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Researching and developing interdisciplinary course that integrates science and art(CISA)

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ABSTRACT

In this study, the purpose is to develop students' comprehensive ability and positive attitude and understanding of interdisciplinary knowledge. For this purpose, an interdisciplinary Course that Integrates Science and Art(CISA) of the elementary education is researched and developed according to the curriculum design and assessment. The study is conducted in the autumn semester of the 2018-2019 school year. The study adopts both qualitative and quantitative approaches. The qualitative approach is used to simply draw a point of view on the effect of curriculum through the use of interviews. The quantitative approach is used to detect the acquisition of knowledge, the acquirement of skill and promotion of attitude. The sample of the study consists of a total of 39 studens, of which 21 are female students and 18 are male students serving in public schools in China. According to the results of the research, it is found that this course improved students' art creation and scientific ability and understanding of multidisciplinary concepts related to the art and science.

Keywords: interdisciplinary course; curriculum integration; science education; art education

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INTRODUCTION

Since the 21st century, the world's countries, such as Finland and France, have taken the integration of interdisciplinary courses as a hot issue in the curriculum reform (National Board of Education, 2014; Conseil supérieur des programmes, 2014). The eighth curriculum reform in 2001 in China's basic education has been emphasize that "In order to change the present situation of too much emphasis on subject orientation, too many subjects and lack of integration, primary schools are required to integrate the curriculum structure and focus on comprehensive curriculum (Ministry of Education, 2001)." Interdisciplinary courses are also emphasized in the newly revised curriculum standards for all subjects (People's Republic of China Ministry of education, 2011; People's Republic of China Ministry of education, 2017), The "Opinions of the Ministry of Education on comprehensively deepening the curriculum reform and implementing the fundamental tasks of cultivate students" pointed out that "on the basis of giving full play to the unique educational functions of various disciplines, we must give full play to the comprehensive educational functions of inter-discipline and carry out interdisciplinary thematic education and teaching activities. The educational content of relevant disciplines is integrated organically to improve students' ability to comprehensively analyze and solve problems (People's Republic of China Ministry of education, 2014). " In this instance, It is imperative to design and implement the interdisciplinary curriculum in the basic education stage. Taking an interdisciplinary curriculum of science and art course as an example, this paper discusses the feasibility of implementing the interdisciplinary curriculum in primary school.

There are many definitions about the "interdisciplinary", This paper quotes Mr. Li's elaboration on the connotation of "interdisciplinary": Interdisciplinary should be based on the research and solution of practical problems. It should be based on disciplines, but go beyond the perspective of single-discipline research and pay attention to the comprehensive understanding and solution of complex problems or subjects. It is necessary to have clear and integrated research methods and thinking patterns. It aims to promote the emergence of new cognition and new products and encourage innovation and creation on an interdisciplinary basis (Li Peining, 2017).

This research attempts to take an interdisciplinary teaching integration course of science and art as an example. Science and art both have their own limitations on cultivating the comprehensive quality of students (Qu Tiehua & Zhang Ayuan, 2015). The objectivity is emphasized in the science curriculum, though the scientific teaching goal has begun to attach importance to cultivating the emotion, attitude and value in recent years (Qu Tiehua & Zhang Ayuan, 2015), but the limitation is still very great. Then art courses emphasize the cultivation of artistic interest and imagination (Zhang Hua 2011), thus giving person a more meaningful life. If we present science artistically and imaginatively, as well as objectively and precisely, students will develop a more complete understanding of what science and scientists are about-one that is likely to capture their imaginations, emotions, and best efforts (Moore, JW. 2001).

In a different vein, perhaps the broadest similarity between the areas (science and art) lies in their values of creative exploration (Paul J. Ogren & Dale L. Bunse, 1971). And both disciplines require careful observation,

contemplation, record keeping, attention to detail and, in the 21st century, use of advanced technology. Artists and scientists use different tools for probing nature and nature provides fascinating challenges for all (A. M. R. P. Bopegedera., 2005). Especially the connection between chemistry and art has been discussed in many literatures (Jay A. Young, 1981). Therefore, combining the complementarities and commonalities of science and art is beneficial to the improvement of students' overall comprehensive quality, and also to the study of science and art curriculum. At the same time, through the study of the interdisciplinary course of science and art, the students can understand the inner relationship between science and art, so that they can consciously analyze the art works with the acquired scientific principles. And can better apply scientific principles to solve practical problems.

The cross-disciplinary course of science and art is also of great help to cultivate students' interest in learning (Omerod MB. & Duckworth D, 1975; RH Tai & CQ Liu & AV Maltese & X Fan, 2006). The course "Chemistry in Daily Life", developed at Columbia University, which combines art courses with chemistry inquiry projects, has succeeded in helping artistic young people develop an interest in, and a more complete understanding of chemistry (Zafra Margolin Lerman, 1986). The combination of science and art can concretize abstract principles to form a more efficient and attractive curriculum, in particular for students who are not interested in science studies or students with relatively weak rational thinking.

Although there are many theoretical studies on interdisciplinary curriculum integration, the action research in primary school classroom is very rare (Liao (Tingting) 2015). This study is based on the 'discolored flower' lesson of the

science textbook of the Jiangsu Education Publishing House, trying to integrate the science and art courses, and discuss the effectiveness and feasibility of the design and implementation of interdisciplinary teaching at the stage of basic education. .

The teaching goal of the course "discolored flower" is to understand the acid and alkaline substances in life, to understand the function of pH indicator; and applying the discolored solution obtained by indicator into the course of "Tie-dye", which is one of art courses, to teach students tie-dye skills as well as spread the heritage of the traditional culture (Long (Haixia) 2015). Then adding the knowledge that "the plant anthocyanins in different acid-base environment to display different colors", these three aspects have strong relevance and confirm to formal logic. The interdisciplinary learning of this course perfectly combines knowledge with real life and applied technology, which meets the requirements of cultivating students from three dimensions of educational objectives—Knowledge and skills; Process and method; the emotion, attitude and value.

