

Research on STSE-HPS Teaching Design Based on the Core Quality of Chemistry Subject—Taking the Teaching Design of "Introduction to Junior Three Chemistry" as an Example

Ruizhu Xu¹, Mengjiao Tuo¹, Ting-ting Yan²

¹ School of Chemistry and Chemical Engineering, Yan'an University, Yan'an 716000, Shaanxi Province, China;

² Xi'an Haitang Vocational College, Xi'an 710038, Shaanxi Province, China

Abstract: For students in the third year of junior high school, it is their first time learning the subject of chemistry. Their future learning will be largely related to the first introduction lesson taught by the teacher, so this article takes the third year chemistry introduction lesson as an example, through the combination of STSE and HPS theories applied to teaching in the process of teaching design, which plays a critical role in cultivating students' core literacy in chemistry.

Keywords: Chemistry subject core literacy; Teaching design; STEM-HPS

Publication date: November, 2020

Publication online: 30 November, 2020

***Corresponding author:** Ruizhu Xu, 564441070@qq.com

For the children in the third grade, it is their first time learning chemistry. They are full of curiosity about chemistry, and Einstein once said: "Interest is the best teacher", so the first question for teachers is how to make children become interested in the subject of chemistry. For this problem, researchers use different ways to devise various teaching designs for the third year chemistry introduction lesson. Nowadays, STSE education and HPS education have attracted much attention. The teaching design is based on the core literacy of the chemistry subject to integrate the two together, designing a third grade chemistry introduction lesson.

1 Design Concept

STSE education is an important part of the STSE field developed from the integration of STS education and environmental education, and it has become the mainstream direction of education reform and development today^[1]. The goal of STSE education is to improve students' comprehensive literacy, so that students can form a sustainable development concept that unifies science, technology, society and the environment, and enhances their sense of social responsibility^[1].

HPS is a teaching model integrating History, Philosophy and Sociology of Science, and an important way to cultivate students' scientific literacy and core literacy^[2]. This teaching mode puts students in the created scene of chemical discovery, following the scientists to feel and experience the process of dynamic generation of chemical knowledge, experience the fun of using theory and experiment to explore the truth, to highlight and cultivate the five core subject literacy of the students. Combining the educational concepts of STSE and HPS in chemistry teaching allow students to promote their active exploration of chemistry knowledge through the study of history of chemistry, and then use hot social topics and frontiers close to real life to create genuine teaching situations for students. The theory is connected with reality to deepen their understanding of knowledge, and then combined with the society and the actual environment to cultivate their ability to conserve energy, sustainable development and solve social problems. At the same time, they can also be

more comprehensive and accurate in nurturing and highlighting the five core chemistry literacy of junior middle school students.

2 Analysis of the Teaching Materials

The introduction lesson is like a chemical seed waiting to germinate, and the teacher will teach the children on how to cultivate this chemical seed in this lesson. The introduction to the junior three chemistry booklet of the PEP textbook starts from the fact that human's daily life is closely related to chemistry, and through the display of various modern scientific and technological achievements, it covers the history of human understanding, application and development of chemistry, as well as the relationship between chemistry and human progress and social development. Lastly, it gives the definition of chemistry, and points out what is the meaning of green chemistry, and then go on to the process of explaining chemistry, and eventually lead the children to gradually understand what chemistry is.

3 Teaching Objectives

"Developing the core literacy of students" is another new curriculum reform concept after the "three-dimensional goal". It answers the question of "who

to train and how to train them", and it comes from the implementation of the fundamental mission of instilling moral and educating people. Therefore, the teaching objectives of this teaching design are as follows:

- (1) Can give examples between chemistry and life, society, science and the environment
- (2) Through the design of experimental exploration, the subject of chemistry is covered with a veil of mystery, making it curious about chemistry, and thus arousing a strong interest in learning chemistry.
- (3) Through the exploration of two interesting experiments, analyze the causes of chemical phenomena from the combination of macroscopic and microscopic view and the ideas of change and reasoning, comprehensively analyze the development process of chemistry, and develop chemistry learning method and thoughts by "learning chemistry from life" and "seeing essence through phenomena".
- (4) Experience the rigorous scientific attitude of scientists, experience the process and fun of scientific inquiry, and discover the close relationship between chemistry and society, chemistry and life, chemistry and technology, and chemistry and the environment, and gradually establish STSE concepts(Figure 1).

