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The Effect of Positive Instruction on a Maker Project in a Vocational High School*

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This study aims to conduct experimental research on the impact of the application of positive instruction in the "Maker Project Practice" courses of vocational high schools on the students' learning outcome. By purposive sampling, 80 juniors taking the "Maker Project Practice" course in two classes of the Department of Automotive Technology in a vocational high school in southern Taiwan were selected as subjects. They participated in the "fuel saving Maker Project Practice" activities during the period of one academic year. Regarding activity design, positive instruction was adopted as the learning strategy, and a "Maker Project Practice" course on fuel saving was implemented with students as the subjects. The "Quasi-experimental design" was adopted, and pretest and post-test were carried out on the experimental group and the control group. In the experimental treatment, the experimental group received the intervention of positive instruction in the "Maker Project Practice" course, while the control group did not receive any experimental treatment. In addition, by reorganizing the statistical analysis of the quantitative questionnaire and qualitative triangulation result, this study determined the following learning outcome conclusions: (1) the application of positive instruction in the "Maker Project Practice" course has significantly positive influence on students' "flow experience"; (2) the application of positive instruction in the "Maker Project Practice" course has significantly positive influence on students' "auto fuel saving literacy". Thereby, this study puts forward suggestions for teaching and future related research.

Keywords: positive instruction; Maker Project Practice; learning outcome; flow experience; auto fuel saving literacy

1. Introduction

1.1 Research Motives

Kostromina and Gnedykh pointed out that the direction of future education development is to cultivate students' three abilities: cognitive ability, learning motivation, and self-organizing ability [1]. In order to enhance students' creativity and national competitiveness, Taiwan's Ministry of Education implemented the 12-year national education curriculum on August 1st, 2014, which extends national education to the stage of senior middle school education. Therefore, in order to integrate skill creativity into school curriculum teaching and cultivate students' integration ability and team spirit, in the 2006 Provisional Curriculum Outline of Higher Vocational Education, the Ministry of Education stipulated that the 2-credit curriculum of "project practice", which was originally a compulsory subject depending on the school, was formally incorporated as a required course of vocational subjects. After a trial run and revision, in the Curriculum Outline issued in 2010, the credits of the "project practice" course were adjusted to 2–6 credits, which enabled schools to update different courses according to the original teaching equipment to achieve the characteristics of "diversity". The "project practice" course can enhance students' professional knowledge, skills, and practical operation ability, and promote close integration between school education and industry fields, in order to understand the future direction of industry development and the demands for human resources, and then, train the professionals needed by society [2].

The practice courses in vocational high schools are characterized by "learning by doing" and "doing by learning", while the "Maker Project Practice" course is a kind of the inspiration educa-

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tion in the practice courses. Through student team cooperation, the "Maker Project Practice" course integrates the professional knowledge and skills learned in the past three years. In this course, students can select suitable research topics according to their interests and team specialty, and the group is requested to consider how to break through difficulties and cultivate their ability to solve problems, thus, it is a "pragmatic and practical" course. Lin and Hsu proposed that expansion of the scale of higher vocational and technical education across the Taiwan Strait should pay attention to building a full-time vocational system, where quality improvements should be in line with industry demands, and the creation of diversity and characteristics should be implemented with the concepts of "pragmatic and practical" and "all-round education" [3]. Placing emphasis on practical operation abilities in the "pragmatic and practical" courses of technical and vocational education is what John Dewey called "learning by doing".

It can be concluded from the above that the "Maker Project Practice" course can enable students to effectively acquire comprehensive learning. Through integrated courses, schools train students to have the abilities of teamwork, problem-identification, problem-solving, pragmatic practice, creative thinking, and research and development. Vocational high school courses attach great importance to cultivating professional skills in line with industry demands, students' problem solving abilities, and other practical abilities, and the "Maker Project Practice" course can contribute to this goal. This study uses the teaching mode of integrating positive emotion in project-based learning (PBL). As practical ability is very important for students, the method of "learn by doing" can cultivate students' abilities in team work, self-study, reflection, and solving problems independently, which can enhance students' self-confidence and improve their learning motivation and outcome.

1.2 Research Purpose

In this study, positive instruction of the "PBL" mode is adopted to design a "fuel saving Maker Project Practice activity" for the "Maker Project Practice" course of the vocational high school. The purposes of this study are:

1. To explore the influence of the application of positive instruction in the "Maker Project Practice" course on students' learning outcome in "flow experience".
2. To explore the influence of the application of positive instruction in the "Maker Project Practice" course on students' learning outcome in "auto fuel saving literacy".

2. Literature Review

2.1 Positive Instruction

In the past, psychology emphasized that guiding students' negative emotions may incur immediate dangers, such as anger, which may lead to aggressive behavior [4]. In addition, negative emotions affect thinking and cause people to lack flexibility and rationality in their thinking, while positive emotions are conducive to imagination [5], the development of individual decision-making actions [6], affect personal well-being [7], and increase creativity [8]. Positive emotions can promote problem solving, enhance psychological stress resistance, and contribute to physical and mental health, social interaction, and realizing potential [9].

Chaung, Hung, Tseng, and Huang pointed out that positive-emotion instruction is a progressive teaching concept. First, through the teaching course of "self-confidence", students are motivated to have self-affirmation from an internal perspective, and to appreciate others; then, through the teaching course of "contentment", students are taught to cherish what they already have and to replace material comfort with spiritual satisfaction; finally, students are guided to participate in the teaching course regarding the belief of "gratitude", in which they are taught to think positively in the face of adversity and to be brave to express and practice gratitude [10]. Lin held that the influence of positive psychology on students' growth mainly lies in: (1) arousing students' positive emotions; (2) improving students' ability to face problems and cultivating their positive thinking ability; (3) developing a hopeful, confident, and introspective learning attitude; (4) creating a positive environment [11]. In addition, Chang and Cheng indicated that, in actual teaching, when students feel afraid and troubled, teachers should pay attention to their own emotions in teaching, be patient, and maintain positive emotions in class, in order that students can be affected by the positive emotions, which can contribute to their adaptive motivational engagement; moreover, the teachers should avoid showing too much negative emotion, as students may be affected by negative emotions, and result in non-adaptive motivational engagement [12].

To sum up, this study defines positive instruction as: teachers integrate positive management and positive emotions into the learning environment of "Maker Project Practice" in class, give full assistance and specific guidance to students with consistent confidence, and replace scolding with encouragement and punishment with reward, in order to create a learning environment full of confidence, vitality, hope, potential, and love for students, guide students to learn positively, trigger students' positive emotions in a progressive pattern, improve students' ability to find and solve problems in the learning process, cultivate students' self-confidence, ability, contentment, gratitude, pleasure, and centripetal force, and enhance their learning efficiency and willingness.

