. It will help enhance students' interest in learning and cross-domain learning capabilities in overall learning, and make learning more practical and practical. Industry docking.

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