The Effects of Stem Integrated into Marine Science Issues on Junior High School Students' Learning Motivation, Learning Interest, and Learning Achievement

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Abstract
STEM education is an integrated concept of mixing Science, Technology, Engineering, and Math fields. The purpose of this study was to explore the effects of STEM integrated into marine science issue on junior high school students' learning motivation, learning interest, and learning achievement. The experimental research method was employed. Two classes of ninth graders were selected from a public Junior High School in Keelung. One class is control group (29 students), using traditional teaching method. One class is experiment group (21 students), using STEM integrated into teaching on earth science course. Both classes had 12 lessons about marine science issue for teaching experiment during one month. Research tools consisted of questionnaires about learning motivation and learning interest and used the test to understand students' achievement, of which the data were analyzed by SPSS. Hope the study can prove that the STEM education with features such as collaborative learning, learning by doing, and connecting life experience can increase students' learning motivation, learning interest, and learning achievement of marine science.

Keywords: STEM education, Marine science, Learning motivation, Learning interest, Learning achievement

I. Introduction

1.1 General Background Information

With the rapid development of science and technology, all the countries in the world have entered the "knowledge society" system. The "knowledge workers" who can collate, analyze and innovate the knowledge and information will be important talents in the new century and new society. This critical talent affects the development of the country's economy, and the capabilities it requires are summarized as "critical capabilities in the 21st century," the so-called 4C: "critical thinking and problem solving", " Effective communication "," collaboration and building "," creativity and innovation ".

In response to national development, personnel training needs, the United States National Science Council (NSB) in 1986 proposed STEM teaching mode, in 2014 President Obama promoted "STEM national talent cultivation strategy", by education strategy change to enhance National competitiveness. STEM teaching model is a combination of science, technology, engineering and mathematics. With the aim of design and exploration, the STEM teaching model will solve the problem with scientific technology and scientific thinking. Knowledge and life experience link. On the other hand, students develop good communication skills, teamwork and hands-on skills, as well as independent thinking, with the ability to innovate and create.

Taiwan is an island nation surrounded by the sea, is rich in marine resources. In recent years, the government has paid more and more attention to marine education. In order to cultivate oceanic talents, it is important for the marine education and marine talents cultivation. Therefore, this research takes marine science topics such as marine litter problem which countries attach importance to in recent years as the teaching content, designs teaching flow and teaching material with STEM teaching pattern, and guides students to explore ocean science, analysis and statistical science data, and makes use of technology and technology. Engineering design brain thinking, hands-on devices to solve the problem of marine litter. It also hopes to enhance students' motivation, interest and effectiveness in marine science by discussing exploration, hands-on learning and other learning processes.

1.2 Research Purpose and Questions

In this study, we'll investigate STEM integrates marine science issues on Junior High School Students' learning motivation, learning interest and learning outcomes.
The purpose of the study is as follows:

1. Discuss STEM integration of marine science issues on junior high school students' learning motivation in marine science.
2. Discuss STEM integration of marine science issues on junior high school students' learning interest in marine science.
3. Discuss STEM integration of marine science issues on junior high school students' learning achievement in marine science.

The following questions are addressed in this study:

1. What is the impact of STEM integration of marine science issues on junior high school students' learning motivation in marine science?

2. What is the impact of STEM integration of marine science issues on junior high school students' learning interest in marine science?
3. What is the impact of STEM integration of marine science issues on junior high school students' learning achievement in marine science?

1.3 Interpretation of the Terms

1. Learning Motivation

In this study, marine science learning motivation is measured by the score in the "STEM Integrated into Marine Science on Junior High School Students' Learning Motivation" Scale. The contents include Attention, Relevance, Confidence and Satisfaction. The "STEM Integrated into Marine Science on Junior High School Students' Learning Motivation" scale options are divided into five items: 1 point, 2 points, 3 points, 4 points and 5 points, which are very disagree, disagree, general, agree and agree with each other. Finally, calculated the scale score of the subjects. The higher the score, the higher the level of recognition of the subjects.

