

Original Research Article

The Status Quo and Reflection on Situation-Creating Method in Junior High School Science Teaching Based on STSE Education

ABSTRACT

In recent years, STSE (science, technology, society, and environment) education ideas have gradually developed and matured in science textbooks, meanwhile situation-creating is a teaching method that can effectively increase students' motivation. When conducting STSE education activities, teachers can infuse STSE education concepts by creating effective teaching situations. With the idea of combining these two to solve practical teaching problems, we analyzed the STSE contents in science textbooks, while investigating the present condition of situation creation in STSE education in a junior high school and summarizing the difficulties encountered in the implementation of STSE teaching, hoping to provide certain help for future STSE situational teaching.

Keywords: STSE education; situation-creating method; science teaching; junior high school.

1. INTRODUCTION

STSE is the acronym of science, technology, society and environment, and STSE education is the education of science, technology, society and environment [1, 2]. Different from the traditional "knowledge-centered" education, STSE education advocates "society-centered" and "student-centered", emphasizing the education to be based on the interests of students and the needs of the society. Science and technology should return to the society and natural environment so as to help students fully understand the impact of science and technology development on the environment and society, enable them to apply what they have learned to productive practice [3, 4].

The situation-creating method refers to the teaching method in which teachers create situations such as problem, competition and happiness that can make students feel relaxed and novel to a certain extent, so as to stimulate students' learning motivation and desire to investigate [5-9]. Therefore, it is beneficial to adopt the teaching method of situation-creating in STSE education.

To truly improve students' scientific literacy, teachers need to use the situation-creating method properly, combine STSE content with textbooks, reveal the essence through careful analysis, and guide students to love science. Therefore, we statistically analyzed the STSE contents in the junior high school science textbooks of Zhejiang Education Press (ZJEP) edition, and sampled the implementation status of STSE education in a junior high school in Hangzhou City.

2. MATERIALS AND METHODS

We used the science textbooks of ZJEP edition as the research material, collected information by reviewing literature method, summarized and compared the data by statistics method.

3. STATISTICAL ANALYSIS OF STSE CONTENTS IN JUNIOR HIGH SCHOOL SCIENCE TEXTBOOKS OF ZJEP EDITION

In the junior high school science textbooks of ZJEP edition, the concept of STSE education has been fully embodied, and the textbooks have a special column of "science, technology, society and environment". The content of STSE is not only found in its own section, but also in the column of "thinking and discussion". Therefore, we conducted a statistical analysis on the STSE related contents involved in these two columns.

3.1 STSE contents statistical analysis in the column of "science, technology, society and environment"

The contents and distribution of STSE in the "Science, technology, society and environment" section were organized as shown in Tables 1-3 below.

As can be seen from the information in Table 1-3, STSE contents in the "science, technology, society and environment" column appear 21 times in two textbooks of Grade 7, 23 times in two textbooks of Grade 8 and 15 times in two textbooks of Grade 9. In terms of content analysis, the knowledge covered in this section is rich and diverse, including knowledge about biomedicine, industry, aerospace, natural disasters, and information about important social events, such as the Wenchuan earthquake.

However, this column does not focus on the principles, but rather on popular science reading materials, which are often used as extracurricular expansion to increase the interest of chapter knowledge. Although the language description is relatively simple and easy to understand, the working mechanism involved in some contents (such as "centrifugal water pump") is complex and difficult to understand.

Table 1. List of STSE contents in the "science, technology, society and environment" section in Grade 7 textbook

Chapter	Section	Content name	Quantity
Volume 1, Chapter 2: Observe the creature	Section 2	Development of microscopy and science	3
	Section 3	Stem cells	
	Section 4	Poisonous snake and emergency measures after being bitten by poisonous snake	
Volume 1, Chapter 3: Earth, the home of mankind	Section 2	Navigation and digital map	4
	Section 3	Formation and utilization of iron ore	
	Section 4	Wenchuan earthquake	
	Section 5	Engineering measures to prevent debris flow	
Volume 1, Chapter 4: Properties of matter	Section 5	liquid crystal	4
	Section 6	Guide groove under rocket launch tower	
	Section 6	Working principle of refrigerator	