2.2 Flow Experience

Flow is an intrinsic psychological state. When a person is wholeheartedly devoted to the activities they engage in, the experience of being filled with positive emotions and forgetting the flow of irrelevant senses and time is called "flow experience", which is similar to challenge-based immersion. Flow experience can be expressed as a person's engagement in a game, meaning when they experience fun, they are willing to play the game again [13–15]. It is further demonstrated that flow experience occurs in both dynamic and static activities. When a person is fully engaged in a situation in the process of activities, they will automatically exclude all unrelated perceptions and enter a flow state, and enjoy and become immersed in this feeling, meaning they achieve a state of self-forgetfulness. Therefore, flow experience may occur at any time and during any activity, and it varies from person to person. In particular, when an individual engages in an activity that matches their abilities and challenges, and they can complete the activity, this flow experience will arise [14].

Chang and Lin proposed that flow experience is a psychological experience that makes people feel happy, attentive, immersed, self-forgetful, satisfied, and in control. This kind of experience can make learners concentrate on and be immersed in learning, and then, generate fun and motivation, which can be conducive to learning [16]. Therefore, Rodriguez-Ardura, Meseguer-Artola, and Ammetller argued that flow can stimulate skill improvement by arousing attention and challenge [17]. Furthermore, Yu and Lin mentioned that flow experience is a kind of self-content one can have when participating in activities, which can motivate continuous engagement, and subsequently, make people feel happy [18].

Based on the related research of flow experience, this study defines "flow experience" as: in "Maker Project Practice" activities, students feel happy, joyful, and forgetful during continuous involvement in the fully-engaged context, and generate feelings, such as the unity of knowledge and practice, internal satisfaction, loss of time, sense of self-control, concentration, and filtration of all perceptions unrelated to the activities, and have an optimal experience that makes them feel challenged, but relaxed and content, which is a transient experience with a relaxed feeling, such as floating in water.

2.3 Maker Education

"Maker" (or called "Self-Maker") is a group of DIY fans who like to make works by themselves with tools and materials and share their creative experience, so that learners can obtain in-depth practices and experiences in four levels: physical (practice, practical experience), mental (problem finding, problem solving, design thinking, STEAM (science, technology, engineering, mathematics, art) knowledge, emotional (active, devoted, accepting loss, risk-taking) and social clustering (cooperative and sharing) [19]. In addition, Barack Obama, President of the United States, publicly called on teachers to hold the Maker spirit to integrate knowledge and skills gained through practice courses, and make science more pragmatic. Harvard Graduate School of education (2015) also emphasized Maker education is of great educational significance to primary and secondary school students as it enables students to learn about operation, innovation and knowledge, and more importantly, strengthens their self-efficacy and helps them establish a sense of belonging in a community through practical learning experience [20]. Therefore, many scholars think that the emphasis of Maker education on the essence of "doing, construction, and innovation" is in line with the exercise and practice view of "learning by doing" in theory put forward by Dewey [21, 22].

Therefore, this paper proposed the following content structure of the learning courses: with the vision of Taiwan's 12-year national basic education as the basis and the design-practice process (development, design, planning, practice) as the education process, carry out project practice with students, so that the students can gain specific experience by personally participating in the practice process, think and integrate relevant knowledge, skills and attitudes into internal literacy in the process, develop the ability to find and solve problems, and finally think about the ways to make improvement and innovation in the process of project practice, and further generate new learning motivation. Such learning course content structure conforms to the theory of experiential learning (Kolb), theory of creativity (Amabile) and also the Maker education theory proposed by Harvard Graduate School of Education (2015) [19].

2.4 Application of Project-Based Learning (PBL) in Maker Education

Project-based teaching and learning was proposed by Kilpatrick at the beginning of the 20th century, which advocated that school education should be based on the projects chosen by learners (students) and encourage learners to work hard to complete the project with their internal motivation [23].

Wu, Huang, Chen, Chien, and Huang suggested that the introduction of PBL into the overall curriculum design allows students to gain a level of understanding, and enhances their application, analysis, and other abilities; moreover, it stimulates the students' growth at the creation level [24]. PBL increases peer interaction, strengthens students' practical application, and enhances their understanding, impression, and advanced thinking of the curriculum content. Therefore, Zhang, Xie, and Li argued that educators have noticed that PBL can help students understand project practice and challenges, and develop professional competence through project practice [25]. Furthermore, David and Marshall stated that PBL is suitable for project practice courses. Allowing students to learn the content of practice courses in the PBL environment through project practice has become the ideal choice of project practice courses [26]. After completion of the course, many students have learned to solve various problems, found value in active learning, and improved the learning outcome of the course.

Cheng and Wang held that PBL (Project-Based Learning; Problem-Based Learning) can be regarded as a kind of Maker education [27]. Through the project practice tasks or the problem-solving thinking logic in this education approach, students can generate learning motivation to seek required knowledge, and complete the learning process through doing by themselves and presentation of the project practice. In recent years, PBL has become the most important "flip" education in advanced countries in the world. Therefore, under the promotion of the Ministry of Education, National Taiwan Normal University has set up the education credit course of "innovative Maker education" to cultivate the Maker ability of teachers and students, so as to implement the Maker education in middle school stage [19]. In addition, the project practice course emphasizes creative design and production as well as problem-solving, and attaches more importance to machine operation and material application, i.e., Maker education. The project practice course also allows students to carry out exploration and project practice. The teaching design of this course is aimed to stimulate students' creativity and encourage them to practice by themselves [22]. With Maker education in the current social phenomenon, teachers encourage students to combine project practice with the integration and application of knowledge and skills related to STEM subjects (Science, Technology, Engineering and Mathematics), so as to help students understand the application relationship between science and engineering. Maker education can provide useful insights for educators in planning [28]. In this regard, the so-called Maker education is the basis for the project practice course in the new curriculum outline issued in 2019 under Taiwan's 12-year national education system. Maker education takes the design-practice process (thinking, discussion, design, planning, practice) as a process of truly establishing "education" and "learning", so that students can internalize the concept of "learning by doing" through discussion and practice experience.

This study defines the PBL model as: in the process of Maker Project Practice, students and teams can use their abilities to discover and solve problems, create works with projects as the goal, and acquire knowledge and skills through interaction with teachers and teams in the process of production and research. The PBL model is a teaching method that allows students to acquire skills and develop the ability to solve problems based on their own initiative, meaning it enables students to find solutions to problems and cultivates them to become self-learners. Therefore, the teaching goal of the PBL model is not just about knowledge acquisition, but focuses on ability cultivation.

