A Survey and Study on Interdisciplinary Learning Attitudes of Primary School Students under the STEM Education Concept

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Abstract : This study draws on the Interdisciplinary Learning Attitudes Scale developed by Eric Wiebe's team, which includes math, science, engineering and 21st Century skills. Based on 714 primary school students from grade 4 to Grade 6, the research results show that students who have had interdisciplinary learning experience are more interested in interdisciplinary learning, and the overall attitude of primary school students toward interdisciplinary learning tends to be positive. The study also found that elementary school students were less likely to pursue STEM-related careers in the future, while boys were more likely to pursue STEM careers than girls were. At the same time, there is no significant difference in the overall interdisciplinary learning attitude of primary school students in gender, but there is a significant difference in the learning attitude of mathematics and engineering technology. In terms of overall interdisciplinary learning attitude, the interdisciplinary learning attitude of the third grade is more positive than that of the sixth grade.

Keywords: STEM Education; Interdisciplinary; Learning Attitude; Interdisciplinary Learning Attitude; Questionnaire Survey

1 Research Background

The new curriculum plan and curriculum standards issued by the Ministry of Education of China in April 2022 clearly require that “all disciplines use no less than 10% of the class hours to design interdisciplinary theme learning”, which reflects the clear orientation of the new curriculum standard - interdisciplinary learning[1]. In the 2022 edition of Science Curriculum Standards for Primary Schools in Compulsory Education, it is proposed that in terms of optimizing curriculum content, interdisciplinary thematic learning activities should be set up to strengthen the correlation between disciplines, drive the comprehensive implementation of curriculum, and strengthen practical requirements[2]. In February 2023, the General Secretary emphasized the addition of science education in the "double reduction" of education[3]. In May of the same year, the Opinions of 18 departments including the Ministry of Education on Strengthening Science Education in Primary and Secondary Schools in the New Era were released, which clearly proposed the overall planning of science education and engineering education and expanded the content and learning methods of science education from the perspective of interdisciplinary education[4]. It can be seen that cultivating students' interdisciplinary ability has become an important goal of basic education. However, at present, there are few researches on the interdisciplinary learning attitude of primary and secondary school students. Through investigation and analysis of the interdisciplinary learning attitude and its influencing factors, this study is expected to provide certain reference value for the interdisciplinary education and teaching of Chinese primary and secondary school students.

2 Research Status

At present, more and more educators begin to pay attention to interdisciplinary learning attitudes. Song Yi (2020) 's research shows that primary school students' attitude towards STEM learning is generally positive, but their attitude towards STEM careers in the future is at an average level, and boys' attitude towards STEM learning and work is much better than girls'[5]. The research of Zhang Yanjun (2020) shows that students' attitude towards STEM

learning has a very important impact on their future development direction of STEM career, and the influence of gender, grade and teachers on students' attitude towards STEM is both common and different in different provinces[6]. Students generally show high interest and positive attitude towards interdisciplinary learning, and they are keen to acquire more comprehensive knowledge through interdisciplinary learning. The emphasis in the education system on developing students' comprehensive abilities and innovative thinking also promotes students' positive attitude towards interdisciplinary learning. For STEM teacher training, Price,J (2010) found that the subject background and gender of teachers would have an impact on students' STEM learning[7].

In general, there are few studies on the interdisciplinary learning ability of primary school students, and further in-depth research on the interdisciplinary learning attitude of primary school students is needed.

3 Research Design

This study refers to the STEM learning attitude scale compiled by Eric Wiebe's team (2000), which includes four dimensions of mathematics, science, engineering technology and 21st century skills[8]. Studies have shown that expectation and value can predict career choice, and expected value theory and self-efficacy theory can effectively complement each other when investigating career ideal and career path adherence[9].