RESEARCH DESIGN AND COURSE STRUCTURE

This research is based on the problems found in students' life situations. "Why does the morning glory change colors in a day?" students once asked. This problem can be explained in terms of biology and chemistry. On the one hand, from a biological point of view, the color-change of the morning glory is related to the anthocyanins, a class of natural water-soluble natural pigments, contained in the plants cell (IUPAC, 1997). The reason of discolour is due to changes in the proportion of pigment components in flowers when flowering. This

change is the physiological process of morning glory. (Liu, 2015). Anthocyanins brighten flowers and fruits and attract animals to help plants pollinate and spread seeds (Timothy & Edwina, 1995). On the other hand, the cause of discoloration can also be explained by chemical principles. The basic structural nucleus of anthocyanins is 2 phenyl benzo Piran, i. e. Flavylium. The structure is shown in Figure 1. Most anthocyanins have substituted hydroxyl groups in the 3, 5 and 7 positions of anthocyanins. All kinds of anthocyanins are formed because of the different substituents (hydroxyl or methoxy) on the carbon sites of the B ring (Tianjin University of Science & Technology, 1981). The color changes with the change of pH value, the color is red when $\text{pH} < 7$, the color is purple when $7 < \text{pH} < 8$ and the color

is blue when $\text{pH} > 11$ (Sichuan University, 1979). Plants rich in anthocyanins include blueberries, grapes, Brassica oleracea and purple sweet potatoes. Their colors are red, blue and purple (Davies, 2004; Archetti & Döring, 2011). On the one hand, plants have a variety of colors because they contain anthocyanins. On the other hand, anthocyanins in some plants varies the color of plants. Color is an important factor in art creation. Therefore, it combines the principle of anthocyanin discoloration with the tie dye creation in fine arts, a interdisciplinary course is designed and implemented. It has been proved that interdisciplinary courses combined with science and art have potential and far-reaching significance in cultivating students' scientific literacy and artistic attainment (Costantino, 2018).

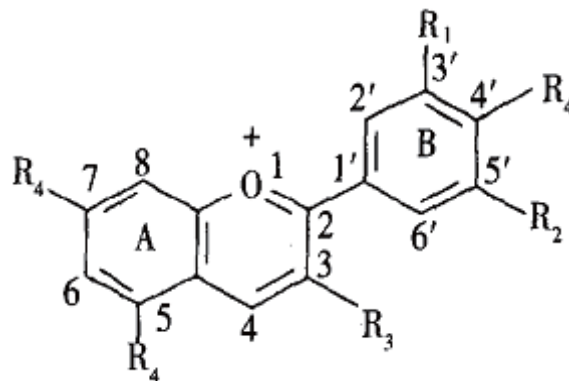


Figure 1. R_1 and R_2 is H, OH or OCH_3 , R_3 is glycosyl or H, R_4 is glycosyl or OH

The basic structure of anthocyanin

Due to the importance of interdisciplinary courses in developing students' science and art literacy, students are taught how to use the alcohol lamp, rubber head dropper and the mortar at the earliest opportunity in many experimental courses and are given the opportunity to practice painting skills in multiple art class. The interdisciplinary courses draws upon the application of fundamental chemical and art principles such as color wheel, bandhnu,

solubility, and acid/base theory taught in early scientific and art courses. Because of the early introduction of the practical procedure and theoretical concepts, it was reasoned that asking students to extract anthocyanin, adjust pH value, bandhnu would be a suitable interdisciplinary curriculum for improving literacy at the stage of elementary education. It was expected that this course would also lead to an improvement in students' understanding of the

concepts related to the art and chemistry and the ability of art creation and scientific practice.

RESEARCH DESIGN

The course that integrates science and art (CISA) was introduced to the Students in Grade Four of an experimental school in Beijing, China. Typically, 39 students were enrolled in the module run over the course in the second semester of grade four. The students were split into six cohorts of approximately 6 to 7 in each group and engaged in the activities for about 45 minutes. In other words, there were six groups that were assigned by the teacher randomly, and three groups were composed of six students and the other three groups composed of seven students. The students conducted the interdisciplinary activities with guidance of two teachers who respectively taught science and art.

Firstly, the teacher was trained about the steps of CISA before the class began. Moreover, we videotaped all the class process to provide data to ensure that the teacher actually implemented the intervention as it was designed. In addition, these activities were designed to explore the concepts of anthocyanin, hue circle, pH, contrast color and adjacent colour. Then, the purpose of these activities is to train students' abilities in scientific practice and artistic creation, and to enhance their positive attitude towards science and art synthesis. Four steps of CISA were successfully accomplished in the class.

Aims

The aims of this study were to investigate the effect of interdisciplinary course instruction designed based on CISA on students' ability of art creation and operate scientifically, to understand the students' mastery of the concept of science and art, to find a change in students' attitude to science and art. The specific

research questions were the following:

- (1) How do students' concepts of science and art change as they complete a series of interdisciplinary activities?
- (2) How do students' ability to practice scientifically and create artistically change as they complete a series of interdisciplinary activities?
- (3) What are the views of the students on the science, art and the integration of science and art?

Sample

The sample of this study consists of 39 students fourth grade students. They were all attending the same chemistry and art course offered in a public elementary school. Among the participants, 18 of them were male, and 21 of them were female. Their study backgrounds and ages were similar.

Instruments

In this part, three sets of instruments, pre test assessment, post test assessment and interview outline that were used in the study, are described. The main topics of the pre test questionnaire and the post test questionnaire are compiled by the Likert Scale. The contents of the test questions are designed by the researchers. Through the examination of the experts in the subject field, the opinions of the frontline teachers to the measurement tools are interviewed, and the improvement is made on this basis. The questionnaire was first conducted in another class of the school. The reliability of the questionnaire was 0.764, the validity of the pre test questionnaire was 0.796, the $p < 0.05$, the reliability of the post test questionnaire was 0.782, the validity of the post test questionnaire was 0.798, and the $p < 0.05$. The questionnaires can be used for formal experiments. Data were obtained and were

analyzed using SPSS19.0 after implementation of the course.

Content and dimension of the questionnaire

The pre test questionnaire and the post test questionnaire are all multiple-choice question. There are 11 questions in the pre test questionnaire and 12 questions in the post test questionnaire, and the students are investigated from three dimensions of knowledge, skill and attitude respectively. The front and back questionnaires are found in Appendix 1 and Appendix 2 respectively. In addition, students will be understood by semi-structured interview after class. Five questions was discussed in the interview. we keep an open approach, focusing on questions related to interdisciplinary courses, such as students' attitude to the curriculum, students' views on the curriculum, and the testing of relevant knowledge in the questionnaire to determine the feedback of the students' questionnaire. Consistent between the answer and the actual interview was ensured.

