



Teaching the Big Concept of Chemistry in the Context of China's Basic Education Reform

Yanyan Tang

College of Chemistry and Chemical Engineering,
Henan University, Kaifeng, China

Suyi Xu

Central Philippine University, Iloilo, Philippines

Ying Xu

College of Chemistry and Chemical Engineering Henan University,
Kaifeng, China, Central Philippine University, Iloilo, Philippines

Pengyun Wang

College of Chemistry and Chemical Engineering,
Henan University, Kaifeng, China

ABSTRACT

In the eighth curriculum reform, China proposed to develop students' core literacy in disciplines, aiming to explore what kind of teaching mode and means can cultivate outstanding talents through Chinese school education, and emphasize the emphasis on the teaching of major concepts of disciplines to make the curriculum content structured. The teaching of major concepts is highly abstract and generalized, which can help students establish a knowledge structure system and promote the transfer and application of knowledge. This paper takes the knowledge of galvanic batteries as the carrier and the question of "why can the fan rotate" as the driving force, forms a cognitive model, and puts forward a unit teaching led by a large concept from the perspective of energy conversion, so that students can better understand the galvanic battery model and apply it to life, so as to promote the development of students' core literacy.

Keywords: Big concept, Core literacy, Education reform, Galvanic cells

Since the beginning of reform and opening up in 1978, China has gone through four stages of basic education reform, each of which has been practiced in combination with national conditions, school conditions and academic conditions, and achieved good results. From the Ministry of Education proposed to strengthen "double-base" teaching in the classroom to primary and secondary schools from "examination-oriented education" to comprehensively improve the national quality of education, the development of China's education has made great progress, from 2001 to 2007 put forward the "three-dimensional goal" students' inquiry ability and autonomy has been well developed, now the teaching under the core literacy emphasizes that big-concept teaching can better implement quality education.

INTRODUCTION OF BIG CONCEPTS

The idea of big concept can be traced back to Bruner, who believes that big concept is the knowledge structure of the discipline, the knowledge framework formed in the student's mind, and this framework is extremely transferable and inductive [1]. Ausubel proposed the theory of "advance organizer", the so-called first organizer is a big concept, that is, a guide material with higher abstraction and generalization, which not only provides a key fixation point for the learning of new knowledge, but also increases the recognizability between new and old knowledge [2]. Erikson believes that the big concept is the core of the discipline, the essence bone marrow of a discipline that removes the surface shell, and has a strong transferability, and over time students can apply the knowledge learned in school to the vertical intradisciplinary context inside and outside the school, as well as the horizontal interdisciplinary context. [3]

In 2011, the Dutch educator Wynne Harlen defined the concept of "big concept" in the book "science education with the concept of big concept" as the concept that we can use to explain and predict a wide range of natural phenomena. It divides big concepts into scientific concepts and concepts about science, and puts forward four characteristics that big concepts should have [4].

Whiteley emphasizes that big concepts are building materials for understanding and can be considered as meaningful patterns to enable people to connect other scattered knowledge points [5].

This requires teachers to integrate textbook knowledge more systematically to provide students with more organized chemical knowledge. The big concept is not disorderly free in the discipline structure but presents a network structure. This network-like structure includes intra-disciplinary network structure and inter-disciplinary network structure (also known as interdisciplinary network structure), and each big concept is the base station that completes the communication between network structures [6]. The big concept network in the discipline refers to the vertical connection of a certain discipline, and the selection and organization of the course content with the big concept as the center in different sections, which is the key clue of the course design. The inter-disciplinary big concept refers to the horizontal connection of certain disciplines, spanning two or more knowledge fields, and the reasonable connection between different disciplines based on a common big concept, which effectively blurs the boundary between disciplines. Any subject will not exist in isolation, and teaching will inevitably involve the comprehensive application of several subjects.

In the "General High School Chemistry Curriculum Standards (2017 Edition 2020 Revision)" issued by the Ministry of Education of China, it is pointed out that "attaching importance to taking the big concept of the discipline as the core, structuring the curriculum content, taking the theme as the guide, contextualizing the curriculum content, and promoting the implementation of the core literacy of the discipline." This is the first time that China's basic education emphasizes in the curriculum standards that the curriculum content needs to be structured with the big concept of the discipline as the core to promote the implementation of the core literacy of the discipline [2].