2.5 Fuel Saving Literacy

According to the definition of the United Nations Educational, Scientific and Cultural Organization (UNESCO), "literacy" refers to the ability to "recognize, understand, interpret, create, calculate, and use printed and written data in different environments". In the traditional definition, "literacy" refers to a person's "ability to read and write", while the modern definition of "literacy" goes beyond the individual reading and writing ability, and focuses on knowledge, attitude (affection), and skills.

With the increasingly severe problem of extreme climate around the world, it has been scientifically validated that global warming and climate change tendencies are caused by human activities, especially the emissions of carbon dioxide from burning fossil fuels [29]. Lo defined energy saving vehicles as: land vehicles characterized by low energy consumption in product manufacturing and usage life cycle, low pollution emissions, non-fossil fuels as the main driving energy, the pursuit of sustainable and balanced development, and a green earth as the goal [30].

In this study, "fuel saving literacy" is defined as: through "Maker Project Practice" courses implemented in schools, the students learn how to reduce the use of fossil fuels consumed by vehicles in the overall process from automobile production, design, manufacturing, transport, and use by consumers, to the final recycling and scrapping, takes high fuel-saving efficiency as the highest design concept and objective for automotive operation, and low exhaust emissions and a small carbon footprint as the highest guiding principles for automotive products. Therefore, it cultivates students' knowledge, attitude, and skills in "fuel saving literacy".

3. Research Design and Implementation

According to the research purposes and the results of literature review, the design and implementation of research regarding the integration of "positive instruction" into the "fuel saving literacy" project course are described, as follows:

3.1 Research Method and Procedures

This study adopts quasi-experimental research to carry out experimental teaching and a questionnaire survey. The PBL model is applied in the learning environment of a "Maker Project Practice" course in one academic year, which includes three periods: preparation period, teaching period, and acceptance period. Teachers guide students to learn and apply fuel saving knowledge and skills, carry out fuel saving Maker Project Practice activities, and explore the effects of "flow experience" on the students' "fuel saving literacy", as shown in Fig. 1. The procedures are described, as follows:

First, plan the "Maker Project Practice" course through literature review and analysis, which includes: design the teaching plan of fuel saving Maker Project Practice activities, develop the "flow experience scale" and "fuel saving literacy scale", make observations, and conduct analysis of the learning process after "integrating positive instruction into PBL". Among them, the designed teaching plan for fuel saving Maker Project Practice activities is carried out in three stages: (a) three-weeks of teaching fuel saving knowledge and skills; (b) 15-weeks of practical course-applications of positive instructions in fuel saving Maker Project Practice activities; (c) 18-weeks of "Maker Project Practice" work verification and the revision of practical applications. Finally, complete a publication of the Maker Project Practice works, and conduct interviews, data collection, and analysis.

Furthermore, in the implementation process of this study, quantitative questionnaires were used to understand the implementation status of fuel saving education in the "Maker Project Practice" course, the "flow experience" of students, the learning outcome of "fuel saving literacy", and impact analysis. In addition, experts and scholars were invited to comment on student works. Qualitative text data regarding the interview feedback of student groups were collected to further explore the design concepts of the project works of the students in each group, as well as their learning processes. Thus, the design of this activity is reviewed to serve as an important

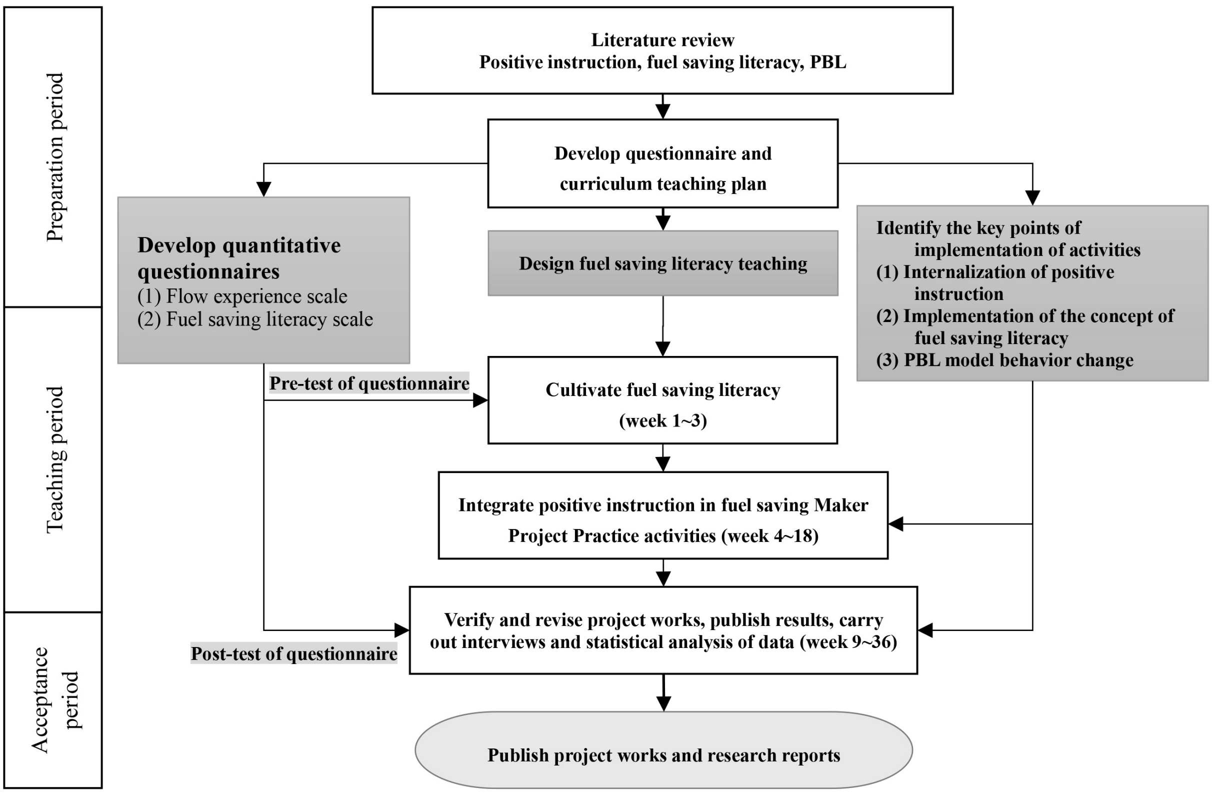

Fig. 1. Research Procedures.

reference for the construction of the Maker Project Practice curriculum and teaching mode. Regarding the encoding principle of the qualitative text data, taking code SI020305 for example, SI stands for student interview data, 02 refers group No. 2, 03 refers to student No. 3, and 05 refers to the 5th statement data.