	Section 7	Armor of spacecraft - burning material	
Volume 2, Chapter 1: Life from generation to generation	Section 1	Tube baby	4
	Section 3	Cloning technology	
	Section 5	Plant tissue culture	
	Section 6	Preservation of food	
Volume 2, Chapter 2: Awareness of the environment	Section 1	You can't drive after drinking	2
	Section 5	Light pollution	
Volume 2, Chapter 3: Motion and force	Section 4	Stopping distance at different speeds	2
	Section 7	Deep sea manned submersible	
Volume 2, Chapter 4: Earth and universe	Section 4	Qiantang river tides	2
	Section 7	The history of human exploration of the universe	
Total			21

Table 2. List of STSE contents in the "science, technology, society and environment" section in Grade 8 textbook

Chapter	Section	Content name	Quantity
Volume 1, Chapter 1: Water and aqueous solution	Section 2	Atom	5
	Section 3	Hot air balloons and boats	
	Section 6	Water purification in Waterworks	
	Section 7	The South-to-North water diversion project	
	Section 7	Desalination of seawater	
Volume 1, Chapter 2: Weather and climate	Section 2	Optimum growth temperature of several crops	5
	Section 3	Centrifugal water pump	
	Section 3	Lift of aircraft	
	Section 5	Weather forecast and agriculture	
	Section 7	Impact of cold wave on transportation and power	
Volume 1, Chapter 3: Regulation of life activities	Section 1	Herbicide	3
	Section 2	Discovery and synthesis of insulin	
	Section 3	Brain science	
Volume 1, Chapter 4: Circuit exploration	Section 1	Electrostatic precipitator	4
	Section 2	Interference current therapy	
	Section 4	Sensitive resistance	
	Section 4	Speed control of electric vehicle	
Volume 2, Chapter 1: Electricity and magnetism	Section 1	Organisms and magnetic fields	2
	Section 5	Development of electricity and magnetism	
Volume 2, Chapter 2: Models and symbols of particles	Section 3	Dating using carbon-14 (an isotope of carbon)	1
Volume 2, Chapter 3: Air and life	Section 8	PM _{2.5} and human health	1
Volume 2, Chapter 4: Plant and soil	Section 3	Soilless culture	2
	Section 6	Heavy metal pollution in soil	
Total			23

Table 3. List of STSE contents in the "science, technology, society and environment" section in Grade 9 textbook

Chapter	Section	Content name	Quantity
Volume 1, Chapter 1: Substances and their changes	Section 4	Effect of caustic soda on protein and oil	3
	Section 6	Salt wells in Zigong, Sichuan	
	Section 6	Preparation of Bordeaux liquid	
Volume 1, Chapter 2: Material transformation and utilization	Section 1	Heavy metal pollution	2
	Section 6	Steelmaking and recycling of "three wastes"	
Volume 1, Chapter 3: Transformation and conservation of energy	Section 5	Jet engine	4
	Section 5	Energy consumption of automobile	
	Section 7	Safety of nuclear power plant	
	Section 7	Source of radiation	
Volume 1, Chapter 4: Metabolism and balance	Section 5	Artificial kidney	1
Volume 2, Chapter 1: Evolutionary nature	Section 5	Genome changes the future	1
Volume 2, Chapter 2: Biology and environment	Section 5	Returning farmland to forest and grassland	1
Volume 2, Chapter 3: Human health	Section 2	Discovery of penicillin	3
	Section 2	Harm of abusing antibiotics	
	Section 5	Osteoporosis	
Total			15

3.2 STSE contents statistical analysis in the column of "thinking and discussion"

The contents of STSE concept embodied in the column "thinking and discussion" are shown in Table 4-6 below.

From the analysis of the information in Table 4-6, the proportion of textbooks in environmental issues is more than the other three, which also shows the urgency of current environmental and resource issues. The effects of science on technology, social life, production, and the environment are difficult to categorize, the four are often interrelated together, and they are bound to bring about changes in society and the environment while promoting technological development.

The main content of this column is aimed at chapter knowledge in depth, the purpose is to stimulate the communication between student groups and deeper thinking on problems, which is of great help to improve students' thinking ability. If teachers can effectively create corresponding situations in this column, they can not only mobilize students' enthusiasm and activate the classroom atmosphere, but also improve students' learning motivation for science and cultivate students' scientific literacy.