2. Learning Interest

In this study, marine science learning motivation is measured by the score in the "STEM Integrated into Marine Science on Junior High School Students' Learning Interest" Scale. It includes the feelings of learning marine science, the cognition of learning marine science and the performance of learning marine science. The "STEM Integrated into Marine Science on Junior High School Students' Learning Interest" scale options are divided into five items: 1 point, 2 points, 3 points, 4 points and 5 points, which are very disagree, disagree, general, agree and agree with each other. Finally, calculated the scale score of the subjects. The higher the score, the higher the level of recognition of the subject

3. Learning Achievement

This research is based on the publication of "Tidal Environment Monthly" published by National Marine Science and Technology Museum (2014,01), "Little Duckling Team Surrounded by the World" (2013), Higher Education Publication (edited by National Taiwan Ocean University) (2012), "One Ocean" (2012) Guide to environmental literacy and foreign language literature and 95 to 104 years of high school test topic content, divided into two parts, one for the choice of test Part, are single-choice questions; two for the concept of the book to write part of the list of 50 marine scientific concepts vocabulary students to check, in accordance with the content of the class and the marine vocabulary known in the table to do 5 questions proposition sentences, each proposition sentences A minimum of 2 vocabulary should be included in the questionnaire. The latter is graded according to three dimensions of Stoddart et al. (2000) openness proposition: correctness, interpretability, and propositional structure. Each dimension has a maximum of 5 points and a minimum of 0 points.

(1) correctness: according to "scientific correctness", "general knowledge", "affective", "incorrect" four options to determine the points.

(2) Explanatory: According to "high interpretation", "descriptive" two options to determine the points.

(3) proposition structure: According to the "double", "simple" two options to determine the points.

Examples of scoring are shown in Table 1.

Table 1

Examples of scoring

Variables	classification	Examples	score
correctness	Scientific correctness	The deeper the water, the lower the light transmittance.	5
	General knowledge	Corals live in the sea.	3
	Affection	The lionfish is beautiful.	1
	Inaccuracy	Crocodiles are fish.	0
Explanatory	Highly explained	Sea-level rise is mainly caused by ocean warming sea warming, resulting in rising sea. In addition, the sea iceberg melting will not lead to sea-level rise. But melting glaciers on land or ice sheets will cause sea-level rise.	5
	Descriptive	Deep-sea fish have a lantern-like light body.	3
proposition structure	Duplex	Cetaceans are marine animals.	5
	Simple type	There is fish in the sea.	3
total			0～15

1.4 Method

1. Quasi-Experimental Research

In this study, quasi-experimental study method, including four types of variables: the independent variable, covariant, control variables and dependent variables. The experimental group was given STEM teaching and the control group was taught by narrative style. The covariant term is a variable enough to affect the experimental results, and the influence of the statistical control method of the covariant analysis is eliminated to minimize the experimental error. The covariant items in this study are learning motivation, learning interest scale and learning achievement Pre-test scores and the results of the previous semester's Earth Science Achievement Test. The control variable is to reduce the other factors interfere with the experiment, must be controlled factors, the study for the student level, teaching time, teaching materials, teaching progress and teaching. There are three dependent variables, including marine science learning motivation, marine science learning interest, marine science learning effectiveness.

2. Questionnaire Method

In order to understand the impact of STEM integration into marine science on learning motivation, learning interest and learning achievement, the first draft of the questionnaire was compiled according to the results of literature analysis, and the students in the ninth grade of public middle school in Keelung City were selected as subjects. Scale "and" Marine Science Learning Outcomes Questionnaire ". After the consultation by the expert opinion and pre-test results and revised to prepare a formal

questionnaire survey.

II. Literature Review

2.1 STEM Education

STEM education was first originated in 1986 the United States. In the 1980s, the United States realized that the shortage of science and technology education caused the shortage of talents in the country. In 1986, the United States National Science Board (NSB) proposed the concept of STEM education integrated by science, technology, engineering and mathematics.The purpose is to train scientific and technological talents to enhance the national competitiveness (Liu Dong, Wu Junjie, Xie Zuoru, Juan, 2013). In 2001, the United States "no children lag behind" the concept of prevalence, more emphasis on the US government to promote STEM education motivation. In 2006, the US Competitiveness Program considered the development of STEM talent as the goal of today's knowledge-based economy and the key to national competitiveness (united states domestic policy council, 2006). US President Barack Obama in 2014, the implementation of "STEM national talent cultivation strategy", highlights the US government emphasis on STEM education upgrade.