At the end of the CISA course, 6 students in the class were randomly selected for interviews, and the interview outline was appended to Appendix 3. Interviews were conducted from students' understanding of concepts, the success of operations and unexpected situations, and the actual emotional experience of students. In view of the problems in the questionnaire, students were asked to find the true feelings of the students.

COURSE STRUCTURE

The elements and content of CISA

Li Peining (2017), on the basis of several scholars (Diana Rhoten, Marc Chun, Veronica Mansilla, Alan Repke) and the National Academy of Sciences of the United States on the interdisciplinary concept of STEM, extracts several major elements of interdisciplinary

concepts:

1. Interdiscipline should rely on the research and solution of practical problems.
2. Interdiscipline should rely on discipline, but it should go beyond the field of single disciplinary research and pay attention to the comprehensive understanding and resolution of complex problems or subjects.
3. There should be a clear and integrated research method and mode of thinking.
4. interdisciplinary should encourage innovation and creation on the basis of interdisciplinary in order to promote the emergence of new cognition and new products.

Based on Li Peining's definition of interdisciplinary elements, we design an interdisciplinary content element, as shown in Table 1.

Firstly, in the elements of real problems, the curriculum design originates from the problems found in the life of the students. Such problems are processed into scientific problems by the researchers and are displayed in the form of curriculum. Most of the materials used in this study are prepared by students from life, such as all kinds of fruits (grapes, blueberries), vegetables (Brassica, carrots), flowers (flowering plum, etc.), reflecting the problem from life and the principle of life for the problem.

Secondly, when studying the issue of anthocyanin discoloration, teachers and students used life science methods to explore the structure and function of anthocyanins. For example, "what's the role of anthocyanin for the plant itself?" The properties and structures of anthocyanins are discussed by means of

material science. For example, "what is the phenomenon of the same anthocyanidin under the different acid and alkali environment, what is the phenomenon of different anthocyanins in the same acid and alkali environment?"

Thirdly, we analyzed the research methods and thinking modes of different disciplines of chemistry and fine arts, and integrated them into the curriculum activities. For example, the experiment is the main method to carry out the chemical research. Under the guidance of the teacher, the students carry out the inquiry experiment of "anthocyanin and acid-base

relationship", experience the thought of controlling the acid and alkali variables and changing the sample. In this process, the students' mathematical logic thinking and abstract thinking dimension are trained. And in the art tie dye links, students through the observation, copying and other ways, through the color of imagination and conception, developed the image thinking and perceptual thinking.

Finally, at the end of the course, the students produced various anthocyanin extracts as pH indicators and various tie dyeing works.

Table 1. Table of interdisciplinary design elements and CISA content

Interdisciplinary elements	course content of CISA
Practical problems	Choose from life, take material from life
Beyond the single subject, fully understanding and solving problems	A comprehensive understanding of anthocyanins from the perspective of chemical biology and art
Integrated research method and thinking Mode	Using the research method and thinking mode of Chemistry and Art
The emergence of new cognition and products	Anthocyanin extracts from various plants as new works pH indicators, tie dyeing

The process of CISA

The process of CISA is the road map of curriculum design and curriculum implementation, playing a guiding role in teachers' teaching. The process includes collecting materials, extracting anthocyanins, testing pH and creating tie dyeing. The process is shown in Figure 2. In addition, we have set up four guiding issues as an activity problem. These four questions are: which plants have higher anthocyanin content; which method can better extract anthocyanins; anthocyanins in different pH environment of the color of what changes; how to use anthocyanin color principle for tie dyeing creation. The activities in the

course process play a driving role in the course of joining the course, and promote the normal course of the course, the guiding problems and the situation of the activities as shown in Table 2.

Results and discussions

The Results of Class process

Collection of Ingredients

Firstly, in the previous course, students learned about the phenomenon of "changing color of the morning glory", formed a problem in the classroom and collected plants from life according to the question of "which plants will change color" after class. Then, in the second

class, the students will share and exchange their findings. On this basis, the materials were screened through access to information and

practical experiments. Finally, we screened grapes, mulberry, carrot and cabbage as further validation materials.

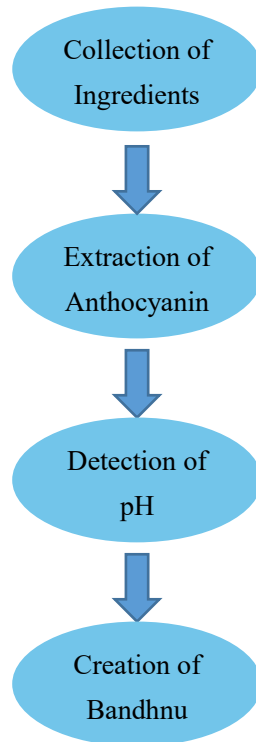


Figure 2. the process of CISA

Table 2. Descriptions of the Activities

Name of the Activity	Guiding Question
Collection of Ingredients	Which plants have higher anthocyanin content?
Extraction of Anthocyanin	Which method is better to extract anthocyanins?
Detection of pH	What changes are the colors of anthocyanins when they meet different pH?
Creation of Bandhnu	How use the color-changing law of anthocyanin to carry on artistic creation?

Extraction of Anthocyanin

The guiding question in this part: which method can extract anthocyanins better. When extracting anthocyanins, the existing data better, we conducted a comparative experiment. Take flowering plum for example, first of all, the petals of two 2.08g were divided into two groups:

proved that there were two main ways of extraction: the first one was dissolving in water; the second was adding alcohol after grinding. In order to test which way to extract anthocyanin is A and B; then, the 60ml water was added to the A beaker, the pigment was extracted by heating and boiling. The 60ml alcohol was added to the

B mortar, and the pigment was extracted by the grinding method. The results showed that before the filtration, the B group was not filtered. The color of the solution was deeper, and the

effect of extracting pigment was better. After filtration, the A group had deeper color. As is shown in figure 3.