The questionnaire in this study was scored using five-point Likert scale. The questionnaire was divided into two parts. The first part included the basic information of the respondents, students' participation in interdisciplinary learning activities and their interest in interdisciplinary learning. The second part is STEM learning attitude, with a total of 20 questions from four dimensions, namely, mathematics learning attitude (1, 2, 3, 4, 5), science learning attitude (6, 7, 8, 9, 10), engineering learning attitude (11, 12, 13, 14, 15), and 21st century skill learning attitude (16, 17, 18, 19, 20). The influencing factors include grade and gender, and the assessment of the influencing factors and interdisciplinary learning attitude is conducted in the form of a scale. According to Likert scale, each question has five options, which are divided into strongly disagree, disagree, uncertain, agree and strongly agree, and are assigned 1 to 5 points respectively.

3.1 Data Source and Reliability and Validity Analysis

In December 2023, a total of 800 paper questionnaires were issued to primary school students in grades four to six in Zhanjiang City, of which 44 had been eliminated, with an effective rate of 94.5%. Among the 714 questionnaires effectively recovered, 370 and 344 were male and female students, and 239, 236 and 239 were students in grades four to six, respectively.

Cronbach's α coefficient was used to evaluate the reliability of the measurement tool. The validity and reliability of 42 valid questionnaires were analyzed. Cronbach's α coefficient is calculated for four dimensions of mathematics, science, engineering technology and skill learning attitude in the 21st century. Cronbach's α of all subscales exceeded 0.8, and the reliability of the total scale exceeded 0.9, indicating good internal consistency of the scale. Through KMO test, it is found that the KMO values of each subscale and total scale are between 0.7 and 0.9, indicating that the variance of the data has a high correlation.

4 Data Analysis

4.1 The Impact of Participation in Interdisciplinary Learning Activities on Interdisciplinary Learning Interest

Table 1. Analysis of the Influence of Participation in Interdisciplinary Learning Activities on Interdisciplinary Learning Interest

Have you been exposed to interdisciplinary learning activities such as scientific and technological creation	Interest in interdisciplinary learning activities				
	Frequency	Mean number	Standard deviation	t	p
Yes	285	4.281	0.915	0.9001	0.000
No	429	3.546	1.266		

It can be seen from Table 1 that among the 714 students, only 285 students have been exposed to project-based learning, scientific and technological creation, popular science

painting, science and technology competition and other interdisciplinary learning activities, and the remaining 429 students have not participated in interdisciplinary learning activities. The independent sample T-test was used to analyze the influence of participation in science and innovation activities on science and technology learning interest. The data showed that the t value was 0.9001 and the P value was less than 0.05, indicating that there was a significant difference in interdisciplinary learning interest in whether or not people participated in interdisciplinary learning activities. Although the number of students participating in interdisciplinary learning activities is less than those who have not participated in it, on the whole, students have a positive attitude towards interdisciplinary learning and have greater interest in interdisciplinary learning activities.

4.2 Analysis of STEM Interdisciplinary Attitudes

It can be seen from Table 2 that primary school students have a positive attitude towards mathematics, science, engineering technology and skills learning in the 21st century (positive attitude refers to the attitude of choosing "agree" and "fully agree", and the concept of positive attitude follows the research of Song Yi and other scholars). Among them, questions 1 and 5 in Table 3 and 10 in table 4 are negative statement questions. When SPSS software is used for data analysis, reverse scoring process is carried out on them.

Table 2. Descriptive Analysis of STEM Learning Attitude Scale of Primary School Students

Survey dimension	Mean ± standard deviation	Variance
Math	3.234±0.910	0.828
Science	3.420±0.798	0.637
Engineering technology	3.522±0.888	0.788
21st century skills	3.687±0.778	0.605
Total schedule	3.466±0.615	0.378

4.2.1 Analysis of pupils' positive attitude towards mathematics

In order to analyze and compare the attitude trend of primary school students towards STEM subjects, the proportion of primary school students with positive attitude towards STEM subjects was counted respectively. The statistical results are as follows (see Table 3-6)

Table 3.Mathematical learning Attitude of Primary School Students Positive Attitude Statistical Table