3.2 Research Structure

As shown in Fig. 2, the structure of this study includes control variable, dependent variables, independent variables and covariates, which are described in detail below:

(1) Control variable

Low interference of teaching experiment is very important for the interpretation of results. In order to reduce the interference with the Experimental group and the Control group, this study uses the same instructor (i.e. researcher) to teach the same content for the same number of hours, and the assessment tools are also same. In this way, it can control the teaching characteristics, teaching content, teaching hours, assessment tools and other variables.

(2) Dependent variables

At the end of the teaching experiment course, the instructor will ask the students to make a small work of the project practice, write a short essay and a final report. Then the instructor will carry out a test with the self-made fuel-saving literacy test paper, with the test results as the learning outcome; a post-test on another variable, the flow experience, will be carried out with the flow experience questionnaire the end of the learning course.

(3) Independent variables

Group division according to the teaching strategy of integrating positive teaching into Maker project practice course (Experimental group and Control group).

(4) Covariates

Before the teaching experiment, the instructor would carry out the pretest with the Experimental group and the Control group by using the self-made fuel-saving literacy test paper, and the results of the pretest would be taken as the covariates.

3.3 Research Subjects

The subjects of the teaching experiment of this study are two classes of 80 juniors taking the "Maker Project Practice" course in the Automotive Department of a vocational high school in southern Taiwan. The implementation time of the experimental teaching is one academic year.

3.4 Research Tools

According to the literature review and curriculum attributes, this study develops the "flow experience scale" and "fuel saving literacy scale", which are explained, as follows:

(1) Reliability and Validity Analysis of Flow Experience Scale

After the preliminary draft of "flow experience scale" was compiled, as based on the professional attributes of the questionnaire, five scholars and experts in fields related to flow experience were invited to conduct expert validity. The scale was then revised and developed into the pre-test questionnaire.

Through item analysis, poor items were deleted from the "flow experience scale". According to factor analysis, the KMO value is 0.84, and the χ^2 value of the Bartlett spherical test is 1249.43 (degree of freedom was 300), which reach a significant level ($p < 0.001$), indicating that there are common factors among the relevant matrices. After categorization of the questions, the final questionnaire

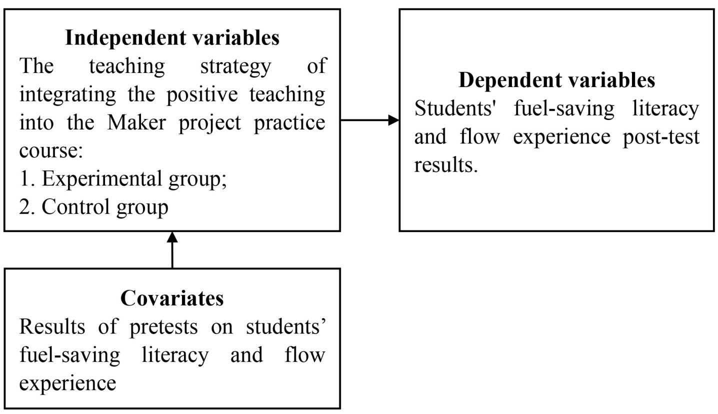

Fig. 2. Research Structure.

Table 1 Reliability Analysis of the Attitude and Behavioral Intention Scale

Dimension	Factor	Cronbach's α	Cronbach's α of the whole scale
Attitude	Active concern for fuel resources (9 items)	0.91	0.94
	Positive attitudes and values (3 items)	0.88	
Behavioral intention	Correct and economical use of gasoline (3 items)	0.71	
	Change and influence others (9 items)	0.72	

contained 25 questions, the cumulative explained variance of the five factors was 61.27%, and the factor load was between 0.48 and 0.77, which is the acceptable standard.

Reliability analysis of the flow experience scale tested the Cronbach α values; the α values of "unity of knowledge and practice" (5 items), "inner satisfaction" (7 items), "loss of sense of time" (5 items), "sense of self-control" (4 items), and "concentration" (4 items) are 0.85, 0.83, 0.81, 0.71, and 0.77, respectively, and the α coefficient of the overall scale is 0.92, indicating that the scale has internal consistency, and thus, was developed into the formal questionnaire.

(2) Reliability and Validity of the Fuel Saving Literacy Scale

The questionnaire of "fuel saving literacy scale" consists of three parts: "personal basic information", "Cognition Scale", and "Attitude and Behavioral Intention Scale".

The "Cognition Scale" was originally planned to have 88 multiple-choice questions (4 options for each question). Yu suggested using Tester for Windows version 3.0 for difficulty and discrimination analysis. The identification index of the test should be more than 0.25, and the difficulty index should be between 0.40 and 0.80 as the selection criteria, while other values that were too low were deleted [31]. This "Cognitions Scale" retains items with a difficulty index ranging from 0.38 to 0.80 (the difficulty index values of items 41, 52, and 61 were 0.38, and judged by the research team as acceptable). In terms of the discrimination index, items with a discrimination index greater than 0.25 were retained. After difficulty and discrimination analysis of this "Cognitions Scale", 25 question items with moderate difficulty and good discrimination were retained.

After the "Attitude and Behavioral Intensity Scale" was preliminarily drafted, five scholars and experts in fields relevant to fuel saving literacy were invited according to the professional attributes of the questionnaire to conduct expert validity, and the revised scale was developed into a pre-test questionnaire. Then, the poor items were deleted through project analysis. According to factor analysis, the KMO value is 0.91 and the χ^2 value of Bartlett spherical test is 1686.33 (degree of freedom was 28), which both reach a significant level ($p < 0.001$), indicating that there are common factors among the relevant matrices. According to Table 1, The questionnaire questions were categorized into 2 dimensions (each including 2 factors), for 24 questions in total, where the cumulative explained variance of the 2 factors of the "Attitude and Behavioral Intensity Scale" is 61.23%, and factor load is between 0.55 and 0.89, which reach the acceptable standard. In reliability analysis, Cronbach's α values were tested, and the α values of the subscales are 0.91, 0.88, 0.71, and 0.72, respectively, while the α coefficient of the overall scale is 0.94, indicating that the scale has internal consistency, and was then developed into the formal questionnaire.