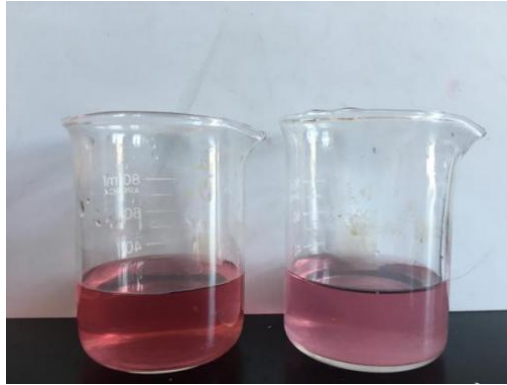


Figure 3 Comparison of two extraction samples

Detection of pH

The guiding question in this part: what changes in the colors of anthocyanins in different pH environments? In this part, pH test paper was used to detect different anthocyanin solution and acid base liquor. The pH was tested: pH of grape was 5, pH of carrot was 6, pH of purple cabbage was 6, pH of mulberry was 5. The

gradient of pH was 2, 4, 6, 8, 10, 12, 14, respectively, as shown in Figure 4. The discoloration of different extracts was explored. The results showed that the range of color change, color contrast and color retention were better. Therefore, the grape skin was selected as the best experimental material.

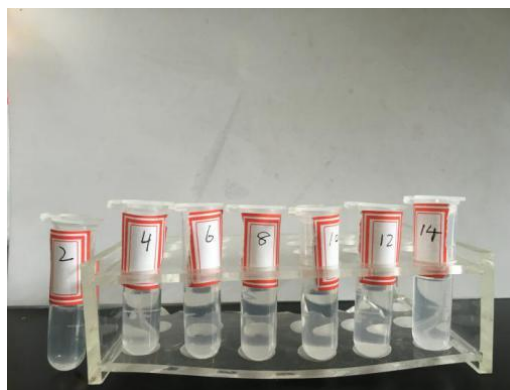


Figure 4 Solution with different pH

Creation of Bandhnu

The fourth part of the guiding question: how use the principle of anthocyanin' changing-color to make creation of bandhnu. This part was based on the results obtained in the previous study,

mainly focusing on students' artistic creativity. Firstly, each student will get a piece of cloth and the dyestuff from the previous steps for tie dyeing. Then, the students learned the basic tie dyeing technique and the color related

knowledge under the guidance of the teacher; finally, the students used the material to play their own imagination to create their own works. As shown in Figure 5. This part of the course exercised the art techniques of copying and writing, and developed perceptual thinking and

concreted thinking in practical activities. With the progress of the course, students' enthusiasm for participation had gradually increased, and each student had his own tie dye works.



Figure 5. Production of Students

Results and Discussions of Knowledge and Ability

The total number of students involved in the survey and course is 39. As shown in Table 7, there are 18 boys and 21 girls. Each student

has received the same public school education in the past few years, so the knowledge background is basically the same. In addition, the age of each student is similar.

Table 3. Gender Statistics

Gender	male	female	total
Number	18	21	39

A total of 39 pretest questionnaires were received, 39 were recovered, the recovery rate was 100%, 39 questionnaires were issued, 37 were recovered, 2 were lost, and the recovery rate was 94.9%. Follow up data analysis is done according to effective data volume.

First, statistics on pretest problem 1 to question 9 are obtained, and table 4 is obtained. The content of the problem is shown in Table 4. Question 1~7 mainly investigates knowledge dimensions. Question 8 and question 9 mainly

examine the perspective of ability. Then, according to the analysis of table 6, some students have a better or even better knowledge base, for example, in the question of "I know a lot of plants, such as morning glory, and so on, the reasons for different colors", 40% of the students answered completely agreement, indicating a better understanding of the cause of change in the color of the morning glory; "I know some of the present." 88.3% of the students answered very much in the question of using art

in science and technology. However, there are some inconsistencies in the further interview. For example, when asking the students "the real reason for the change of the color of the

morning glory", the students' answers are on the surface and there are some mistakes, such as temperature, sunshine, etc., and do not reach the degree of "strongly agree"

Table 4. The content table of the problems in the pretest

Question	content
Q1	I can list more than 3 colors of the morning glory
Q2	I know that many plants such as morning glory show different colors.
Q3	I know complementary colors, contrasting colors, similar colors and adjacent colors.
Q4	I know the role of anthocyanins in plants
Q5	I have personally made vegetable juice (or juice) in my life.
Q6	I've tried to create a tie - dye work
Q7	I can cite examples of interrelation between art and science.
Q8	I understand that some of the fine works now use science and technology.
Q9	In the art class, I will associate with the knowledge of science.

From the perspective of knowledge theory, the postmodernist knowledge view holds that the essence of knowledge is not objectivity and truth, but knowledge is closely related to the subject of knowledge. It is the gradual construction of the subject through interaction with the object and other subjects, and the formation of constructivism is the only essence of knowledge. The randomness of knowledge generation indicates that knowledge is diverse. This makes the traditional knowledge view to a certain extent affected. Therefore, the closed, linear teaching mode that pursues causal sequence is not compatible with the development of knowledge and the development of society. The diversity of knowledge requires the inject of knowledge into

the curriculum and strengthens the link between disciplines. At the same time, the postmodernist view of knowledge holds that the development of contemporary knowledge has been gradually integrated on the basis of the differentiation, and the knowledge of various disciplines and various types of knowledge intersect each other and constitutes a complex ecosystem. Interdisciplinary research and teaching activities are entering the mainstream(Iv, 2016). Therefore, scientific knowledge and art knowledge are not isolated in the human brain. They are interdependent in a complex and comprehensive form through human initiative, which makes the knowledge of various disciplines on the basis of mutual promotion, and the students' knowledge of science and art

after a carefully designed course. The gain has been improved. After the analysis of the post test questionnaire, the students' knowledge dimension and ability

dimension increased most, but the answer rate of "strongly agreed" was decreased in question 8.