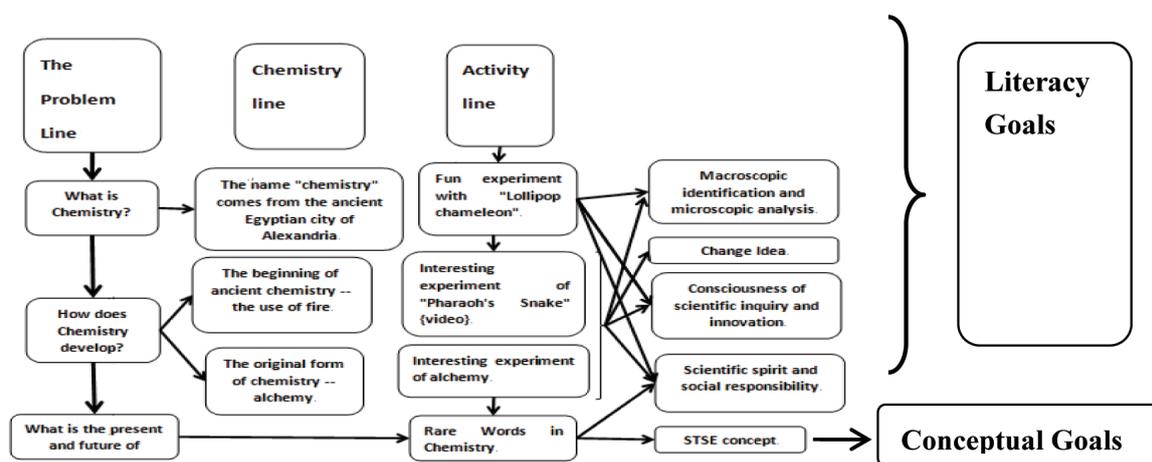


Figure 1. Teaching Process

5 Teaching Process----- Problem-driven Learning

5.1 Question 1: What is chemistry?

【 Teacher 】 When one was young, everyone must have been puzzled as to why the balloons sold on the street can fly into the sky, but the balloons we blow

ourselves cannot fly; when firecrackers are set off during the New Year, a small firecracker can make such a loud sound. Why are there various colors and patterns of fireworks in the sky, etc., but you will be with a mysterious guest today, and it will solve all your questions and confusions. What is it? (Introducing the term 'chemistry')

【 Students 】 Chemistry

【 Teacher 】 The British call it "chemistry", and I say it is "chem is try", that is, chemistry is to try. So since chemistry means trying, I have a cup of water (with a small amount of sodium hydroxide solution) and a lollipop that you all like to eat (the ingredients contain fructose, glucose, maltose and other reducing sugars), who would like to perform a little magic for everyone?

【 Experiment: Lollipop Chameleon 】 Ask a classmate to add a small amount of potassium permanganate prepared beforehand to this cup of water and mix well, then put a lollipop into it and start stirring.

【 Teacher 】 This student, please stop the stirring first. What do you think this cup of purple water has turned into?

【 Students 】 It has become a glass of green "apple juice". Ask this student to continue stirring with lollipop, everyone continue to observe what it becomes?

【 Students 】 It has turned into a cup of yellow "orange juice", some people say it has turned into a cup of yellow "mango" juice.

【 Teacher 】 We applaud and congratulate this student for turning a glass of water into "apple juice" and then "mango juice", but these juices are fake (all the students laughed), so the magic power that this student had was empowered by chemistry. So "what is chemistry?"

【 Writes on blackboard 】 Chemistry

(Design intent: Through the design of the "Lollipop Chameleon" experiment, we put a veil of mystery on the subject of chemistry, and make students have a strong interest and curiosity in chemistry, highlighting the core literacy of "macroscopic identification and microscopic analysis", "concepts of change", and "scientific inquiry and innovative awareness" of the chemistry subject, and then grasp the curiosity of students to introduce the topic of today's study: What is chemistry?)

5.2 Question 2: The History of Development of Chemistry?

【 The birthplace of chemistry 】 -----The origin of the name "chemistry"

【 Teacher 】 Each of us has a name, so how did everyone get their name? So where did the term "chemistry" originate?

【 Teacher 】 In our history of chemistry, it is

generally believed that the term "chemistry" originated in the city of Alexandria in ancient Egypt. This city is located at the mouth of the Nile River. There were not only the technologies of metallurgy, dyeing, and glass manufacturing, but also ancient Greek philosophy. The combination of the two led to the birth of the concept of "chemistry". Later, the word "chemistry" appeared for the first time in the book of gold and silver production in Alexandria, and it was also the first time in the world. (The students were surprised)

【 The beginning of ancient chemistry 】 -----The use of fire

【 Teacher 】 Students, do you know how the Olympic flame is lit?

【 Students 】 Of course it is lit with a lighter or a match.

【 Teacher 】 It's incorrect. The Olympic flame cannot be ignited with matches or lighters. Instead, sunlight is collected and converged with a condenser, which is the principle that you use a magnifying glass to light a paper in the sun. In the long-term struggle between mankind and nature, we had learned to use fire and start a fire by methods such as drilling wood, friction and so on.

【 Play video 】 "The Pharaoh's Snake"

【 Teacher 】 Isn't it amazing? These substances do not burn like what we usually see in burning, but crawling out like snakes. In ancient times, due to the lack of scientific knowledge, people thought that this was a kind of witchcraft with a spell.

【 Teacher 】 Because of people's discovery of fire, many scientists have raised the same question: Why does matter burn? What kind of conditions will it burn? In response to these questions, scientists have verified their hypotheses through various experiments. Finally, French chemist Lavoisier believes that the burning of substances is due to the presence of oxygen! Do the students agree with Lavoisier's point of view?