3.5 Integration of Positive Instruction in Project Curriculum Design

In this study, positive instruction was integrated into the design of the project courses, including three periods: preparation period, teaching period, and acceptance period. The key points of implementation are, as follows:

(1) Preparation Period For Improvement of Teachers' Positive Instruction Ability

The "preparation period" mainly focuses on the improvement of teachers' abilities. Teachers are required to participate in positive instruction training courses and have professional literacy of positive instruction, in order that they can integrate positive instruction into theory and practice (technology) teaching and give students positive energy. Furthermore, teachers shall adopt the cooperative learning mode to teach the Maker Project Practice course, guide students to understand the importance of teamwork, communication, and coordination, encourage students to help and encourage each other, and create a positive learning environment. Finally, the teachers shall remind students that the essence of Maker Project Practice is "learning by doing" and more often "learning by mistakes". Students do not need to feel depressed when they encounter setbacks and should not be afraid of failure, as learning from mistakes to achieve success creates precious knowledge and experience.

(2) Teaching Period-integration Of Positive Elements into Teaching and Teacher-Student Interaction

The "teaching period" focuses on the interactions between teachers and students, as well as the integration of positive elements into teaching. Students are encouraged to adopt positive thinking approaches, and actively seek solutions when facing setbacks or failures during Maker Project Practice. Furthermore, teachers should actively interact with students, provide advice and care, encourage students to persevere and implement learning accompaniment. In addition, teachers should create a positive learning environment that enables students to discuss the project, promotes teacher-student interaction, increases mutual trust and understanding, and strives to achieve the desired Maker Project Practice results.

(3) Acceptance period – Internalization and Demonstration of Students' Positive Emotions

The "acceptance period" focuses on cultivating students' positive emotional literacy and applying it to the learning of Maker Project Practice course knowledge and skills; for example, students may not dare to report their "work results" on a stage for fear of forgetting words or saying the wrong things. The teachers shall use positive thinking to remind students that every grading teacher offers positive and kind advice from a professional perspective regarding the student reports of each group. Furthermore, as confidence in making a presentation comes from adequate preparation before the report, students are encouraged to practice more and understand the process and principle of Maker Project Practice. In this way, students are guided to internalize positive emotions and show them in the process of learning professional knowledge and skills, in order to cultivate their self-confidence.

3.6 Curriculum Design and Teaching Outline of Maker Project Course

(1) Introduction of Maker Course

This course focuses on introducing the integration of basic knowledge, skills and attitudes promoted by Maker education, including energy conservation and carbon reduction, innovative design and problem-solving methods, skills in operating various tools and instruments, as well as methods of project practice. The Maker education mentioned in this course mainly takes the project practice procedures (making, thinking and creating) proposed by scholars as the teaching process [19, 27], that is: (1) Carry out Maker project practice (doing); (2) Put forward Maker project conception (thinking); (3) Integrate innovative design and making (creating). In addition to emphasizing the above-mentioned connotations, this course will also highlight the application value of these connotations in teaching practice, and the ways to make innovate design and implement Maker teaching activities.

(2) Course Objectives

Understand the Maker and innovative design methods; be familiar with the skills in operating tools and instruments; understand the methods of project practice; develop the basic literacy and application ability of a Maker.

(3) Course Content

Unit 1 Maker project practice (making).

Week 1: Course introduction (fuel-saving literacy, operation of tools and instruments, Arduino single chip and sensor application technology; innovative Maker education and status introduction; application of innovative Maker ability in teaching and education); industrial safety and health education; project practice, including cutting, grinding, welding and assembly.

Week 2: Operation of various machines and tools.

Week 3: Operation and material handling of various machines and tools.

Week 4: Various creative practices.

Week 5: Various creative teaching and applications in education.

Unit 2 Maker project conception (thinking).

Week 6: Understand and use basic circuit elements and equipment (multimeter, bread board, resistance and color code meter, resistance series/parallel connection, voltage and current measurement).

Week 7: Understand capacitance and simple circuit design (practice of mathematics and scientific design, application of multiple symbols).

Week 8: Theory, application, and practice of sensor components.

Week 9: Arduino simple circuit design (or programming).

Week 10: Arduino simple circuit application (or program application).

Week 11: Introduction and application of 3D printing software.

Week 12: Introduction and application of 3D printer.

Week 13: Project practice integration and making.

Week 14: Project practice report and discussion.

Unit 3 Integrate creation and making (creating).

Week 15: Creation methods of Maker.

Week 16: Work processing and problem solving.

Week 17: Work processing and innovation.

Week18: Application of innovative Maker education in educational fields; completion and publication of project practice works.

4. Results

By using the purposeful sampling method, 80 juniors in two classes of the Department of Automotive Technology of the case school in connection with the "fuel saving Maker Project Practice" were selected as samples. After taking the "Maker Project Practice" course, which was taught mainly by positive instruction for one academic year, the students took the "flow experience scale" and "fuel-saving literacy scale" test in a self-reported manner, and 80 valid questionnaires were collected, for an effective recovery rate of 100%. The results of quantitative analysis on the basic data, flow experience, and fuel saving literacy, and the qualitative analysis of students' learning process are summarized, as follows.

4.1 Basic Data Analysis

Among the 80 respondents on flow experience, in terms of the demographic variable "gender", most students were "male" (79 male students, accounting for 98.8%); in terms of the times of experience in "Maker Project Practice", most students have "one time" experience (52 students, accounting for 65%).

4.2 Analysis of Flow Experience

The flow experience analysis of this study includes two aspects: the analysis of the differences among the dimensions of students' flow experience and the analysis of the difference between pre-test and post-test, which are illustrated, as follows:

(1) Analysis of the Dimensions of Students' Flow Experience

In this study, the post-test questionnaire on "flow experience" includes 5 dimensions. According to Table 2, the mean values of the dimensions of "flow experience" range from 3.53 to 3.64. Among them, "inner satisfaction" has the highest mean value of 3.64, followed by "loss of sense of time" (3.63). The F value of "flow experience" is 3841.85 (p = 0.000 <0.001), reaching the significant level. In order to understand the comparison among different dimensions, post comparisons were made on the dimensions, which determined that "inner satisfaction" was significantly higher than "unity of knowledge and practice".

1. In Maker Project Practice, when students solve the problems encountered in Maker Project Practice, they know that the project will be more complete.
2. From the beginning to the end of Maker Project Practice, students will be very committed.
3. Students can learn how to express their professional skills in Maker Project Practice.
4. Students can be "concentrated" in every link of Maker Project Practice.
5. Students can concentrate on their work without being distracted when carrying out Maker Project Practice.
6. The positive and negative feedbacks of the reviewers and teachers can usually provide motivation for students to continue Maker Project Practice.
7. Students can clearly know how to cooperate with the team when they implement Maker Project Practices.