Table 4. List of technology contents of STSE concept in the "thinking and discussion" section in textbooks

Textbook	Number	Content
Grade 7,	1	According to what you have seen and heard, talk about the high-

Volume 2		tech products or projects that have emerged with the development of science.
	2	How to make a level with a heavy vertical line?
Grade 8, Volume 2	3	What is the difference between AC and DC? By consulting the data, we can understand why we usually use AC rather than DC.
Grade 9, Volume 1	4	Give examples of using the reaction between acid and base in life.
	5	Consult relevant materials to understand the application of salt in industrial production.
	6	Collect data on chemical fertilizers and discuss their properties and functions.
	7	Aluminum alloy is widely used in doors and windows of modern buildings. Can you tell me why pure iron or pure aluminum is not used?
	8	Some students' teeth are not arranged neatly. Do you know what method is used for orthodontics in medicine?
	9	Investigate the metal anti-corrosion measures commonly used in life.
	10	What other new materials do you know? Please check the Internet and communicate with your classmates.
	11	What other electrical appliances work by using the thermal effect of current? What are the advantages and disadvantages of current thermal effect?
Grade 9, Volume 2	12	When people have severe diarrhea and severe vomiting, what are the main reasons why they often need to be treated by infusion?

Table 5. List of society contents of STSE concept in the " thinking and discussion " section in textbooks

Textbook	Number	Content
Grade 7, Volume 1	1	Talk about the convenience and adverse effects of the Internet on production and life.
	2	What types of terrain are there in your hometown? What impact does this topographic feature have on local economic development?
Grade 7, Volume 2	3	Why can't color blindness be a motor vehicle driver or other job that needs to distinguish color?
Grade 9, Volume 1	4	Do you think blood donation will affect your health? When you grow up, are you willing to participate in unpaid blood donation? Investigate the situation of local voluntary blood donation.
Grade 9, Volume 2	5	The reference in "heliocentric theory" that the universe is centered on the sun is incorrect. Explain it with the relevant knowledge you know.
	6	What is the significance of the human genome project? What problems may it cause?
	7	Please find the relevant information. Do you agree that transgenic engineering is widely used in agriculture and food production? Why?
	8	What are the main reasons for the increase of sexually transmitted diseases in China in recent 10 years? What countermeasures do you think should be taken?
	9	What kind of eating habits should be formed to improve the

		ability of cancer prevention and cancer prevention?
	10	How to stay away from drugs?

Table 6. List of environment contents of STSE concept in the " thinking and discussion " section in textbooks

Textbook	Number	Content
Grade 7, Volume 1	1	What can we do to protect biodiversity in our daily life? Collect relevant information about nature reserves and animal and botanical gardens and discuss their importance.
	2	According to the formation conditions of debris flow, what methods can reduce the occurrence and harm of debris flow?
Grade 8, Volume 1	3	Why are water supply difficult in some cities in countries with very rich water resources?
	4	How can we save water at home and at school? Talk about specific methods.
	5	What threats will global warming pose to mankind? What activities around us will cause damage to the atmospheric environment? What should be done to protect the atmospheric environment?
	6	What human activities can cause floods or increase the harm of floods?
Grade 8, Volume 2	7	With the rapid development of modern industry, human beings burn a lot of coal and oil. What impact will this have on the carbon cycle?
	8	What are the advantages and disadvantages of "greenhouse effect"? What measures can we take to prevent the aggravation of the "greenhouse effect"?
	9	What sources of air pollution do you know? What are the pollutants produced by these pollution sources?
	10	Give examples of people's health affected by air pollution.
	11	What measures can we take to reduce air pollution in our daily life?
	12	Combined with the reference data in this paper, discuss the harm of brick kiln production to soil resources and the effective protection measures should be taken.
	13	What other pollutants can cause local soil pollution? What preventive or protective measures do you think should be taken in view of the current situation of pollution?
Grade 9, Volume 1	14	What do you think is the unreasonable development and utilization of cultivated land in the local area? How to protect soil resources effectively?
	15	What problems may metal pollution cause? How does China solve these problems?
	16	In order to protect the environment, prevent pollution and finally develop industry under the condition of maintaining a good environment, what measures have China taken to deal with and solve the "three wastes"?
Grade 9, Volume 2	17	Comparing forest ecosystem with desert ecosystem, which ecosystem has strong automatic regulation ability? Why?
	18	Why can afforestation effectively reduce flood and drought disasters?