		Problem 1	Problem 2	problem 3	problem 4	problem 5
Grade	Grade Four	59.8%	59.8%	37.7%	35.1%	59.8%
	Grade Five	61.0%	52.9%	38.1%	29.6%	53.0%
	Grade Six	41.4%	42.6%	28.0%	23.0%	42.7%
Gender	Male	58.4%	27.6%	42.1%	44.3%	53.5%
	Female	49.4%	19.5%	33.1%	28.0%	50.0%

The positive attitude of “Math is my worst subject” (Question 1) and “Math is difficult for me” (question 5) decreases with the increase of grade level. The reason may be that students will encounter more difficult problems in learning math, which affects their positive attitude toward math. The proportion of positive attitude in question 3 “I am good at math" and question 4 "I believe I can do advanced work in math” is low. Although most students do not think math is difficult, few students choose to be good at math. Therefore, it can be seen that students set high standards for “good at math” and think they have room for improvement. And students lack confidence in their ability to perform advanced jobs in mathematics. The low percentage of positive attitudes in question 2, “I will choose a job related to mathematics in the future” indicates that most people are reluctant to pursue a career related to mathematics. From the perspective of gender, boys have higher positive attitude towards math learning than girls, and boys are more willing to engage in math related work.

4.2.2 Analysis of pupils' positive attitude towards science

For question 6, “I feel confident in my academic study” and question 7, “I will consider a career in science”, the proportion of students in Grade 4 is significantly higher than that in grade 5 and 6. Generally speaking,

students are not interested in a career in science. Question 8, “Science helps me make a living” and question 9, “I can learn science well”, there is little difference between grade 4 and grade 5, but the proportion of Grade 6 is significantly lower, which may be that Grade 6 students are facing the pressure of small rise and may pay more attention to the exam-oriented subjects. Question 10, “I can understand other subjects, but it is difficult to understand science”, the proportion of positive attitudes in fourth and sixth grade is significantly lower than that in fifth grade. From the perspective of gender, boys and girls have little difference in the proportion of positive attitudes towards science learning, but boys are slightly more interested in considering a career in science than girls.

Table 4. Statistical Table of Primary School Students' Positive Attitude Towards Science Learning

		Problem6	Problem7	Problem8	Problem9	Problem10
Grade	Grade Four	51.0%	41.7%	51.5%	56.5%	46.0%
	Grade Five	40.3%	30.9%	50.4%	58.5%	57.2%
	Grade Six	39.7%	33.5%	38.5%	42.3%	43.5%
Gender	Male	44.3%	37.6%	46.8%	50.1%	51.1%
	Female	43.0%	34.3%	46.8%	54.4%	49.4%

4.2.3 Analysis of pupils' positive attitude towards engineering technolog

Table 5. Positive Attitude of Primary School Students' Learning Attitude Towards Engineering Technology

		Problem11	Problem12	Problem13	Problem14	Problem15
Grade	Grade Four	56.9%	38.5%	60.0%	46.9%	52.3%
	Grade Five	64.4%	36.0%	59.3%	55.1%	41.5%
	Grade Six	63.2%	35.6%	52.7%	55.2%	40.6%
Gender	Male	65.7%	40.5%	55.4%	58.9%	50.0%
	Female	57.0%	35.5%	56.7%	45.3%	39.2%

For question 11, “I like to imagine the situation of creating new products” and question 14, “I am interested in the working principle of electronic products”, the proportion of positive attitude in grade 4 is lower than that in grade 5 and 6, indicating that with the growth of age, grade 5 and 6 cognitive ability is enhanced, and they are more interested in creating new products and electronic products. Question 12, “I'm good at fixing and making things,” is not a significant grade difference. Question 13, “I hope my future work will use creativity and creative ability”, the difference between grades four and five is not large, and the proportion of grade six is significantly lower. Question 15, “I believe I can succeed in engineering work”, the proportion of positive attitude in grade 4 is significantly higher than that in grade 5 and 6. Except for question 13 “I hope my creativity and creativity will be used in my future work”, male students have a higher proportion of positive attitude than female students in other aspects, which indicates that compared with female students, male students usually have higher exploration desire and spatial cognition ability, and are more willing to engage in engineering work.