This shows that, by the end of the course, the students feel that no matter what problems or difficulties they encountered in the process of Maker Project Practice, they had obviously greater feelings of "inner satisfaction", as compared with the "unity of knowledge and practice" regarding whether the project works were professionally and perfectly presented.

(2) Difference Analysis Between the Pre-test and Post-test of Flow Experience among Students

Analysis was conducted on the dimensions of students' "flow experience" in the "Maker Project Practice" course, as well as on the implementation of pre-test and post-test dependent sample t-test analysis, in order to understand whether students'

Table 2 Comparison Table of Dimensions of Flow Experience

Flow experience	**Mean value**	**Standard deviation**	***F* Value**
(1) unity of knowledge and practice	3.53	0.59	3841.85*** (2) > (1) LSD
(2) inner satisfaction	3.64	0.56	
(3) loss of sense of time	3.63	0.61	
(4) sense of self-control	3.58	0.61	
(5) concentration	3.58	0.58	

Note: ***$p < 0.001$.

Table 3. Summary Table of Dependent Sample t Test Analysis of the Dimensions of "Flow Experience" in Maker Project Practice

Items (N = 80)	Type	Mean value	Standard deviation	Mean deviation	Standard deviation	t
Unity of knowledge and practice	Pre-test	2.15	0.48	–1.39	0.65	–18.93***
	Post-test	3.53	0.59			
Inner satisfaction	Pre-test	2.02	0.50	–1.63	0.70	–20.87***
	Post-test	3.64	0.56			
Loss of sense of time	Pre-test	2.14	0.67	–1.48	0.86	–15.36***
	Post-test	3.62	0.61			
Sense of self-control	Pre-test	2.18	0.59	–1.40	0.68	–18.53***
	Post-test	3.58	0.61			
Concentration	Pre-test	2.03	0.57	–1.55	0.74	–18.83***
	Post-test	3.58	0.58			
Total dimension	Pre-test	2.10	0.46	–1.49	0.60	–22.33***
	Post-test	3.59	0.52			

Note: ***$p < 0.001$.

learning outcome in the dimensions of "flow experience" in Maker Project Practice was improved after this activity, and the analysis results are shown in Table 3. The t value of the total dimension of "flow experience" is –22.33, the post-test mean value is greater than the pre-test, and the difference is significant. The post-test mean value of each dimension is greater than the pre-test, and the difference is significant. The t values of the "unity of knowledge and practice", "inner satisfaction", "loss of sense of time", "sense of self-control", and "concentration" are –18.93, –20.87, –15.36, –18.53, and –18.83, respectively. In summary, most of the students had significant positive improvement in the learning outcome of "flow experience" after the project activities.

4.3 Difference Analysis of Fuel Saving Literacy

In the analysis of students' learning outcome of "fuel saving literacy", pre-test and post-test dependent sample t tests were implemented, in order to understand whether the students improved their "fuel saving literacy" after this activity, as shown in Table 4. The t value of the total dimension of "fuel saving literacy" is –27.55, the post-test mean value is greater than the pre-test, and the difference is significant. In terms of the learning outcome of each dimension, the t values of the "cognitive dimension", "attitude dimension", and "behavioral intention dimension" are –2.81, –33.41, and –21.08, respectively. The post-test mean value of the learning outcome of each dimension of "fuel saving literacy" is greater than the pre-test, and the difference is significant. In summary, most of the students had significant positive improvement in the learning outcome of "fuel saving literacy" after the project activities.

4.4 Analysis of Students' Learning Process of "Maker Project Practice"

This section takes the Maker Project Practice works of only one group of students (5 students), as shown

Table 4 Summary Table of Dependent Sample t Test Analysis of the Dimensions of the "Fuel Saving Literacy" in Maker Project Practice

Items (N = 80)	Type	Mean value	Standard deviation	Mean deviation	Standard deviation	*t*
Cognition	Pre-test	3.24	0.80	–0.30	0.96	–2.81**
	Post-test	3.54	0.69			
Attitude	Pre-test	1.88	0.51	–2.30	0.61	–33.41***
	Post-test	4.17	0.42			
Behavioral intention	Pre-test	1.97	0.59	–1.95	0.83	–21.08***
	Post-test	3.92	0.59			
Total dimension	Pre-test	2.36	0.38	–1.52	0.49	–27.55***
	Post-test	3.88	0.40			

Note: **$p < 0.01$, ***$p < 0.001$.

Table 5 Summary of Maker Project Practice Works by Case Students

Project Title	**Automatic Idling Stop Device with Super Capacitor**
Motivation and Purpose of Maker Project Practice	Mitigate global warming Reduce the idle running time of vehicles Reduce fuel consumption and waste emission pollution Achieve fuel saving and carbon reduction
Design Principle of Fuel Saving Device	Adopt Arduino single chip and sensor applications Design the function of automatically detecting a running engine Control the vehicle to automatically stop after idling for 5 seconds

in Table 5, as a case study to explore the students' performance in the learning process of "fuel saving Maker Project Practice" after positive instruction, which can be used as a reference for the future refinement of this "Maker Project Practice" course. The analysis of students' learning process was carried out by focusing on three aspects of the case project: (1) internalization of positive instruction, (2) implementation of fuel saving literacy, (3) presentation of PBL works. Finally, the substantial benefits of the project works, as derived by students, are explained.

(1) Internalization of Positive Instruction – Encourage Students to Learn and Implement the Positive Thinking Mode, and apply it to the Thinking and Solving of Real Problems.

The purpose of this course is to cultivate students' habit of positive thinking through positive instruction. After data collection and group discussions, students learned about the problem of abnormal climate caused by global warming. Through positive instruction, students were encouraged to explore the problems in the real world, and to actively consider ways to solve them. For example, the Maker Project Practice of a case student work "Automatic Idling Stop Device with a Super Capacitor" was designed to reduce fuel consumption and exhaust emissions by reducing the idle running time of vehicles; thereby, effectively saving fuel, reducing carbon emissions, and contributing to the protection of earth. In the process, the teachers created a positive thinking learning environment, gave careful instructions and explanations, and guided students to practice, learn, and grow, in order to build their self-confidence and sense of achievement.