In the context of the new curriculum reform, the proposal of core literacy is intended to explore what kind of teaching mode and means can truly cultivate outstanding talents in Chinese schools. In 2020, major changes have been made to the high school entrance examination system in various provinces and cities and the college entrance examination system in different regions. It requires a considerable number of students to carry out vocational and technical education after the academic examination. At the same time, the '3 + 1 + 2' elective system is implemented in the first grade of senior high school, which requires teachers to guide students to make reasonable planning for future learning. It poses a challenge to how to develop students 'key competencies' and 'essential character' in class.

The "General High School Chemistry Curriculum Standards (2017 Edition)" (hereinafter referred to as the "New Curriculum Standards") clearly states that the subject curriculum should "attach importance to the core of the big concept of the subject and structure the course content." [2].

THE BIG CONCEPTUAL FRAMEWORK IN THE KNOWLEDGE OF 'CHEMICAL ENERGY AND ELECTRIC ENERGY'

As the key to leading the implementation of the core literacy of the discipline in the curriculum reform in the new era of China, the big concept has become a hot topic in the field of education. If teachers master the basic conceptual framework of the subject, it will help students retain the memory of subject knowledge and promote the transfer of learning [8].

The unit of "chemical energy and electric energy" in the compulsory stage of Chinese high school textbook belongs to the part of "chemical reaction and energy conversion" in the theme 3 of the new curriculum standard. The new curriculum standard of China clearly points out: 'Knowing that chemical reaction can realize the conversion of chemical energy and other forms of energy, taking the primary battery as an example to understand that chemical energy can be converted into electrical energy, and preliminarily understand the working principle of the primary battery from the perspective of redox reaction' [9]; teaching strategies should 'play the functional value of important knowledge, help Chinese students develop the basic perspective of understanding chemical reactions, and form basic concepts' 'When things change or are changed, energy conversion occurs, but the total amount of energy in the universe is always constant' [10]. The content of chemical energy and electrical energy in the PEP high school chemistry compulsory (Book 2) textbook (hereinafter referred to as the "new textbook") published in China in 2019 mainly includes the primary battery and its working principle, the design and production of simple batteries (the discussion of the elements of the primary battery and its nature and function), and the chemical battery (the simple understanding of zinc manganese dry battery and lead-acid battery). The teaching design is based on the big concept of "when things change or are changed, energy conversion will occur, but the total amount of energy in the universe is always the same," to help students form a model cognition.

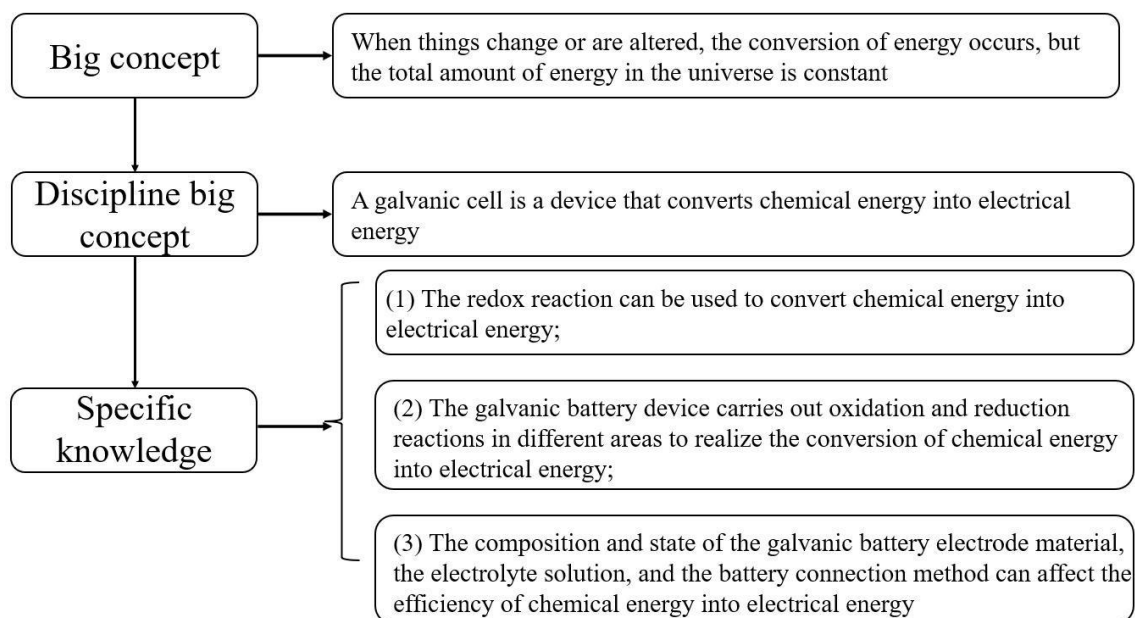


Fig.1 The big concept knowledge framework in ' chemical energy and electric energy '