With the advent of the new generation, the traditional teaching mode can not meet the needs of national talent cultivation. Although the current mode of education in Taiwan is gradually changing, the majority of teachers are still teaching and learning as the main target.Teachers to teach students to test, students in order to test and learn, the knowledge can not be applied flexibly in daily life and future work, resulting in students can not successfully enter the workplace after graduation, the workplace shortage of talent after another. The main purpose of STEM education is to help students move away from fragmented and fragmented learning and memorizing processes, transforming the knowledge and mechanical processes learned by students into a process of exploring the interconnectedness of different worlds (Zhao Zhongjian, 2012: While education). STEM education is different from the previous sub-class, and inter-disciplinary approach to the integration of teaching. Division teaching easy to make students can not be all subjects of knowledge coherence, application, thinking is also more closed. Students can apply their knowledge to various fields, so that students brainstorming, to promote thinking, enhance innovation, creativity, creativity. In addition, STEM education emphasizes the link between theory and real society and life experience, which will enable students to improve learning motivation and interest, and work smoothly with the work. On the other hand, STEM education emphasizes teamwork, in order to cope with future employment trends, in the group discussion to learn the division of labor, mutual cooperation, good communication, but also implement the "No child left behind" educational philosophy. Finally, STEM education, interdisciplinary integration, and life experience, teamwork and other teaching characteristics, and then with the core of STEM education - hands-on, so that students can become key capabilities with the 21st century - critical thinking and problem-solving, effective communication, The team to create, create and innovate the future of national talent.

In this study, STEM was integrated into the marine science topic. The experimental teaching of the ninth grade students was supplemented by questionnaire and questionnaire.

2.2 The Meaning of Marine Science Education

In recent years, the world in science and technology continue to explore the ocean to explore their ability to enhance the understanding of marine ecology and the environment, in order to respond to the 21st century "blue revolution", Taiwan's economy towards knowledge-based economy and innovation in economic development, marine-related industries Began to transition, the traditional marine industry gradually developed into the experience of service-oriented or high-tech industries, so the needs of professionals in the industry needs and the original content is also different. The development of marine education in Taiwan, hoping to strengthen the school students at all levels of marine literacy, and then cultivate the industry needed high-quality talent (Ministry of Education, 2007).

At the primary and secondary levels, marine education is based on marine basic education knowledge, and its implications are mainly in the areas of natural and applied science (Ministry of Education, 2007). In 2008, the Ministry of Education promulgated the "Nine-Year Curriculum for National Primary and Secondary Schools" (Marine Education), which divides marine education into five thematic axes - marine recreation, marine society, marine culture, marine science and marine resources (Ministry of Education, 2008). It is hoped that students will be able to improve their marine scientific literacy through marine science education, so that students will learn to use the principles and skills of marine science and technology to solve their daily problems in the process of solving problems (Luo Lunxin, Zhang Zhengjie, Tong Yuanpin, Yang Wenzheng, 2013).

The marine science education defined in this study refers to the marine science education in the oceanic subject axis (marine recreation, maritime society, marine culture, marine science, marine resources) of the "Outline of marine education for national primary and secondary schools" proposed by the Ministry of Education in 2008. Marine Science and Ocean Resources. Its sub-categories include "Marine Geology and Chemistry", "Marine Geology and Geology", "Marine Meteorology", "Marine Applied Science", "Marine Foods", "Biological Resources", "Non-living Resources", "Environmental Protection and Conservation "(Ministry of Education, 2008).