> "Through the project activities, I have learned to bravely face problems and to try to solve the problems by myself first, and only seek help from my teacher when I really have no solutions." (SI020301)

> "Thanks to my tutor's tireless explanations of the relevant principles of the project, I have built the confidence to solve any difficulties encountered in Maker Project Practice with a positive attitude, and I also appreciate the teacher's positive encouragement and assistance" (SI020101)

> "In the beginning, I had no confidence at all that I could accomplish the project, but thanks to my tutor's encouragement, I finally had the courage to face the problems in my life and developed the ability to think positively." (SI020202)

> "Despite the difficulty encountered in this project activity, we have made breakthroughs and innovations in the existing structure or knowledge, and accomplished the project through team cooperation." (SI020401)

> "Knowing that I was not confident, the tutor always gave me careful instructions, so that I could make progress and grow, and generate a sense of self-confidence and achievement, which motivated me to continue to move forward." (SI020302)

> "The tutor let the students devote themselves to learning and enjoy it, and know the importance of gratitude and cherishment in the learning process. Thanks to this course." (SI070305)

(2) Practice fuel saving literacy – Guiding students' learning and application of fuel saving knowledge and skills, and integrate theory and practice in "learning by doing"

The purpose of this course is to cultivate students' fuel saving literacy. Through the teaching of fuel saving and the collection and discussion of relevant literature, students can acquire the knowledge of fuel saving and apply it to the creative thinking and improvement designs of related vehicle topics; for example, the case students learned about the problems of fuel consumption waste and exhaust emissions during idling of vehicles, thus, they started to consider how to reduce unnecessary fuel consumption and exhaust emissions. As shown in Fig. 3, the design principle of the case students used Arduino programming to achieve the automatic control and setting of the temperature sensor, voltage sensor, Hall speed sensor, etc. With such principles, the students designed the "automatic idling stop device with a super capacitor", which has the function of automatically detecting an engine in the idling state. When all the detected conditions reach the set value, the vehicle would automatically stop idling after 5 seconds, thus, reducing fuel consumption waste and exhaust emission pollution.

In addition, students added creative designs; with the Arduino settings, the vehicle can be restarted by pressing the accelerator pedal and

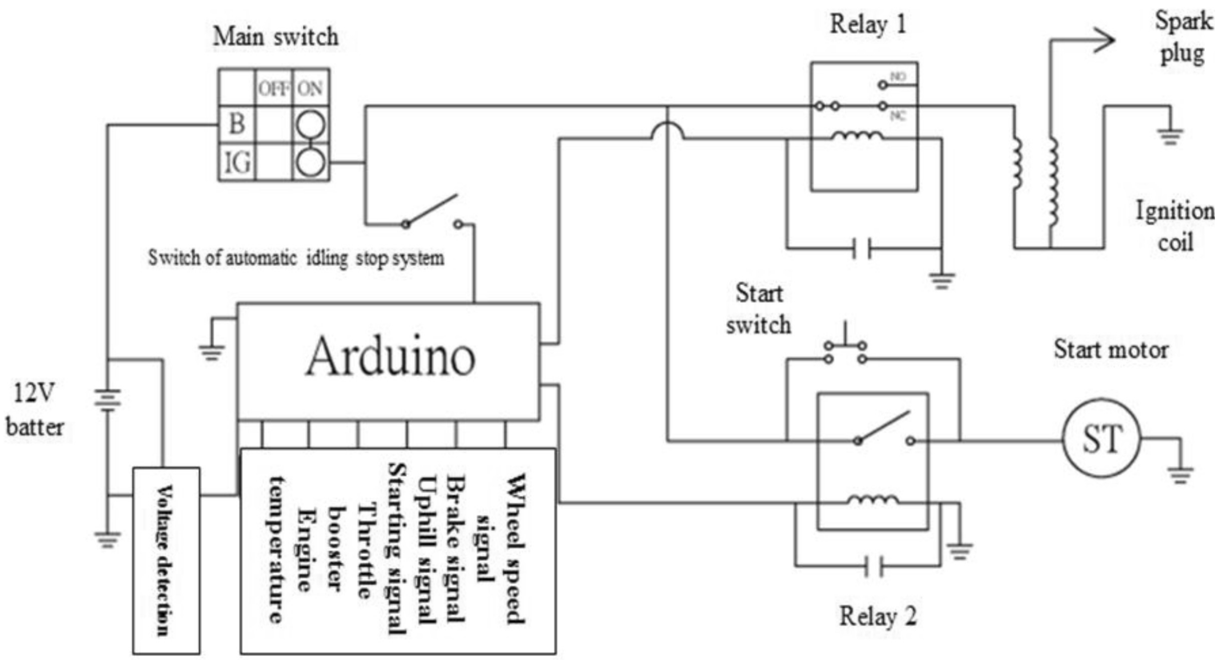

Fig. 3. Circuit Diagram of the Automatic Idling Stop Device.

brake pedal at the same time, which makes it more convenient for the vehicle to restart. In the process, students learned how to correctly use the applications of the super capacitor (Farah capacitor), meaning when the engine is started again, it can instantly output a lot of current to support the battery, thus, prolonging the service life of the battery. The students believed that this project can effectively save energy and reduce carbon, as well as integrate the relevant professional knowledge and skills of vehicle maintenance, as learned in higher vocational colleges.

> "In the process of Maker Project Practice, we learned to conduct engine maintenance and smooth operation." (SI020102)

> "The difficulties encountered in Maker Project Practice are because of our lack of professional knowledge and Arduino programming ability." (SI020302)

> "In the learning process, I obtained professional knowledge about engines and Arduino programming, as well as knowledge about vehicles and their electrical systems." (SI020202)

> "In the learning process, I obtained knowledge about Arduino programming, engine maintenance, and super capacitors." (SI020403)

> "In the course of Maker Project Practice, we could practice what we have learned and flexibly apply the principles of automobile science, as taught by our teachers, to solve our problems." (SI030103)

> "We have learned the actuation principle of the brake system and the causes and solutions of brake failure." (SI060102)

> "The difficulty we encountered in Maker Project Practice is that it took a lot of time to produce works in different fields." (SI090102)

(3) PBL Works Presentation – Student-centered Maker Project Practice Knowledge Learning Program, which Emphasizes the Presentation of Students' Cooperative Learning Achievements

This project course was taught mainly by PBL and was student-centered. Students were guided to complete a creative design of a fuel saving device through group cooperative learning and practical operation, in order to cultivate their abilities in Maker Project Practice and problem solving. For example, through discussion, design, production, functional verification, and other procedures of Maker Project Practice, the case students managed to complete the physical work of an "automatic idling stop device with a super capacitor", as shown in Fig. 4. In Maker Project Practice, students were trained to strengthen their practical application of their fuel saving device design, learn extracurricular knowledge and skills through team cooperation and interactive exchanges, be willing to face the issues of fuel saving, consider the methods to reduce the idle running time of vehicles, and create their own project works, in order to achieve the effect of saving fuel and reducing carbon emissions.