Table 5. The content table of the problems in the post test

Question	content
Q1	I learned that morning glory has many different colors
Q2	I know that anthocyanins are the reason why many plants like morning glory
Q3	I learned related knowledge of complementary colors, contrasting colors, similar colors, and neighboring colors
Q4	In this class, I learned the knowledge of color cycle and did art exercises
Q5	I know the role of anthocyanins in the plant
Q6	I managed to change the color of vegetable juice (or juice) in class
Q7	I successfully made art tie-dye works with vegetable dyes in class
Q8	I think there are some links between art and science
Q9	I understand that there are art works made using science and technology
Q10	In the art class, I will associate knowledge of science

Table 6. statistics on the answers to questions in the pretest questionnaire

	Strongly agree (%)	Agreement (%)	Not necessarily (%)	A little disagree (%)	Strongly disagree (%)	Total (%)
Q1	20.0	20.0	21.7	28.3	10.0	100
Q2	40.0	31.7	20.0	6.7	1.7	100
Q3	20.0	40.0	25.0	11.7	3.3	100
Q4	11.7	20.0	20.0	23.3	25.0	100
Q5	20.0	25.0	28.3	18.3	8.3	100
Q6	36.7	15.0	16.7	18.3	13.3	100
Q7	15.0	16.7	33.3	16.7	18.3	100
Q8	88.3	5.0	3.3	3.3	0	100
Q9	45.0	20.0	5.0	5.0	25.0	100

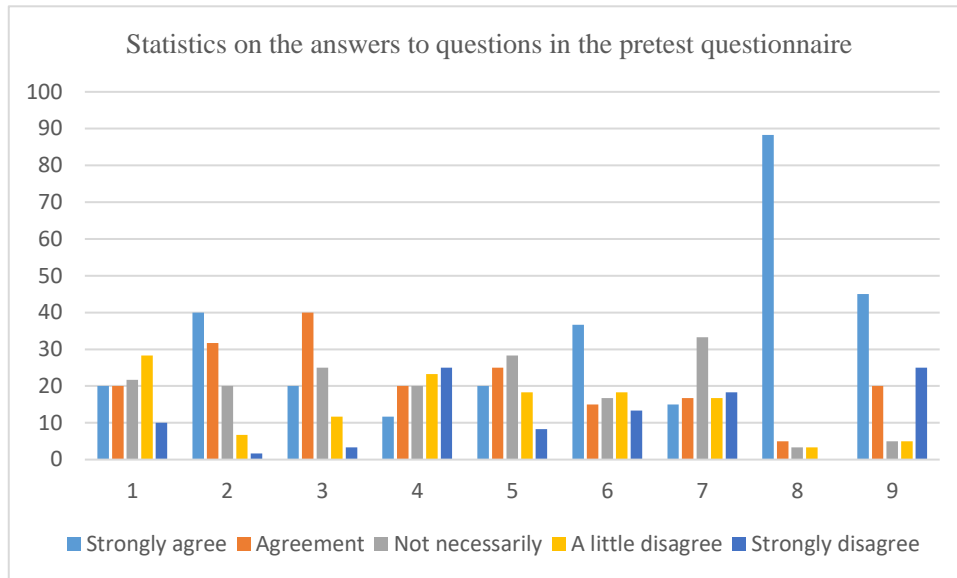


Figure6. Statistics on the answers to questions in the pretest questionnaire

Analysis of table 7 and table 8 shows that figure 6 and figure 7 show that the number of respondents who answered "strongly agree" has increased significantly (except for question 8).

As for the dimensions of competence, the problem of student decline in response 8 is explained in subsequent interviews. Howard Gardner, a psychologist at the Institute of education and research, Harvard University, has refuted the above views on the basis of a large number of studies and experiments on human potential, and put forward a definition of the relative intelligence. Gardiner defines intelligence as "the value standard of a social and cultural environment in which the individual uses the ability to solve real problems or produce and create a product in a certain social and cultural environment".

In his opinion, on the one hand, intelligence is not a kind of ability but a set of abilities; on the other hand, intelligence is not in the way of integration but in an independent way. On this basis, he expounded the categories of intelligence and its theory of multiple intelligences. The results of multiple intelligence

theory and brain science research indicate that students' learning should be pluralistic and integrated. One of the aims of education is to develop students' multiple intelligences. But because the intelligence of different students is different, and each student's intelligence is pluralistic and independent of each other, the students' interests and talents are not shown in the course of a single subject. Therefore, the integration of curriculum provides such a strong point. The integration of the curriculum modifies the fragmentary nature of the content of the branch courses, and creates a comprehensive and comprehensive understanding way for students to learn from their experience. Students who have different interests and various intelligence levels can deeply explore the contents of integrated disciplines and devote themselves to meaningful learning. Develop their unique abilities and promote their individualized development. And the integration of freeze-thaw is not an isolated concern for their ability to master knowledge in a single subject. In the interdisciplinary teaching of multidisciplinary integration, the horizontal connection and integration of knowledge and

ability in various disciplines will be established overall quality of the students(Iv, 2016). so as to promote the overall development of the

Table 7. statistics on the answers to questions in the posttest questionnaire

	Strongly agree (%)	Agreement (%)	Not necessarily (%)	A little disagree (%)	Strongly disagree (%)	Total (%)
Q1	77.6	20.7	0	1.7	0	100
Q2	79.3	15.5	3.4	0	1.7	100
Q3	75.9	19.0	3.4	0	1.7	100
Q4	77.6	20.7	0	1.7	0	100
Q5	79.3	19.0	0	1.7	0	100
Q6	15.0	16.7	33.3	16.7	18.3	100
Q7	72.4	13.8	0	12.1	1.7	100
Q8	75.9	24.1	0	0	0	100
Q9	77.6	19.0	1.7	0	1.7	100

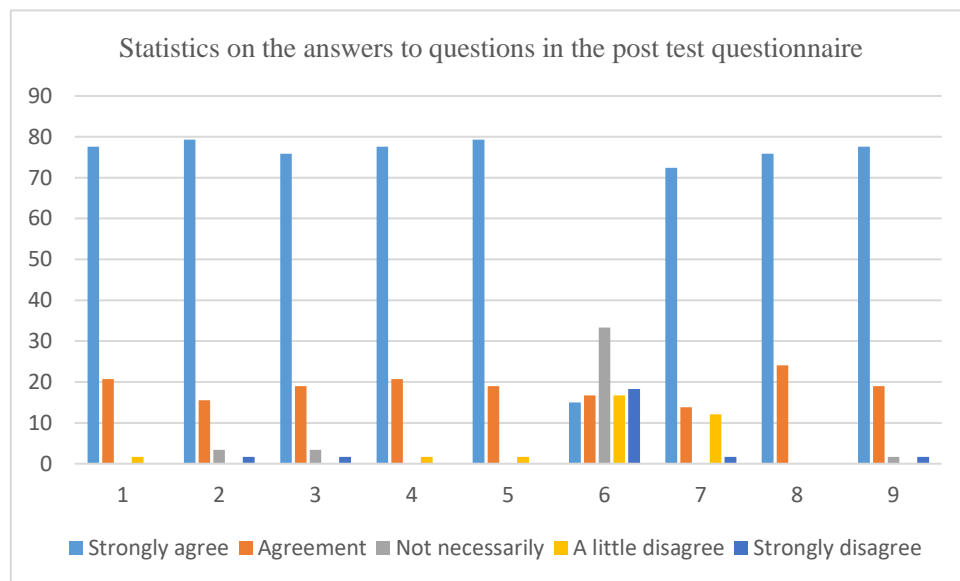


Figure7. Statistics on the answers to questions in the post test questionnaire

Results and Discussions on Students' Attitudes towards Science and Art

In order to show the degree of students' common love for science and art, we would like to share the proportion of the total number of students in science and art as a Combination,