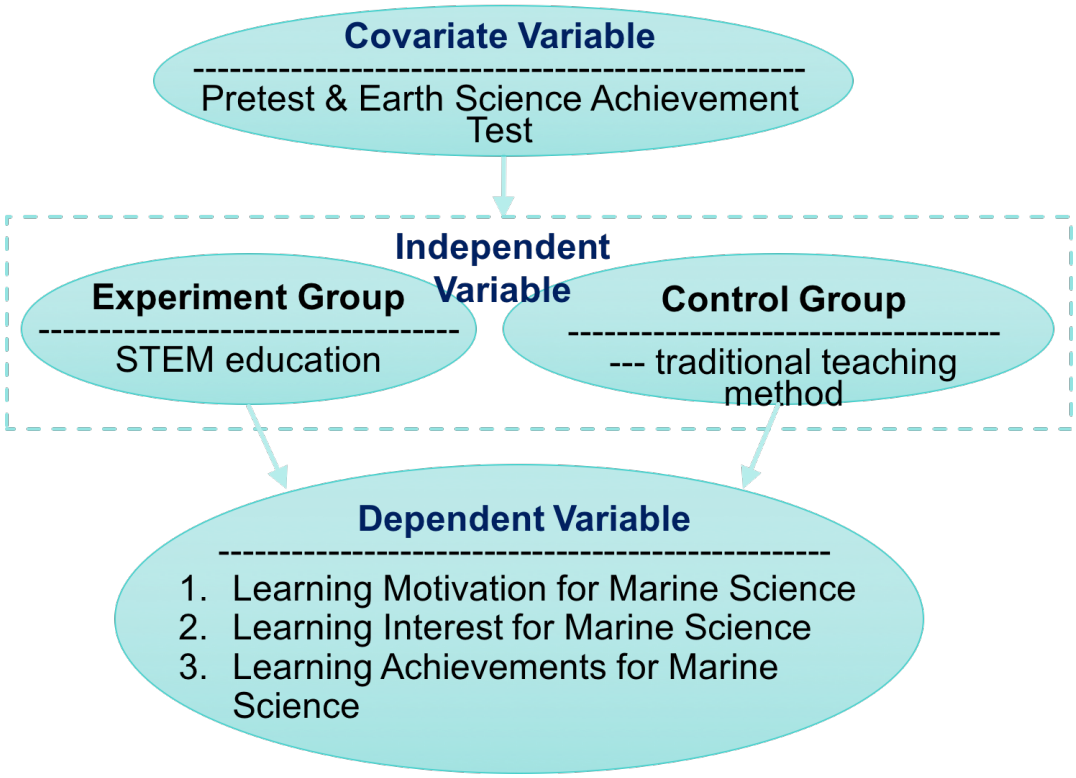
III. Research Design

3.1 Research Framework

The purpose of this study is to understand the impact of integrating STEM education into marine science topics on the learning motivation, learning interest and learning outcomes of junior middle school students. The experiment group and the control group were designed. The experiment group used the STEM teaching mode, and the control group adopted the traditional general teaching method. The two groups were tested before the experiment as the basis. The structure of this study is as follows:

Figure 2

STEM into the marine science issues on the students learning motivation, learning interest and learning effectiveness of the impact of the structure diagram.



3.2 Research Subjects

In this study, a group of 9 students in a public middle school in Keelung City were enrolled in this study. There were 20 subjects in the experimental group and 27 in the control group.

3.3 Research Instrument

According to the purpose and problem of this study, the research tools used were "STEM Teaching Program", "Narrative Teaching Program", "Marine Science Learning Motivation Scale", "Marine Science Learning Interest Scale" And "Marine Science Learning Achievement Test Questions - Selection Question and Concept Map Assessment". The following is a description of the research tools.

3.3.1 STEM Teaching Program

The STEM Teaching Program was designed by the present researchers and implemented in the Earth Science course in the ninth semester of the middle school year. The purpose of the course is to enable students to learn marine science knowledge from life experiences and apply the knowledge acquired in past biology, physics and chemistry, mathematics and life science and technology courses. In the classroom, a cooperative learning and reward system will be adopted and students will be encouraged to create a "trash bin" device in the hope of enhancing students' learning motivation, learning interest and learning through interdisciplinary integration, group discussion and publication and hands-on learning. Effectiveness.

Teaching implementation phase of six weeks, two sessions per week, a total of twelve classes. The first week is "The importance of the ocean, the relationship between the sea and the human race", the second week is "ocean currents and circulation", the third week is "exploring marine litter", the fourth week is "marine trash knowledge and influence" And the sixth week as "hands-on preparation of marine trash," to guide

students to think and discuss issues, develop students good communication, use the knowledge to solve problems and hands-on ability.