> "Our strategy for completing Maker Project Practice is to identify problems first, understand them deeply, think about solutions, and complete the production and validation of the finished products of the project." (SI020104)

> "When we encountered problems in Maker Project Practice, we usually tried to solve them through net-

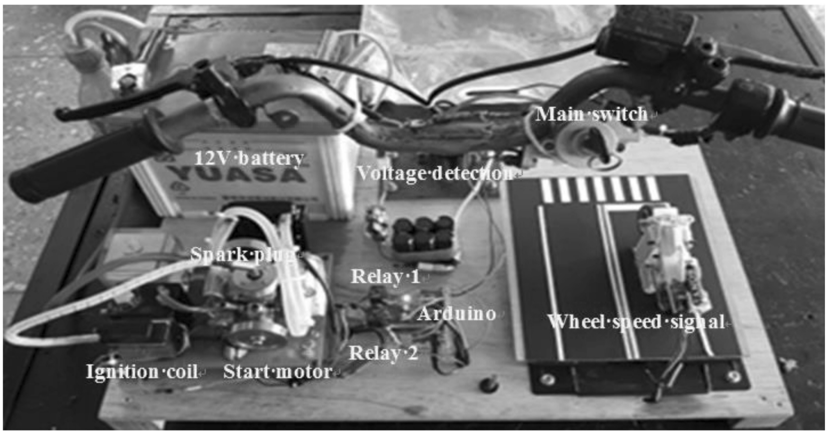

Fig. 4. Finished Product Model of Automatic Idling Stop Device.

work searching, seeking help from our tutors, or consulting university professors." (SI020303)

"I learned how to complete Maker Project Practice, and also improved my ability in project presentation." (SI020203)

"The strategy in the learning process is to use the knowledge of computers and textbooks to query the desired data." (SI020404)

"I originally would not look up the data on the internet, but always asked the teacher directly. Yet, when I started to make the project, a lot of knowledge was obtained from the network. This is what I learned from this project." (SI010103)

"When we had problems in Maker Project Practice and learning, we tried to solve them by team discussion." (SI100403)

"It is very difficult to verify the function of the finished products of Maker Project Practice because different types of refrigeration chips have different effects. Thus, it takes a lot of time to test repeatedly to find the most suitable configuration. At the same time, it also needs to consider the problem of insufficient cooling." (SI080103)

(4) Substantive Benefits of Student Project Results – Encouraging Students to Participate in National Competitions, and Developing Students' Self-confidence and Practical Experience

The student projects with integrated positive instruction had fruitful results. Students were encouraged to form teams to participate in the "2018 Maker Project Practice Competition of Professional Groups of National Higher Secondary Schools". The case project work of an "automatic idling stop device with a super capacitor", which was completed after continuous discussion and cooperation by the whole group of teachers and students, successfully passed the preliminary, intermediary, and final contests, and won first prize in the Power Mechanical Engineering Group of the project.

5. Discussions and Suggestions

Based on the above results, this study came to the following discussions and suggestions:

5.1 Discussions

(1) Among the dimensions of the flow experience of Maker Project Practice, most students in the higher vocational school experienced significantly higher "inner satisfaction" than "unity of knowledge and practice"

Through research and analysis, it is known that, after the "Maker Project Practice" course was completed, it was easy for the students to have "inner satisfaction", which was significantly higher than the "unity of knowledge and practice", indicating that students were prone to be immersed in the teacher' s positive instruction style, manner, and attitude. Moreover, they would learn from scratch in a progressive manner through repeated operation and learning; on the contrary, in the process of "Maker Project Practice", they did not care too much about whether or not the work was professional or perfectly presented.

(2) Most students in the higher vocational school obtained significantly higher scores in the post-test of "flow experience" than in the pre-test after taking the "Maker Project Practice" course applying positive instruction.

The results of this study show that, after taking the "Maker Project Practice" course applying positive instruction, juniors of higher vocational education had significant improvement in the dimensions and overall outcome of "flow experience", indicating that students made progress in the learning process, and could complete their project works in a happy learning atmosphere where both "Maker Project Practice" and the learning process were presented.

They could actively participate in the learning of the "Maker Project Practice" course of fuel saving education in a positive instructional atmosphere full of happiness, joy, self- forgetfulness, and love.

(3) After taking the "Maker Project Practice" course applying positive instruction, most students in the higher vocational school obtained significantly higher scores in the post-test of "fuel saving literacy" than in the pre-test.

The results of this study show that, after taking the "Maker Project Practice" course applying positive instruction, juniors of higher vocational education made significant improvements in the dimensions and overall outcome of "fuel saving literacy", indicating that students had better learning outcomes regarding "fuel saving literacy" in the learning process. The research results also show that, in the process of "Maker Project Practice", regardless of any problems encountered during practice, including learning difficulties and lack of professional ability, the students learned to search the Internet by themselves or discuss with each other in the group, and finally, seek help from teachers or professors if necessary. Most students also started to actively care about the relevant knowledge issues regarding fuel resources and gained a positive learning attitude and greater value motivation. The activities guided the students to effectively improve their "fuel saving literacy" and "Maker Project Practice" through peer-to-peer learning.

5.2 Suggestions

Based on the results of this study, the following suggestions are put forward for the future practice teaching of "Maker Project Practice" courses.

(1) Schools should actively promote a positive instruction environment and practical teaching.

This study found that most students expressed positive affirmation for practical teaching that applies positive instruction. Therefore, schools should integrate positive instruction into curriculum planning, provide positive instruction cases, encourage positive thinking and positive emotional strategies, impart students with positive energy, and provide students with a learning environment that features positive instruction for learning in a happy mood.

(2) Make plans to improve teachers' capability of positive instruction and fuel-saving literacy to enhance their energy and counseling effectiveness

A course with positive instruction can effectively improve the students' learning outcomes in obtaining the knowledge and skills related to the curriculum. Therefore, it is suggested that teachers should develop their positive thinking ability and literacy improvement plans, such as the guidance for Maker Project Practice, inspiring speeches, and the control of class activities, in order to strengthen their basic professional ability, constantly accumulate experiences in teaching PBL, and absorb the experience of experts and scholars. Furthermore, teachers could improve their counseling abilities in positive instruction and fuel-saving literacy through further studies. In addition, they should conduct frequent self-enrichment and reflection, and hold a positive attitude with positive thinking, in order to guide students to learn positively and stimulate their potential.

6. Conclusion

The results of this study show that students felt happy in learning the "Maker Project Practices" under the teacher's positive instruction strategy. In the process of learning, they were constantly growing and progressing, and could give full play to their infinite creativity. Finally, they managed to finish the project and publish the Maker Project Practice work that won first place in the country, which was a very difficult achievement. It can be seen that, if students can learn in an environment that provides positive instruction and careful guidance, they will surely achieve good results.

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