and the high degree of Combination shows that the number of students who like science and art in the student group is more, and the results of science and art are better. Question 10 "in the art and science classes, what I like most" to make statistics on table 8 and post test table 9,

and make table 8 and table 9 in the form of pie chart. The results of the previous survey, as shown in Figure 8, showed that before the course was carried out, only 31.7% of the total number of people who liked science only accounted for 18.3% of the total number, and the degree of integration was 50%. However, after the implementation of the curriculum, the students' attitude to science and art as shown in

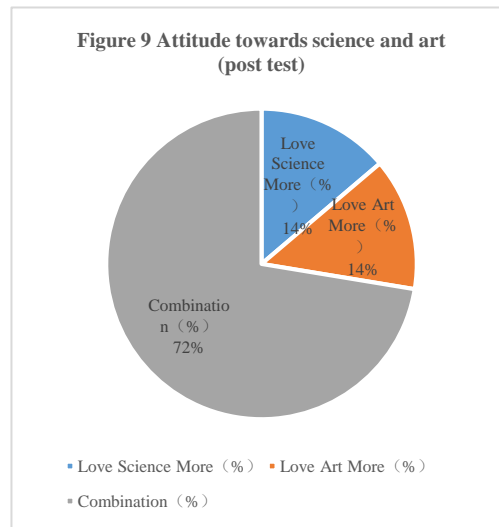
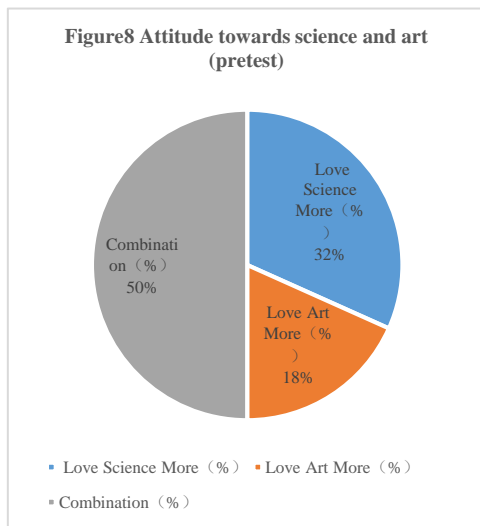
Figure 9 shows that the number of people who like science only accounts for 14% of the total. Only 14% of the total number of people like fine arts, and the degree of integration is 72%. It shows that students like art and science at the same time. Science and art courses are effective in improving students' positive attitude towards two subjects.

Table 8. Attitude towards science and art (pretest)

	Love Science More (%)	Love Art More (%)	Combination (%)	Total (%)
Q10	31.7	18.3	50.0	100

Table 9. Attitude towards science and art (post test)

	Love Science More (%)	Love Art More (%)	Combination (%)	Total (%)
Q10	13.8	13.8	72.4	100



The number of students who answered "strongly agree and agreement" showed the effect of the course, so a comparison of the number of "very agreeing and agreeing" in the three dimensions could reflect the degree of the

positive tendency of the students. As shown in Figure 10, students' enthusiasm for courses increased significantly after courses. For example, in question 1, question 4, and question 7, the positive tendency of the

students increased by 58.3%, 66.6%, and 145%, 210% and 171%, respectively. It shows that the effect of the curriculum on the overall improvement of students is particularly good.

Table 10. The number of respondents who answered "strongly agree and agreement" in the pretest questionnaire.

	Strongly agree (%)	Agreement (%)	Total (%)
Q1	20.0	20.0	40
Q2	40.0	31.7	71.7
Q3	20.0	40.0	60
Q4	11.7	20.0	31.7
Q5	20.0	25.0	45
Q6	36.7	15.0	51.7
Q7	15.0	16.7	31.7
Q8	88.3	5.0	93.3
Q9	45.0	20.0	65.0

Table 11. The number of respondents who answered "strongly agree and agreement" in the posttest questionnaire.

	Strongly agree (%)	Agreement (%)	Total (%)
Q1	77.6	20.7	98.3
Q2	79.3	15.5	94.8
Q3	75.9	19.0	94.9
Q4	77.6	20.7	98.3
Q5	79.3	19.0	98.3
Q6	15.0	16.7	31.7
Q7	72.4	13.8	86.2
Q8	75.9	24.1	100
Q9	77.6	19.0	96.6

The obvious reasons for students' promotion can be explained by situational learning theory. The learning scenario of polyscience courses focuses on knowledge and focuses on abstract and systematic problems. In the educational context of the classroom, it is often isolated and divorced from the background to acquire knowledge and the development of general and abstract abilities.

Such a course is based on the assumption that students can generalizations these abilities through teaching so as to apply these abilities. However, researchers gradually found that generalization skills often did not promote knowledge transfer. Knowledge and cognitive skills are highly dependent on their background. The real background not only implies resources to students, but also is a leading organizer of related problem-solving backgrounds. The curriculum integration provides support background and knowledge skills through the cross integration of different disciplines. It inlays the subject of the curriculum in the rich context. It can reflect the concept of the problem and its

significance in the related fields from many angles, and help the students to develop the flexible knowledge representation and promote the exploration and understanding of the use of knowledge.

Results and Discussions on Students' Attitudes towards Science and Art

It is shown from table 12 that the chi square value of the pretest questionnaire is 0.852, indicating that the difference between the two is not obvious. Through the study of science and art interdisciplinary courses, the degree of students' love for science and art courses has improved significantly. It shows that the interdisciplinary course of science and art can promote each other and help students to form a positive attitude towards the integration of science and art. However, there is no significant relationship between the formation of students' attitudes and gender. That is, interdisciplinary courses in science and art have the same promotional effect on students. It is concluded that gender is not an important factor affecting students' interdisciplinary attitude.