3.3.2 Narrative Teaching Program

In addition to the different teaching methods, the rest of the conditions are the same, the same six-week course, but also the use of cooperative learning and incentive system . But the curriculum design does not emphasize the relevance of curriculum knowledge and life experience, but also not included in mathematical computing, biological knowledge and hands-on content.

3.3.3 Marine Science Learning Motivation Scale

This research tool is based on the dimensions of a certain research scale, and then develops the marine science learning motivation scale of this research. The scale was based on the Likert Five-Point Scale, and students chose "very agree", "agree", "normal", "disagree" or "strongly disagree" according to the topic. The scale contains four dimensions, Attention, Relevance, Confidence, and Satisfaction.

(1) Expert review: After the preparation of the first draft of the research tool, in order to improve the content of the letter and effect, discussed with the instructor, compiled into an expert questionnaire. First, the expert validity questionnaires are printed to explain the purpose, structure and method of the study. Five experts and five middle school teachers are invited to the field of marine sciences education. In view of the content, title and description of the questionnaire, to provide advice, recovery expert validity questionnaire, and then in accordance with the evaluation of scholars and teachers to provide the views of the aggregation, after confirmation of the preparation is completed, then pre-test.

(2) Pre-test: In this study, the learning motivation scale pre-test selection of experimental group and control group of students outside the pre-test, issued a sample of 122, 122 were recovered, the recovery rate of 100%.

(3) Validity: In order to understand the construction validity of the learning motivation scale, the scale was analyzed by factor analysis. The Kaiser-Meyer-Olkin (KMO) sampling suitability and the Bartlett's spherical test show that the scale can be analyzed by factor analysis. According to Kaiser (1974), if the KMO value is less than 0.5, (Wu Minglong, 2009), the results of the scale of the KMO sampling suitability for the number of .938, shows that the number of samples is sufficient, and Bartlett's spherical test of significant (see Wu Minglong, 2009) , Showing that the factors between the mutually exclusive exclusion, it can be factor analysis.

(4) In this study, Cronbach's α coefficient was used to test the internal consistency of the scale and subscale. The Cronbach's α value of the formal pre-test questionnaire was: (1) Attention 0.876 (2) Relevant 0.851 (3) Confidence 0.839 (4) Satisfied with 0.921, the total scale was 0.952, all above .83, so the scale internal consistency can be accepted.

Table 2
The Reliability of Learning Motivation

Dimensions	αValue	Number of questions
Attention	.876	5
Related	.851	4
Confidence	.839	3
Satisfy	.921	5
Total	.952	17

3.3.4 Marine Science Learning Interest Scale

The Likert 5-point scale was used in this study. Students chose "very agree", "agree", "normal", "disagree" or "strongly disagree" according to the topic. This scale includes 11 topics, namely, "feelings of the ocean", "knowledge of the sea" and "performance of the department." This scale was reviewed together with the Marine Science Learning Motivation Scale. After the deletion of the unsuitable items, the questionnaires were compiled into a formal questionnaire and pre-tested in conjunction with the Marine Science Learning Motivation Scale. The following is the reliability and validity of this scale:

(1) Validity: The scale of the KMO sampling suitability of the amount of .916, shows the number of samples is sufficient, and Bartlett's spherical test of significant, showing the independent mutex between the various factors, it can be factor analysis.

(2) Reliability test: Cronbach's α value of the formal pre-test questionnaire in the three-dimensional study of the sea of interest, respectively (1) the feelings of the ocean feelings 0.882 (2) of the marine knowledge 0.954 (3) marine scientific performance 0.875, the total scale of 0.932, are up to .88 or more, so the scale internal consistency can be accepted.

Table 3
Reliability of learning interest scale

Dimensions	αValue	Number of questions
Feelings about the ocean	.882	3
Cognition of marine science	.954	4
Action to marine science	.875	4
Total	.932	11

To sum up, this study of learning motivation, learning interest scale letter appropriate degree, as shown in the table below.