4.2.4 Analysis of pupils' positive attitude towards skills in the 21st century

Table 6. Statistical Table of Positive Attitude of Pupils' Skills Learning Attitude in the 21st Century

		Problem16	Problem17	Problem18	Problem19	Problem20
Grade	Grade Four	43.5%	53.6%	56.1%	58.2%	68.7%
	Grade Five	35.6%	66.1%	58.5%	53.4%	66.1%
	Grade Six	38.1%	59.4%	59.4%	56.5%	72.0%
Gender	Male	41.4%	58.1%	52.4%	56.2%	66.5%
	Female	36.6%	61.3%	64.0%	52.8%	71.5%

Question 16, “I believe I can lead others to achieve their goals,” the fourth grade may be in a stage of development with higher self-confidence, less affected by realistic pressures and setbacks, and more optimistic about their own abilities. Question 17, “I believe I can take other people's views into account when making decisions,” showed a

higher proportion of positive attitudes in fifth grade. Question 18, "I am confident that I can make my own learning goals" and question 19, "I believe that I can cooperate well with different students", there is no obvious difference between grades, and students of all grades have a high proportion of positive attitudes. Question 20, "I believe that I can respect the differences of my partners", has a high proportion of positive attitudes in all grades, among which grade 6 has the highest proportion of positive attitudes, indicating that students generally have cooperation and respect for differences. Compared with female students, male students are more likely to believe that they can lead others to achieve their goals and cooperate well with different classmates, while their positive attitude in other aspects is slightly lower than that of female students. Female students are more positive in respecting the differences between partners and setting learning goals.

4.3 Gender Differences in Pupils' Attitudes Towards Interdisciplinary Learning

Table 7. Independent Sample T-Test of Stem Learning Attitudes of Different Genders

Survey dimension	Male(N=370)	Female(N=344)	t	P
Math	3.31±0.93	3.15±0.87	2.34	0.019
Science	3.39±0.83	3.44±0.75	-0.78	0.439
Engineering technology	3.60±0.93	3.43±0.83	2.64	0.009
21st century skills	3.64±0.81	3.73±0.73	-1.58	0.114
Total schedule	3.32±0.61	3.26±0.54	1.207	0.228

As can be seen from the above table, independent sample t test was used to analyze gender differences in mathematics learning attitude, science learning attitude and engineering technology learning attitude, and there were five differences in skills learning attitude in the 21st century. From the above table, it can be seen that male and female attitudes to science learning and attitudes to skills learning in the 21st century are consistent ($p > 0.05$), and there is no difference. However, there were significant differences in the attitudes towards mathematics and engineering technology ($P<0.05$), that is, there were differences in the attitudes towards mathematics and engineering technology between men and women. From the perspective of the overall attitude towards learning, there was no significant difference in the attitude of different genders towards inter-learning learning ($P<0.05$).

4.4 Grade Differences in STEM Learning Attitudes of Primary School Students

Table 8. Non-Parametric Test of STEM Learning Attitudes in Different Grades

Survey dimension		Frequency	Rank mean	Kruskal-Wallis H	P	Multiple comparison
Math	Grade Four	239	403.17	34.407	0.000	Grade Four>Grade Six Grade Five>Grade Six
	Grade Five	236	373.35			
	Grade Six	239	296.18			
Science	Grade Four	239	366.08	5.195	0.074	
	Grade Five	236	375.67			
	Grade Six	239	330.97			
Engineering technology	Grade Four	239	347.94	1.021	0.600	
	Grade Five	236	367.00			
	Grade Six	239	357.69			
21st century skills	Grade Four	239	352.47	0.217	0.897	
	Grade Five	236	360.28			
	Grade Six	239	359.78			
Total schedule	Grade Four	239	375.6	9.637	0.008	Grade Four>Grade Six Grade Five>Grade Six
	Grade Five	236	373.34			
	Grade Six	239	323.76			