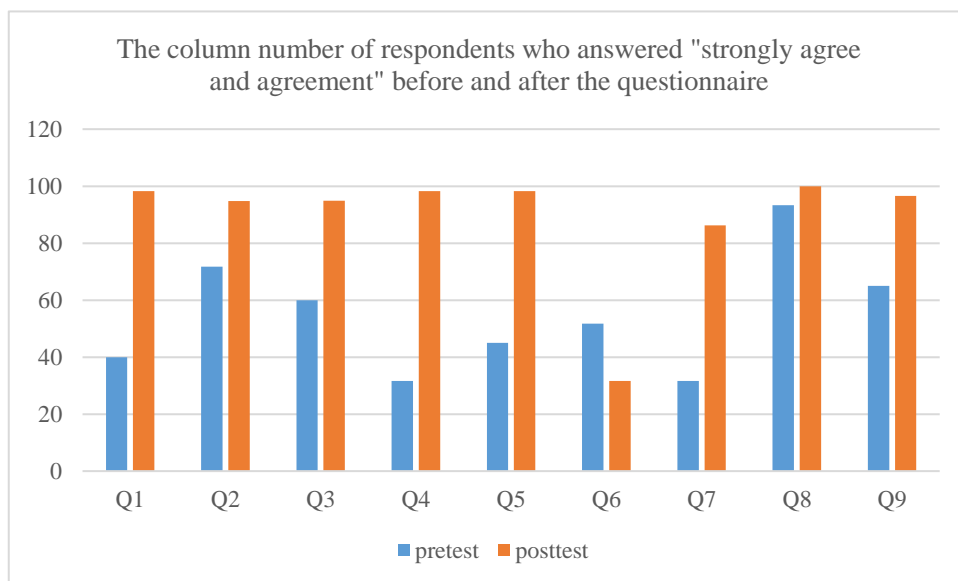


Figure 10. The column number of respondents who answered "strongly agree and agreement" before and after the questionnaire

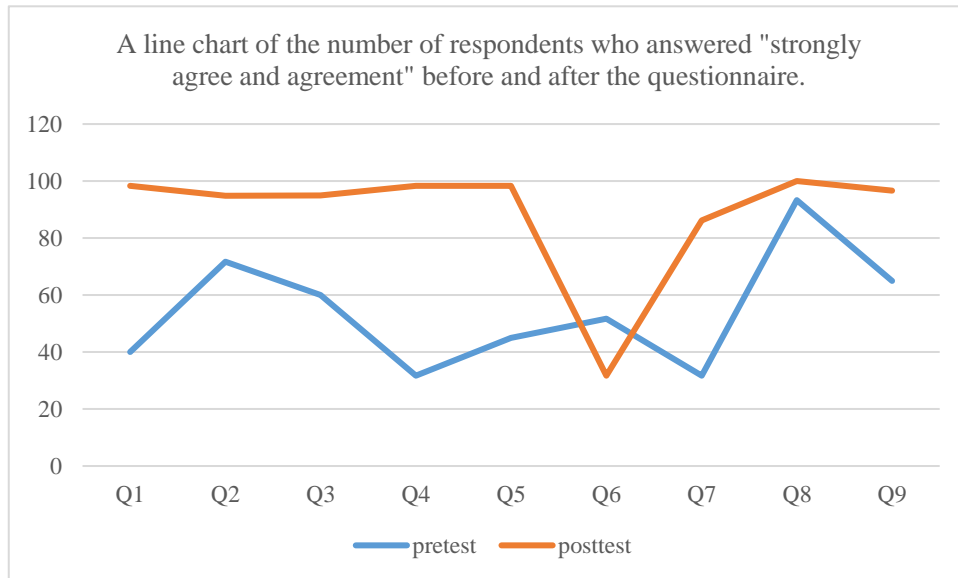


Figure 11. A line chart of the number of respondents who answered "strongly agree and agreement" before and after the questionnaire.

Table 12. chi-square test chart of pretest

	Value	df	Sig. (bilateral)
Pearson chi-square	0.320a	2	0.852
likelihood ratio	0.321	2	0.852
Linear and linear combination	0.288	1	0.591
N in a valid case	60		

The expected count of A. 1 cell (16.7%) is less than 5. The minimum expected count is 3.30.

Table 13. chi-square test chart of post test

	Value	df	Sig. (bilateral)
Pearson chi-square	0.376a	2	0.829
likelihood ratio	0.386	2	0.825
Linear and linear combination	0.320	1	0.571
N in a valid case	58		

The expected count of A. 2 cell (33.3%) is less than 5. The minimum expected count is 2.48.

The Results and Discussion of Students' Interview

After the implementation of the course, 6 students were interviewed randomly. The content of the specific interview is shown in Appendix 4. Through interviews with students, several conclusions were drawn.

Firstly, students are strongly interested in CISA courses. When asked the students:

"Did you succeed in making tie dye works? What are your feelings?" the student 1 (happily) replied, "yes! The feeling (Curriculum) is very interesting. (dyed cloth) is tied together. Some places are red, and their colors are very obvious.

Another 2 student (firmly) replied, "yes! It's fun to do it.

And when asking the student, "do you want to have a CISA course that often combines art and Science in the future?" why ", student 1 (excitedly, glances) answer:" hope! " It's fun to learn different knowledge. Student 2 returned to the road: "I hope (feels like this class) is very interesting, one lesson can learn two classes of knowledge."

Secondly, although the students' responses to the knowledge dimension were higher in the questionnaires, the students responded generally in the actual interview. For example, when the experimenter asked, "why do morning glory flowers have different colors at different times?"

Student 1 answered: the content of anthocyanin and alkali is different.

Student 2 answered: anthocyanin is different.

Although the answers of all two students are reasonable, they are scattered. This shows that students do not have enough knowledge to master the system.

When the experimenter asked, "what creative works can we make from plant pigments?" 1

students answered "tie dye" an answer, while two students did not answer. This shows that the divergent thinking of students is not well developed, and there are still certain limitations.