We plotted the above statistics in a graph as shown in Fig. 1.

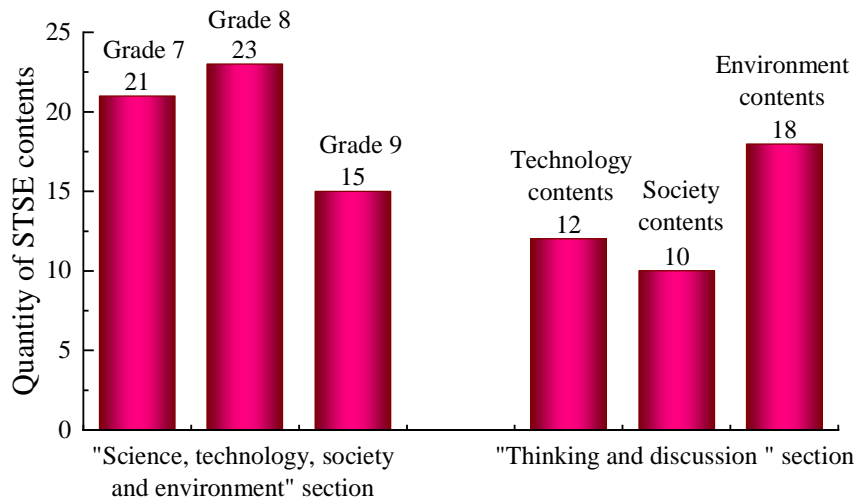


Fig. 1. STSE contents quantitative statistics in junior high school science textbooks of ZJEP edition

4. SURVEY ON THE STATUS QUO OF SITUATION CREATION IMPLEMENTATION IN STSE EDUCATION

4.1 Student Questionnaire

Students have the most intuitive feeling about the degree of implementation of situation creation in STSE education. Therefore, it is necessary to find out the students' learning status and learning needs. We selected two classes of students in Grade one and two classes of students in Grade two with similar academic abilities in a junior high school in Hangzhou as the survey respondents. A total of 184 questionnaires were distributed, and 160 questionnaires were actually valid.

The whole questionnaire consists of 8 questions, of which questions 1 and 2 are about students' interest in the current science classroom and their positive feedback during the class, questions 3 and 4 reflect the students' understanding of the STSE education concept, and questions 5-8 are about students' own experiences with STSE education. In the following, we analyze the questionnaire results from these three perspectives.

4.1.1 Students' interest in science class

The first question was "Do you think the current science class is interesting?", the results of the questionnaire are shown in Fig. 2.

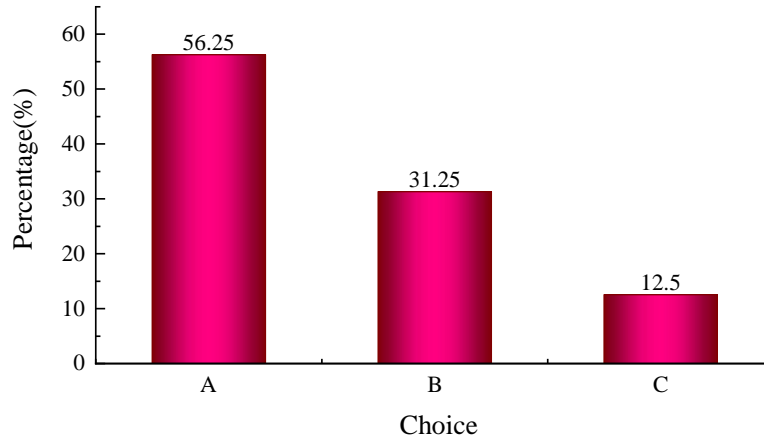


Fig. 2. Statistical results of the survey "Do you think the current science class is interesting?"