UNIT TEACHING OBJECTIVES AND OVERALLTEACHING IDEAS

Overall Teaching Ideas

Guided by the big concept of the subject, taking the real problem as the situation, let the students gradually establish the original battery model in the situation, so as to analyze and apply the established model to the real situation again, and enhance the students' sense of social responsibility and innovation consciousness. The content of this section is divided into two hours of teaching, see figure 2.

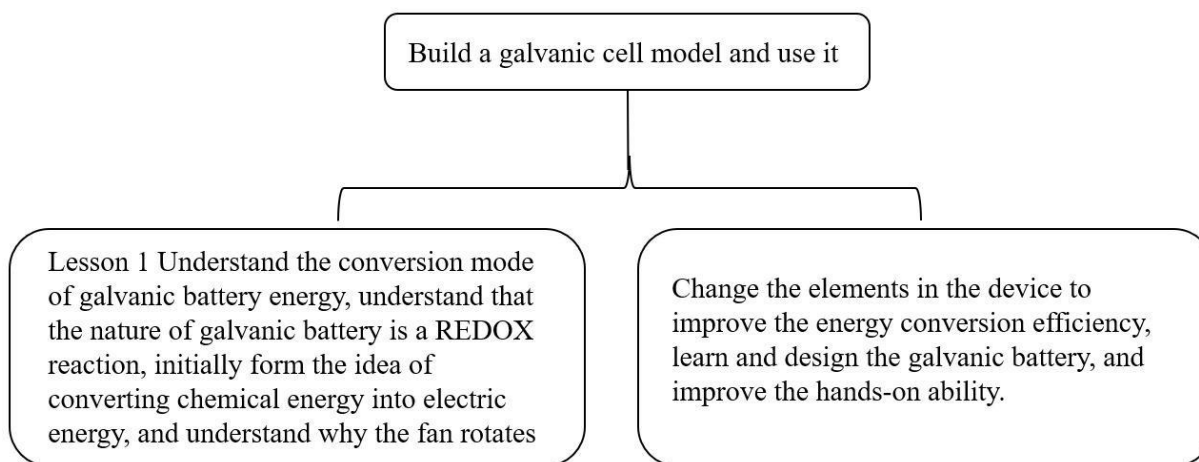


Fig.2 Distribution of teaching hours

Analysis of Learning Situation

In junior high school and senior high school, Chinese students learn the relevant knowledge of 'chemical energy and electric energy':

1. Students learned the knowledge of the order of metal activity in Chinese junior high school chemistry textbooks;
2. Students in the first volume of the compulsory textbook for senior one in China learned

- that the essence of the redox reaction is the transfer of electrons;
3. The first section of this chapter studies the knowledge of chemical energy and thermal energy, and recognizes that the fracture and formation of chemical bonds in chemical reactions are the essential reasons for energy changes in chemical reactions.

Before this, Chinese students have learned some basic experiments, but they have not yet involved themselves in designing experiments. Therefore, through this unit learning, students' ability to design experiments can be improved.

Teaching Objectives

1. Understanding the primary battery from the perspective of chemical reaction and energy conversion, and understanding the essence of chemical energy and electrical energy conversion;
2. Establish a systematic analysis of the electrochemical process to form an understanding of the nature of electrochemistry;
3. Understanding the practical significance and important application of electrochemical knowledge, looking forward to the future design of the battery;

Teaching Difficulties

1. Understand the relationship between the essential changes and conservation of chemical energy and electrical energy from the perspective of redox reaction.
2. Experimental study on the conditions of the primary battery;

Teaching Methods

Teaching method, experimental inquiry method, discussion method

THE TEACHING DESIGN OF 'CHEMICAL ENERGY AND ELECTRICAL ENERGY' UNDER THE GUIDANCE OF BIG CONCEPT

Professor Zhang Xinghua combed the teaching design of chemical energy and electrical energy in China from 2010 to 2020, and found that there are still few articles on the study of big concepts. The big concepts of disciplines are highly abstract and general. The unit teaching design guided by the big concepts of disciplines can help students establish a knowledge structure system and promote the transfer and application of knowledge. The content of 'chemical energy and electric energy' in this section reflects the important concept of chemistry: energy concept, which allows students to learn through this class that the conversion of energy requires certain conditions. The primary battery is a device that converts chemical energy into electric energy. Changing certain conditions can improve the efficiency of converting chemical energy into electric energy.