Non-parametric test was used to study the differences in the attitudes of different grades towards mathematics, science, engineering technology and 21st century skills. As can be

seen from Table 9, there are no significant differences among grades in science, engineering technology and 21st century skills (P>0.05). There are significant differences in mathematics learning attitude among different grades (P<0.05). Through multiple comparative analysis, it is found that there are significant differences in mathematics learning attitude among students of different grades.

As for the overall interdisciplinary learning attitude analysis, different grades show significant attitudes towards interdisciplinary learning ($p < 0.05$), which means that different grades have different attitudes towards interdisciplinary learning. Through multiple comparative analysis, it is found that the interdisciplinary learning attitude of grade four and grade five is better than that of grade six, while there is no significant difference between grade four and grade five students.

5 Research Conclusions and Suggestions

5.1 Conclusions of the Study

(1)Students with interdisciplinary learning experience are more interested in interdisciplinary learning. Through the independent sample T-test analysis, it is found that students who have participated in project-based learning, scientific and technological creation, popular science painting, science and technology competition and other interdisciplinary learning activities have significant differences in interest in interdisciplinary learning compared with students who have not participated in them. Through the practice of interdisciplinary learning activities, students have a deeper understanding of the links between different disciplines and realize the importance of interdisciplinary learning.

(2)Primary school students have room for improvement in STEM career willingness, and the willingness of male students is higher than that of female students. The research results found that male and female students' career intention was generally not high, which may be due to the fact that primary school students were in the stage of cognitive development, less exposed to the application of interdisciplinary in real life, and lack of intuitive feeling. Although male and female students' self-assessment level in terms of practical skills and STEM career intention was not high, compared with female students, male and female students' self-assessment level was lower. Male students are more willing to engage in STEM education-related jobs, which is consistent with Luo Ronghua's research conclusion[10].

(3)Pupils' overall attitude towards interdisciplinary learning tends to be positive. Overall, most students recognize that math, science, engineering, and 21st century skills have a positive impact on their own development. Schools at all levels and of all kinds should actively carry out interdisciplinary learning activities, such as popular science exhibition, popular science painting, science and technology sports meeting, so that students can learn more interdisciplinary knowledge and improve their interdisciplinary learning ability and application ability.

5.2 Research Recommendations

When conducting interdisciplinary learning activities, we should cultivate primary school students' positive learning attitude, emphasize cooperation and team spirit, and promote the professional development of STEM teachers.

(1)Cultivate a positive interdisciplinary learning attitude. Foster positive learning attitudes in primary school students by stimulating their interest and curiosity in interdisciplinary learning. Teachers can design interesting projects, provide practical application scenarios, and connect with daily life, so that students realize the importance and interest of interdisciplinary learning, teachers can also provide students with independent exploration space, and cultivate students' independent learning ability.

(2)Cultivate cooperation and team spirit among primary school students. In an interdisciplinary learning team, each member may come from a different disciplinary background and possess different expertise and skills. By assigning tasks properly and making everyone aware of their role in the team, they can better leverage their strengths. Interdisciplinary learning usually involves multiple subject areas and requires collaboration and teamwork among students. Therefore, it is crucial to cultivate students' cooperation and team spirit.

(3)Promote the interdisciplinary competence development of primary school teachers. Some researchers have pointed out that there are still many problems in carrying out

interdisciplinary teaching, such as teachers' failure to provide adequate help to students, or teachers' intentional or unintentional substitution for students' research[11]. In the future, it is necessary to strengthen teacher training and professional development, establish a professional learning community for primary school teachers, and improve their interdisciplinary teaching ability. Teachers can participate in relevant training courses and seminars to learn about the latest interdisciplinary teaching methods.

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