**A. interesting B. general C. boring*

The second question was "Are you always able to express your views actively and proactively about the questions in the science classroom?", the results of the questionnaire are shown in Fig. 3.

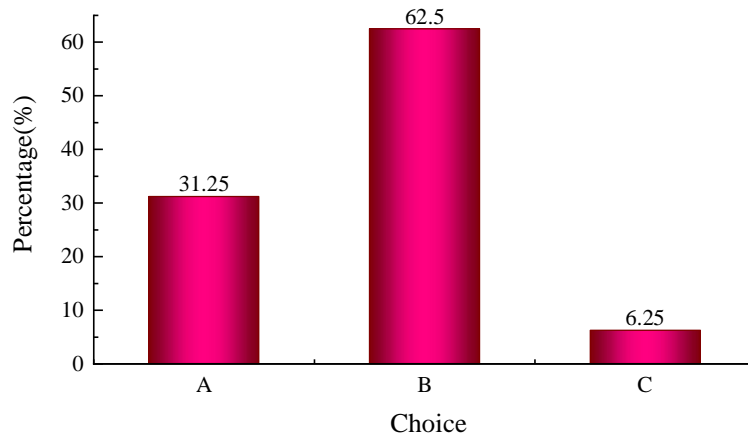


Fig. 3. Statistical results of the survey "Are you always able to express your views actively and proactively about the questions in the science classroom?"

**A. Actively B. Generally C. Not actively*

As can be seen from Fig. 2 and 3, among the respondents, more than half of the students surveyed thought that the current science class was interesting, but the students who were willing to actively give feedback to the teachers in class were not in the majority. 62.5% of the students still chose "generally" motivation, which means that they were still passive. It can be seen that the students are interested in science class, but are less active in the classroom.

4.1.2 Students' cognition of STSE concept

The third question was "Do you know the relationship between science, technology, social production and life, and the environment?", the results of the questionnaire are shown in Fig. 4.

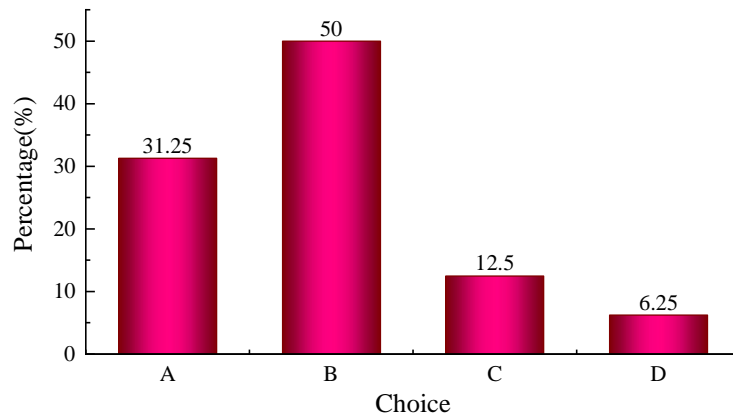


Fig. 4. Statistical results of the survey "Do you know the relationship between science, technology, social production and life, and the environment?"

**A. It is clear that the four of them affect each other*

B. I know that the four have influence on each other, but I don't know the specific examples

C. I don't know much about it, I only know the relationship between one or two of them

D. I don't know

Question 4 was "Do you think STSE knowledge is important?", the results of the questionnaire are shown in Fig. 5.

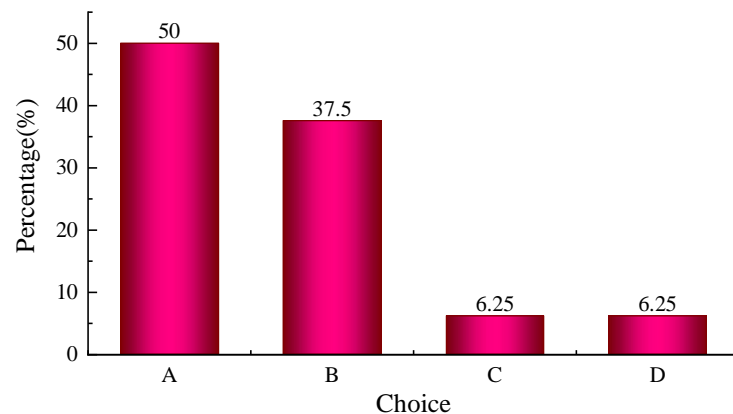


Fig. 5. Statistical results of the survey "Do you think STSE knowledge is important?"