The First-Class Teaching Design

[Situational introduction]

Teacher demonstration experiment:

[Task 1] Why can the fan rotate?

What is the energy conversion relationship when the fan rotates?

Which reactions can generate current to make the fan rotate? Why Zn and dilute H_2SO_4 direct reaction can not let the fan rotation

Activity 1: Students discuss the energy conversion relationship;

Activity 2: The experiment verifies whether the active metal alone reacts with dilute H_2SO_4 to generate a current; Activity 3 : Build copper-zinc primary batteries to rotate the fan ; Energy can be converted to each other ; Chemical reaction is an important way to realize energy conversion.

Chemical energy can be converted into electrical energy by redox reaction.

[Building Model]

[Task 2] Taking the built copper-zinc primary battery as an example, the working principle of the primary battery is analyzed.

Why are there bubbles on the copper surface? Where does the electron come from?

How do the ions in the solution move? Activity 4: Try to write the electrode reaction;

Activity 5: Using the ammeter to judge the positive and negative electrodes of the copper-zinc primary battery and analyze the reasons;

Activity 6: Taking copper-zinc primary battery as an example, the primary battery model is constructed;

the primary battery device makes the oxidation and reduction reactions generate current at different electrodes, and realize the conversion of chemical energy into electrical energy.

[Deepening Model]

[Task 3] Select different electrodes and design more primary batteries based on the above model; summarize the conditions for the formation of primary batteries?

Activity 7: Experiment to explore and summarize the conditions for the formation of the primary battery;

1. Zinc, iron, dilute sulfuric acid;
2. Zinc, graphite, dilute sulfuric acid;
3. Iron, copper, dilute sulfuric acid;
4. Zinc, zinc, dilute sulfuric acid;
5. Other conditions remain unchanged to change the type
6. of solution using alcohol, dilute sulfuric acid;
7. Other conditions unchanged, two electrodes were inserted into two beakers; observe whether the current is generated to draw a conclusion;

The transformation of energy is conditional;

the formation of the primary battery needs to meet certain conditions:

(1) There are two metals with different activities (or one is yes or no).

1. Under the guidance of the big concept, the application model is explored through experiments to internalize the big concept.

The concept of big concept education is based on the fact that the course content in teaching is too complicated, the connection between knowledge and knowledge is weak, the knowledge learned by students is fragmented, divorced from life, and it is difficult to transfer and apply [11]. The big concept reflects the deep meaning behind the knowledge.

Through the study of the first class, the students understand the components of the primary battery model and the primary battery, and form a basic energy concept. However, these methods need to be internalized and repeated in practice.

REFLECTION AND CONCLUSION

Professor He Caixia proposed that we can analyze and grasp the concept of chemistry from the following aspects: First, it points to the research object and basic problems of chemistry; the second is to point to the research methods and cognitive methods of chemistry; the third is to point to the purpose and value of chemistry research [12]. The teaching design under the guidance of the big concept condenses the subject knowledge and focuses on the essence of the subject, but some contents cannot run through it, so it should be targeted [13]. For example, in this class, the direction of ion migration in solution is a macroscopic phenomenon that cannot be seen in the experiment. Teachers need to use other methods to make up for the missing part of the big concept teaching design. [14]. On the whole, guided by big concepts, guiding teaching design is helpful to the construction of students' energy transformation concept and the development of subject core literacy [15]. We need to continue to learn, develop more content to integrate into a big concept, so that students' learning more depth and breadth.

Chinese students' cognition of primary batteries needs to be further deepened in elective courses, and the relevant core literacy goals of disciplines cannot be achieved through one or two classes. It is necessary to construct unit teaching content in combination with relevant content in the elective stage, design teaching as a whole, and combine teaching content with students' cognitive characteristics [15], so as to gradually develop students' core literacy of disciplines.

Each curriculum reform in China represents the progress of the times and also puts forward new requirements for teacher development. It is necessary for Chinese experts and teachers of various subjects to combine theory and practice to explore a path that belongs to the development of students' core literacy in China, so as to cultivate students' correct values, essential characters and key abilities.

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