Table 4
The variables and their facets were studied, and the statistical tables of variance and reliability were extracted.

Study Variables	Dimensions	Extraction Variance	Combined Reliability
Marine Science Learning motivation	Attention	0.8199	0.9578
	Related	0.8227	0.9329
	Confidence	0.8040	0.9249
	Satisfy	0.8254	0.9594
Marine Science Learning interest	Feelings about the ocean	0.7762	0.9121
	Cognition of marine science	0.8284	0.9507
	Action to marine science	0.7452	0.9221

3.3.5 Marine Science Learning Achievement Test Questions - Selection Question and Concept Map Assessment

This research tool is based on the "Tidal Environment" (2014,01) published by the National Marine Science and Technology Museum, the "Little Duckling Team Surrounded by the World" (2013), published by Higher Education (edited by National Taiwan Ocean University Professor) (2012), National Geographic published "One Ocean" (2012) environmental literacy teaching guide foreign language literature and 95 ~ 104 years high school learning topic content development. The questionnaires are divided into two major parts. They are: (1) Marine Science Learning Outcomes Questionnaire - 15 questions, divided into three major dimensions: "Memory", 4 questions, "Understanding", 4 questions, Thinking, "including application, analysis, evaluation and creation, 7 questions. (2) Questionnaire of marine science learning performance - concept map type, divided into three major dimensions: "correctness", "explanatory", "proposition structure".

After the preparation of the first draft of the above research tools, in order to improve

the content of the letter and effect, after discussion with the instructor, compiled into an expert questionnaire. First, the expert validity questionnaires are printed to explain the purpose, structure and method of the study. Five experts and five middle school teachers in the field of marine sciences education are invited to study the content, title, and description of the questionnaire. To provide advice, recovery expert validity questionnaire, and then in accordance with the evaluation of scholars and teachers to provide the views of the aggregation, after confirmation of the preparation is completed, then pre-test. Pre-test sample to 122 ninth-grade students for the object, the project analysis to delete the inappropriate subject, compiled into a formal questionnaire.

IV. Results and Conclusions

4.1 Students with STEM education have high learning motivation then the students with traditional teaching method.

4.1.1 Descriptive statistics

According to the differences of learning motivation scale between the experimental group and the control group, the descriptive statistics obtained by collecting the related data are shown in the table.

Table 5

The statistical summary table of learning motivation in the experimental group and the control group.

Dimensions	Category	Number of people	Average	Number of questions	Standard deviation
Attention	Experimental group	20	18.850	5	2.8704
	Control group	27	17.519	5	4.7747
Related	Experimental group	20	15.100	4	2.1250
	Control group	27	13.963	4	3.4023
Confidence	Experimental group	20	12.050	3	1.6051
	Control group	27	10.852	3	2.9313
Satisfy	Experimental group	20	17.350	5	3.4531
	Control group	27	15.926	5	4.8984
Total	Experimental group	20	63.350	17	7.9556
	Control group	27	58.259	17	14.8650

The data in the table shows that the average score of the experimental group in each dimension is higher than that in the control group.

4.1.2 Single Factor Covariant Analysis

For the experimental group and the control group of students learning motivation scale before the test results for the covariates to teaching method for the self-variable, post-test scores for the dependent variable, for single factor covariance analysis, the results are listed in the table, ($F = 4.216$, $p = .046 < .05$), so the hypothesis "experimental group and control group in the attention of the score was no significant difference between the two groups," the study group and the control group in the "learning motivation" Should be rejected. ($F = 5.771$, $p = .021 < .05$). Therefore, the null hypothesis "There was no significant difference in the score between the experimental group and the control group" should be rejected. ($F = 3.752$, $p = .059 > .05$), so the null hypothesis "the experimental group and the control group in the application of the score was no significant difference" should be accepted. ($F = 5.768$, $p = .021 < .05$), the null hypothesis "There was no significant difference in the satisfaction score between the experimental group and the control group" should be rejected. ($F = 5.871$, $p = .020 < .05$), the null hypothesis "There was no significant difference in the total score between the experimental group and the control group" should be rejected. Statistical test results The results of the experimental group and the control group were significantly different in the "attention", "relevant", "satisfaction" and "total score", and the experimental group's performance was better than the control group, only "confidence" did not reach significant difference , Indicating that STEM into marine science on the students in the learning motivation has good results.