**A. Very important, very helpful in daily life and improving scientific literacy*

B. Important, because it will be covered in the exam

C. General, it depends on whether the teacher emphasizes it or not

D. It doesn't matter

The survey results in Fig. 4 and 5 show that total 81.25% of the interviewed students knew the basic relationship between science, technology, society, and environment, but most of them still did not understand it deeply enough to meet the requirements in the new curriculum standards of mastering the interaction of these four STSE components. In addition, among the respondents, 50% of the students recognized the value of STSE education and believed that it would be helpful to production and daily life. And 37.5% of the students agreed that the reason was the need for examinations, this result also shows the impact of the pressure of further studies on STSE education. We believe that this impact is not only negative, on the contrary, if the content of the exam can be more involved in STSE,

the popularity of STSE education will be greatly increased, which will help students understand the significance of STSE education.

4.1.3 the students' own experience of situation creation in STSE education

Question 5 was "In the science classroom, does your teacher relate science knowledge to technology, society, and the environment?", the results of the questionnaire are shown in Fig. 6.

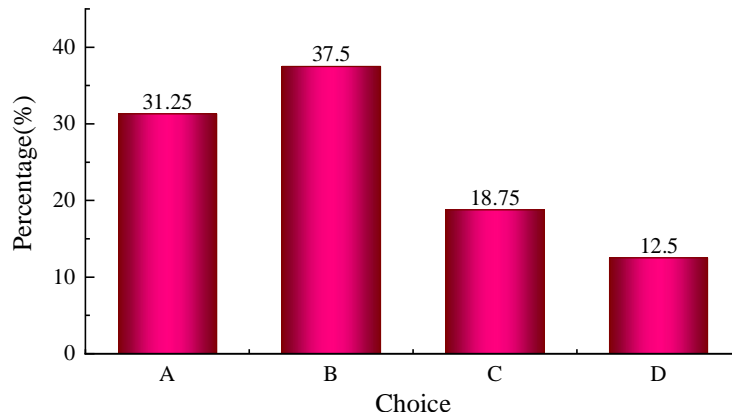


Fig. 6. Statistical results of the survey "In the science classroom, does your teacher relate science knowledge to technology, society, and the environment?"

- *A. The teacher attaches great importance to it and gives us space to discuss it*
- B. The teacher pays more attention to it and often teaches about relevant content*
- C. The teacher doesn't mention it often and pays more attention to the contents of the book*
- D. The teacher basically didn't talk about it*

As shown in Fig. 6, a total of 68.75% of the students believed that their science teachers paid more attention to STSE-related content, and among them, about half of the students were able to conduct class discussions on related topics. However, a total of 31.25% of the students still said that their teachers did not pay much attention to STSE content. We analyzed the reasons for this, which may be that too many chapter knowledge points and too little class time make teachers give up teaching this part of knowledge, but we also do not exclude that students themselves do not have a complete grasp of STSE concepts and do not make clear judgments to give correct feedback.

Question 6 was "In what way does your science teacher usually teach STSE-related knowledge?" (multiple choice), the results of the questionnaire are shown in Fig. 7.

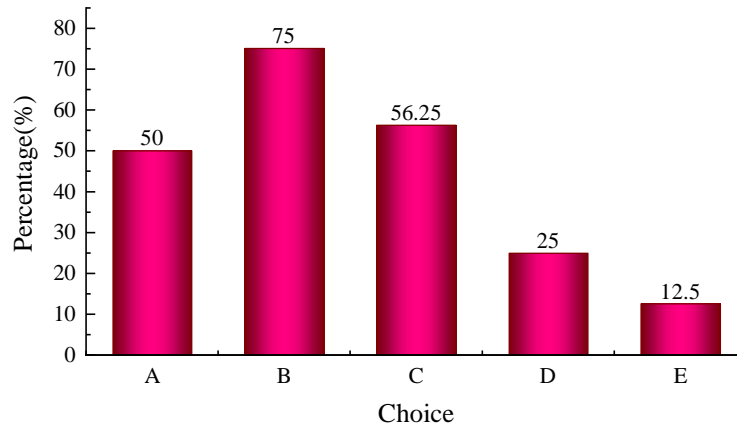


Fig. 7. Statistical results of the survey "In what way does your science teacher usually teach STSE-related knowledge?"