【 Students 】 agree unanimously

【 Teacher 】 For such a simple conclusion, it took a long time to find the correct statement and answer. Therefore, in the scientific world, any scientific theory is obtained by a scientist after a long time. Yes, our current study is actually standing on the shoulders of giants, so you must cherish this kind of learning opportunity, study science and work hard to realize the Chinese dream of great renaissance.

【 The original form of chemistry 】 ----- Alchemy

【 Teacher 】 You may not have heard of alchemy, but alchemy should be familiar to you! Who in Journey to the West can make an elixir?

【 Students 】 The students replied excitedly: "Tai Shang Lao Jun".

【 Teacher 】 Well, the Tai Shang Lao Jun in foreign countries was called an alchemist. The teacher also came to be a "Tai Shang Lao Jun" today, not churning out an elixir, but turning a copper coin into a gold coin.

【 Demonstration experiment 】 Put a copper coin and some zinc flakes into the zinc sulfate solution and heat it to boil, take out the copper coin that was put in and find that it becomes a "silver coin", and then scorch the "silver coin" on high temperature flame. After a while, it was discovered that the "silver coin" has become a "gold coin".

【 Teacher 】 Did the teacher really conjure up gold? The teacher did not make real gold, but those alchemists in the ancient times believed that they had really made gold. In future studies, you will be able to answer the questions for these alchemists. Nowadays many magic tricks use the principle of chemical knowledge to blind everyone's eyes, so the world of chemistry is mysterious and interesting. You must be really looking forward to learning it in the future!

【 Teacher 】 At the end of today's lesson, everyone must still not know what chemistry is? You have such doubts, and previous scientists also have the same doubts too. Based on the findings of previous chemists and scientists, Dalton and Avogadro had come to an important conclusion: matter is composed of atoms and molecules. The recombination of atoms in a molecule is the basis of chemical change.

【 Teacher 】 Therefore, we can give an accurate definition of chemistry: Chemistry is the science of studying the nature, composition, structure, and changing laws of matter at the molecular and atomic levels.

(Design intent: Through the exploration of two interesting experiments of "Pharaoh's Snake" and "Alchemy", the reasons behind chemical phenomena are analyzed from the combination of macroscopic and microscopic views and the ideas of change and reasoning, so that students can experience the rigorous scientific attitude of the scientists, and experience the process and fun of scientific inquiry.

This highlighted the core literacy of "macroscopic identification and microscopic analysis", "concept of change", "scientific inquiry and innovative awareness" and "scientific spirit and social responsibility" in the subject of chemistry ^[3].)

5.3 Question 3: How will chemistry develop now and in the future?

【 Teacher 】 Students please turn to the last page of the book. Here is a table called the periodic table of elements. Each grid is called an element, and each element has a fixed name. The teacher will now play a video for everyone, the lyrics in the video use the names of these elements. Please refer to the periodic table to listen to this song!

【 Play video 】 "Uncommon Words in Chemistry"

【 Teacher 】 After listening, everyone should be very emotional! Each element has its own purpose. I hope that everyone living in China will also play their role and be a useful person. Knowing so much about the past of chemistry, what does the present of chemistry look like? What will the future of chemistry hold? Please look at the four pictures on page 4 of the textbook. This is the contribution of chemistry to us now. For the future of chemistry, we will move towards the direction of "green chemistry", and do our best to not pollute the environment while benefiting the world. So what you can do now is to study chemistry well and protect the environment in your daily life.

6 Conclusion

In this class, we learned about the life deeds of chemistry, from the origin of the name to the use of fire, alchemy and atomic and molecular theories, and finally to the various fields of energy, materials, medicine, information, environment and life science in modern day, as well as green chemistry in the future. We have discovered that chemistry is actually closely related to our lives, so we must develop a good habit of learning chemistry from life and the idea of seeing the essence through phenomena. Bring these things and enter the magical world of chemistry, the teacher believes that you will have different rewards!

Design Purpose: In this link, the latest media resources and the conclusion of this lesson was introduced so that students can develop the methods and ideas of "learning chemistry from life" and

"seeing essence through phenomena", so that students can discover the close relationship between chemistry and society, life, and technology, gradually establish the concept of STSE, and highlight the core literacy of "scientific spirit and social responsibility" in the subject of chemistry.

References

- [1] Wang WJ. Research of High School Chemistry Teaching Design Based on STSE Education Concept [D]. Xinyang Normal University, 2019.
- [2] Wang S, Jin Y. Teaching Practice of HPS Based on the Nature of Science—The Teaching Design of Introduction to Junior Middle School Chemistry[J]. *Journal of Chemical Education*, 2015, 36(1): 39-42.
- [3] Liu Y, Wang XH, Zhang DH. Teaching Design of “Iron Salts and Ferrous Salts” Based on Chemistry Discipline Core Literacy[J]. *Chinese Journal of Chemical Education*, 2019, 40(7): 33-37.