Table 6

The covariance analysis of learning motivation between experimental and control groups.

Dimensions	Source of variation	Type III squared sum	Degree of freedom	Average sum of squares	F value	Sig
Attention	Between groups (teaching method)	82.260	1	82.260	4.216	.046*
	Group (deviation)	858.545	44	19.512		
Related	Between groups (teaching method)	55.093	1	55.093	5.771	.021*
	Group (deviation)	420.033	44	9.546		
Confidence	Between groups (teaching method)	25.015	1	25.015	3.752	.059
	Group (deviation)	293.393	44	6.668		
Satisfy	Between groups (teaching method)	128.106	1	128.106	5.768	.021*
	Group (deviation)	977.238	44	22.210		

Total	Between groups (teaching method)	1140.390	1	1140.390	5.871	.020*
	Group (deviation)	8545.901	44	194.225		

*$p < .05$ **$p < .01$ ***$p < .001$

4.2 Students with STEM education have high learning interest then the students with traditional teaching method.

4.2.1 Descriptive statistics

According to the differences of learning interest scale between the experimental group and the control group, the descriptive statistics obtained by collecting the related data are shown in the table.

Table 7

The statistical summary table of learning interest in the experimental group and the control group.

Dimensions	Category	Number of people	Average	Number of questions	Standard deviation
Feelings about the ocean	Experimental group	20	10.300	3	1.5252
	Control group	27	9.815	3	1.8195
Cognition of marine science	Experimental group	20	15.500	4	2.3283
	Control group	27	14.074	4	3.4633
Action to marine science	Experimental group	20	13.950	4	2.2355
	Control group	27	13.148	4	3.1096
Total	Experimental group	20	39.750	11	4.5408
	Control group	27	37.037	11	7.2985

The data in the table shows that the average score of the experimental group in each dimension is higher than that in the control group.

4.2.2 Single Factor Covariant Analysis

For the experimental group and control group students learning interest scale before the test results for the covariates to the teaching method for the self-variable, post-test scores for the dependent variable, for single factor covariance analysis, the results are listed in the table, that There was significant difference between the experimental group and the control group ($P = .009 < 0.01$) in the " feelings about the ocean " in the "learning interest", so there was no hypothesis that the experimental group and the control group Shall not be significantly different "shall be rejected. ($F = 4.711$, p

= .035 <.05), the null hypothesis "There is no significant difference between the experimental group and the control group in the recognition of the marine sciences" should be rejected . (F = 3.705, p = .061> .05), the null hypothesis "There was no significant difference between the experimental group and the control group in their scores on the performance of the marine sciences" Should be accepted. (F = 6.320, p = .016 <.05), the null hypothesis "There was no significant difference in the total score between the experimental group and the control group" should be rejected. Statistical test results The results of the experimental and control groups were significantly different in terms of " feelings about the ocean ", " cognition of marine science " and "total score", and the results of the experimental group were superior to those of the control group. "action to marine science "did not reach significant differences, indicating that STEM into marine science on the interest of students in the study have good results.

Table 8.
The covariance analysis of learning interest between experimental and control groups

Dimensions	Source of variation	Type III squared sum	Degree of freedom	Average sum of squares	F value	Sig
Feelings about the ocean	Between groups (teaching method)	31.177	1	31.177	7.434	
	Group (deviation)	184.524	44	4.194		
Cognition of marine science	Between groups (teaching method)	48.520	1	48.520	4.711	
	Group (deviation)	453.129	44	10.298		
Action to marine science	Between groups (teaching method)	34.940	1	34.940	3.705	
	Group (deviation)	414.970	44	9.431		
Total	Between groups (teaching method)	339.313	1	339.313	6.320	
	Group (deviation)	2362.461	44	53.692		

**p <.05 **p <.01 ***p <.001*

4.3 Students with STEM education have high learning achievement then the students with traditional teaching method.

4.3.1 Descriptive statistics
According to the differences of learning achievement scale between the experimental group and the control group, the descriptive statistics obtained by collecting the related data are shown in the table.