When the experimenter asked, "will you appreciate and create art works with the knowledge of coloring ring?" Two students gave affirmative reply, but after continuing to ask the reason, the student answered 1: I don't know. 2 students answer: because the use of the color ring can make the opposite color, (can make) almost (adjacent) color, indicating that students have a certain understanding of the knowledge of the color ring.

Thirdly, different students have different knowledge and ability. In the interview, 6 students almost always have a positive attitude to the CISA course. However, in the knowledge dimension, some students can understand the intrinsic reasons for the change of color, such as pH, anthocyanin, and some students do not answer it. In the ability dimension, the students have learned to appreciate beauty through the color ring. The skill of the technique of work, the skill of tie dye and so on, while some students can not express these abilities.

CONCLUSION

Based on this study, first of all, we designed the interdisciplinary course of science and art, and implemented the course from four steps of collecting materials - anthocyanin - detecting pH - tie dyeing. Then we draw the following conclusions: students can complete the whole course of the course, from their own collection of materials to tie dye creation, students have a better understanding of the concept of interdisciplinary, and a higher level of knowledge. The students' interdisciplinary abilities such as the chemical experiment operation and the art creation technique have

been improved, and the students' attitude toward the interdisciplinary whole has a positive change, and there is no significant difference between the male and female, which is suitable for all students. Finally, the richness and low cost of the course also make the formal promotion of the curriculum in schools more feasible.

LIMITATIONS

Although our research has many advantages, there are still some shortcomings. There are three limitations in the current study. First, we know the important role of control group in educational research experiments, but this experiment does not need a control group. First, there is no need to compare the interdisciplinary students and those who do not participate in interdisciplinary students. In addition, many studies have proved that the branch science and art courses have little effect on students' academic change. Second, in further interviews with students, some students are found in the answers and actual answers in the questions. This is an individual phenomenon, but it still needs attention. Third, the number of samples in this study is less, the effect of the implementation of the larger scope of the course can not be determined. When the other is implemented in the environment, the corresponding materials and teachers will change accordingly, so the follow-up needs to be followed by larger samples and other regional experiments.

ASSOCIATED CONTENT

Appendix 1, Appendix 2, Appendix 3

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Questionnaire for Students Learning Science I

Welcome to participate in this questionnaire survey. The purpose of this study is to understand students' scientific learning situation, so as to help them learn better. This questionnaire does not include the name, there are no right or wrong answers in questionnaire. When you fill in the answer, please follow your own thought and the personal situation truthfully. We promise that the questionnaire information will only be used for research and will never be disclosed to the public. Thank you for your cooperation.

Q1. Your gender is:

- A. male B. female

Q2. I can list more than three colors of morning glory

- A. strongly agree B. agreement C. Not necessarily
D. a little disagree E. Strongly disagree

Q3. I know why many plants like morning glory display different colors

- A. strongly agree B. agreement C. Not necessarily
D. a little disagree E. Strongly disagree

Q4. I know complementary colors, contrasting colors, similar colors and adjacent colors

- A. strongly agree B. agreement C. Not necessarily
D. a little disagree E. Strongly disagree

Q5. I understand the function of anthocyanin in plants

- A. strongly agree B. agreement C. Not necessarily
D. a little disagree E. Strongly disagree

Q6. I have made vegetable juice (or juice) in life

- A. strongly agree B. agreement C. Not necessarily
D. a little disagree E. Strongly disagree

Q7. I have tried to create tie-dye works

- A. strongly agree B. agreement C. Not necessarily
D. a little disagree E. Strongly disagree

Q8. I can give examples of the interconnection between art and science

- A. strongly agree B. agreement C. Not necessarily
D. a little disagree E. Strongly disagree

Q9. I understand that a large number of art works use science and technology

- A. strongly agree B. agreement C. Not necessarily
D. a little disagree E. Strongly disagree

Q10. In the art class, I will associate knowledge of science

- A. strongly agree B. agreement C. Not necessarily
D. a little disagree E. Strongly disagree

Q11. My favorite classes are art or science

- A. art class B. science class C. both of all

Questionnaire for Students Learning Science II

Welcome to participate in this questionnaire survey. The purpose of this study is to understand students' scientific learning situation, so as to help them learn better. This questionnaire does not include the name, there are no right or wrong answers in questionnaire. When you fill in the answer, please following yourself thought and the personal situation truthfully. We promise that the questionnaire information will only be used for research and will never be disclosed to the public. Thank you for your cooperation.

Q1. Your gender is:

- A. male B. female

Q2. I learned that morning glory has many different colors

- A. strongly agree B. agreement C. Not necessarily
D. a little disagree E. Strongly disagree

Q3. I know that anthocyanins are the reason why many plants like morning glory display different colors in different environments

- A. strongly agree B. agreement C. Not necessarily
D. a little disagree E. Strongly disagree

Q4. I learned related knowledge of complementary colors, contrasting colors, similar colors, and neighboring colors

- A. strongly agree B. agreement C. Not necessarily
D. a little disagree E. Strongly disagree

Q5. In this class, I learned the knowledge of color cycle and did art exercises

- A. strongly agree B. agreement C. Not necessarily
D. a little disagree E. Strongly disagree

Q6. I know the role of anthocyanins in the plant

- A. strongly agree B. agreement C. Not necessarily
D. a little disagree E. Strongly disagree

Q7. I managed to change the color of vegetable juice (or juice) in class

- A. strongly agree B. agreement C. Not necessarily
D. a little disagree E. Strongly disagree

Q8. I successfully made art tie-dye works with vegetable dyes in class

- A. strongly agree B. agreement C. Not necessarily
D. a little disagree E. Strongly disagree

Q9. I think there are some links between art and science

- A. strongly agree B. agreement C. Not necessarily
D. a little disagree E. Strongly disagree

Q10. I understand that there are art works made using science and technology

- A. strongly agree B. agreement C. Not necessarily
D. a little disagree E. Strongly disagree

Q11. In the art class, I will associate knowledge of science

- A. strongly agree B. agreement C. Not necessarily

D. a little disagree E. Strongly disagree

Q12. My favorite classes are art or science

A.art class B.science class C.both of all

The Interview Outline

Q1. Why do morning glory change color at different times?

Q2. Which creative work can we use plant pigment to make?

Q3. Will you bring your knowledge of color rings to appreciate art in the future?

Q4. Have you made any tie-dye works? How do you feel?

Q5. Would you like to take art and science courses frequently in the future?