**A. By creating some interesting situations*

B. By relating to real life situations or sharing their own experiences and feelings

C. By having discussions among classmates

D. Teaching conclusive knowledge directly

E. Other

As shown in Fig. 7, most of the teachers chose to deepen students' understanding of STSE by making real-life connections or sharing their own experiences. In addition, the second most popular method was to have students discuss the results in small groups. Situation creating was also chosen by many teachers, but it was not the preferred method. A small percentage of teachers skip to the concluding statements. Obviously, direct narration saves time but lacks both teaching and learning interest, which can prevent students from having a tangible experience and is not conducive to memorability.

Question 7 was "Does your science teacher often create situations in teaching?", the results of the questionnaire are shown in Fig. 8.

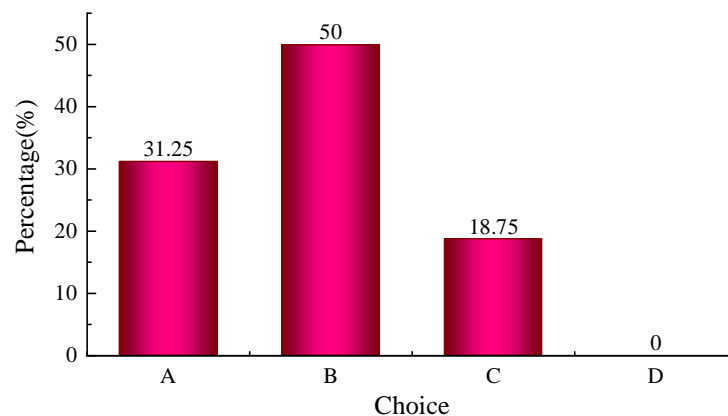


Fig. 8. Statistical results of the survey "Does your science teacher often create situations in teaching?"

**A. Often, very interesting*

B. Occasionally, it feels fresh

C. Not very often, usually go straight to the chapter content

D. Did not notice

The statistical results in Fig. 8 show that 31.25% of the students surveyed believed that their teachers often used the method of situation creation in STSE education, 50% of the students said that their teachers occasionally created situations for STSE content, and 18.75% of the students indicated that their teachers used a more direct approach to teaching this content. In our opinion, it is difficult to apply the situational creation method in STSE education. But at the same time, due to the limitation of chapter knowledge and the limitation of teachers' energy, they can not design teaching plan for each relevant piece of STSE content. As a result, the degree of application is not as high as theoretically predicted.

Question 8 was "Are you satisfied with the content of the 'Science, Technology, Society and Environment' section of science textbooks?", the results of the questionnaire are shown in Fig. 9.

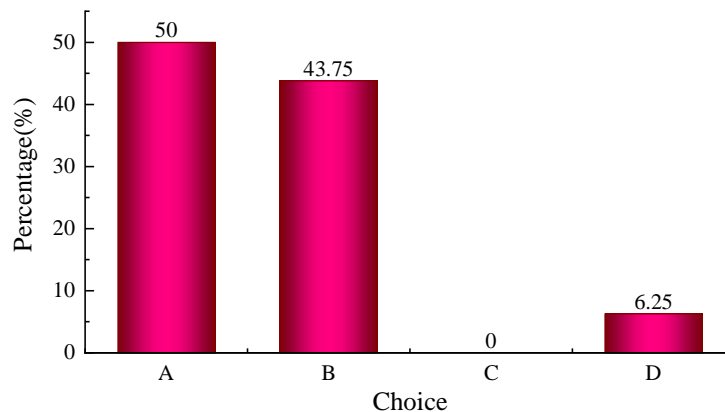


Fig. 9. Statistical results of the survey "Are you satisfied with the content of the 'Science, Technology, Society and Environment' section of science textbooks?"