Table 9
The statistical summary table of learning achievement test (1) in the experimental group and the control group.

Dimensions	Category	Number of people	Average	Number of questions	Standard deviation
Memory	Experimental group	20	3.200	4	1.0563
	Control group	27	3.370	4	.9667
Understanding	Experimental group	20	2.900	4	.7182
	Control group	27	3.074	4	.9168
High-level applications	Experimental group	20	4.800	7	1.6416
	Control group	27	3.593	7	1.8451
Total	Experimental group	20	10.900	15	2.8266
	Control group	27	10.037	15	2.6527

From the data in the table, the experimental group in the high-level and total score of the average score, higher than the control group.

Table 10
The statistical summary table of learning achievement test (2) in the experimental group and the control group.

Dimensions	Category	Number of people	Average	Number of questions	Standard deviation
Correctness	Experimental group	20	43.650	15	8.5918
	Control group	27	34.815	15	12.5852
Explanatory	Experimental group	20	34.100	15	2.7891
	Control group	27	32.852	15	3.1219
Proposition structure	Experimental group	20	46.650	15	7.7614
	Control group	27	38.407	15	8.9968
Total	Experimental group	20	124.400	15	16.7061
	Control group	27	106.074	15	22.8135

The data in the table shows that the average score of the experimental group in each dimension is higher than that in the control group.

4.3.2 Single Factor Covariant Analysis

For the experimental group and the control group of students learning achievement (a) before the test scores for the covariates to teaching method for the self-variable, post-test scores for the dependent variable, for single factor covariance analysis, the results are listed in the table, ($F = 0.317$, $p = .576 > .05$) .Therefore, there is no hypothesis in experiment group and control group in the memory of "learning achievement (a)", and the difference between the experimental group and the control group is not significant No significant difference in score "should be accepted. ($F = 0.193$, $p = .663 > .05$), so the null hypothesis "experimental group and control group in understanding the score was no significant difference" should be accepted. ($F = 10.824$, $p = .002 < .01$), the null hypothesis "There was no significant difference in the high-level score between the experimental group and the control group" should be rejected. ($F = 4.319$, $p = .044 < .05$). Therefore, the null hypothesis "There was no significant difference in the total score between the experimental group and the control group" should be rejected. Statistical test results The scores of the experimental group and the control group were significantly different between "high level" and "total score", and the scores of the experimental group were better than the control group, only "memory" and "understanding" did not show significant difference, Integration into the marine science on the students in the learning results have good results.

Table 11
The covariance analysis of learning achievement test (1) between experimental and control groups

Dimensions	Source of variation	Type III squared sum	Degree of freedom	Average sum of squares	F value	Sig
Memory	Between groups (teaching method)	.312	1	.312	.317	.576
	Group (deviation)	43.246	44	.983		
Understanding	Between groups (teaching method)	.136	1	.136	.193	.663
	Group (deviation)	31.037	44	.705		
High-level applications	Between groups (teaching method)	35.773	1	35.773	10.824	.002**
	Group (deviation)	145.412	44	3.305		
Total	Between groups (teaching method)	33.882	1	33.882	4.319	.044*
	Group (deviation)	345.218	44	7.846		

*$p < .05$ **$p < .01$ ***$p < .001$

Table 12
The covariance analysis of l learning achievement test (2) between experimental and control groups

Dimensions	Source of variation	Type III squared sum	Degree of freedom	Average sum of squares	F value	Sig
Correctness	Between groups (teaching method)	658.060	1	658.060	27.227	.000***
	Group (deviation)	1063.434	1	24.169		
Explanatory	Between groups (teaching method)	34.814	1	34.814	4.210	.046*
	Group (deviation)	363.897	44	8.270		
Proposition structure	Between groups (teaching method)	665.255	1	665.255	18.489	.000***
	Group (deviation)	1583.175	44	35.981		
Total	Between groups (teaching method)	4151.345	1	4151.345	51.291	.000***
	Group (deviation)	3561.267	44	80.938		

*$p < .05$ **$p < .01$ ***$p < .001$

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