**A. Satisfied, it is interesting and helpful*

B. General, it is not very important

C. Unsatisfied, it is too difficult to understand

D. Other

As can be seen from Fig. 9, the current science courses were attractive to students, and most students agreed with the value of STSE education, but the actual degree of STSE education proceeding is not ideal. Moreover, it is not easy to apply situation-creating method in STSE education, and the requirements for teachers are very high. But this is indeed a good way to deepen students' understanding of the relationship between the four STSE components, and enable students to transform from a "passive" acceptance state to an "active" participation state in the classroom.

4.2 Teacher interviews

We also interviewed the science teachers of this junior high school about the current application of situation-creating method in STSE education, including three veteran teachers with more than six years of teaching experience, two new teachers who had been teaching for less than three years, and one newly appointed science teacher. The interviews with different teachers yielded differentiated perspectives, which can be analyzed from the following three aspects.

4.2.1 The teacher's cognition of the STSE concept

The concept of STSE education did not arise in the past two years, so science teachers at this stage all knew about it, but the degree of understanding was different. Among the six teachers interviewed, the concept of STSE was generally recognized, and the respondents all believed that it was necessary to implement it.

4.2.2 Status of implementation of STSE education

From the interview, it can be concluded that new teachers were generally more enthusiastic about conducting STSE education, but veteran teachers tended to consider more complex factors and were therefore less willing to implement it. It can also be shown that although STSE education had a high degree of recognition, there were still greater difficulties in actual teaching.

The existing real predicament in junior high schools makes the conditions for developing STSE education harsh, which can be summarized into the following five points:

First, there was a lot of pressure to advance to higher education. Because the distribution of high school entrance examination sites in STSE was non-intensive, this led teachers to perceive little test-taking utility and attach little importance to them.

Second, the class time schedule arrangement was tense. Due to many knowledge points in chapters, limited classroom time and heavy subject teaching tasks, teachers could not spare more time to carry out STSE-related education.

Third, there were differences in students' learning ability. Different students had different degrees of acceptance of knowledge, and in the context of large classes, teachers could not take care of all students at the same time, which narrowed the range of choices for teachers to teach knowledge.

Fourth, teachers' own level was limited. The natural and effective combination of STSE-related knowledge with textbook knowledge required teachers to have strong ability and sufficient experience, which was difficult for many teachers.

Fifth, there was a lack of a systematic STSE curriculum. Although there was the idea of STSE in the textbooks, they were not systematic, targeted education was still not enough. Relying only on the tenured teachers their own to create was too demanding and less realistic.

4.2.3 Considerations related to situation creation in STSE education

The interviewees generally affirmed the feasibility of using situation-creating method to conduct STSE education. We summarize the interview results and summarize the relevant factors considered by the interviewees, including teaching time, students' attention, students' real-life experiences, and the degree of fit between STSE knowledge and curriculum knowledge points. The interviewees also emphasized that the sense of distance and authenticity of the situation in the teaching design would have a great impact on the effectiveness of the course.

Based on the above analysis results, it can be seen that although STSE education has a high degree of recognition among teachers, there are many difficult problems in the design and application of situation creation in STSE education, so the degree of practice is limited. But this also affirms the significance of this paper's research, which is to solve the difficult

problems, so that the application of situation-creating method in STSE education can be improved in both depth and breadth.

5. CONCLUSION

We statistically analyzed the part about STSE in the junior high school science textbook of ZJEP edition. And based on the results of the students' questionnaires and the teachers' interviews of a junior high school in Hangzhou, the difficulties of STSE situational education in practice were summarized as follows: the pressure of entering high school for promotion made it of little value for entrance examinations; the limited classroom time made it of no educational space; students' learning ability made it impossible to clarify its scope; teachers' own level limited its development; the lack of a systematic curriculum made it too idealistic; the wide range of chapter knowledge points made it too difficult to choose the topics to teach. Although there were problems in practical application, both teachers and students had hopes for STSE situational teaching.

The application of situation-creating method in STSE education is in line with the concept of sustainable development and the current development needs of students. It is believed that through the joint efforts of the educational community, STSE situational education can make greater progress in depth and breadth.

CONSENT

All the interviewees consent the use of their views for analysis and publication purpose of the study.

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