

Construction Model for Teaching Chemistry based on Games

Ling Li

Chongqing Jianshan middle school, Chongqing, 400700, China

Abstract

Focusing on the concepts of the subject and structuring the content of the course are significant ways to cultivate students' core competences, and which are also effective methods to cultivate students' innovation ability. However, the implementation of concept teaching has caused some new predicament. Based on the educational philosophy of concept teaching and the triple representation theory of chemistry, this study puts forward the teaching propositions about teaching chemistry based on game(TCBoG), and constructs the teaching model and application process of teaching chemistry based on game(TCBoG). The construction model provides reference for teaching practice and theoretical research.

Keywords

Teaching Chemistry based on Game(TCBoG); Teaching Model; Big Concept Teaching; Triple Representation.

1. Introduction

The "General High School Curriculum Plan (2017 Edition 2020 Revision)" puts forward the requirement of "emphasizing the big concept of the subject and structuring the curriculum content" for the revision of the curriculum standards of all subjects. There are three main forms of structuring curriculum content: structuring based on knowledge association, structuring based on cognitive thinking, and structuring based on major concepts of disciplines (MOE,2020). The big concept is an important way to implement core competency (Chaoyou Shao, Yunyu Cui,2016). The big concept helps to achieve high-path migration and is an important way to cultivate innovation ability (Hui Liu,2020). The majority of educators pay more and more attention to the cultivation of core competency of subjects with the promulgation of core competency, the revision of curriculum standards, the implementation of the new college entrance examination, and the use of new teaching materials. Because only human competency will not be overwhelmed by the information age, and people's thinking cannot be replaced by artificial intelligence. Personal development can catch up with the speed of knowledge growth only by lifelong learning. It requires what teachers teach students is no longer the conclusions from researchers, but the thinking skill like experts and the method scientists recognize the world. However, we should also note that paying attention to the teaching of big concepts and the cultivation of core competency does not mean that we no longer pay attention to the achievement of knowledge and skill goals. In fact, one of the two can't be neglected. At present, the big concept teaching has fallen into such a dilemma. The long-term structured big concept teaching has significantly improved students' discipline thinking, but the mastery of specific knowledge is not as good as before, which makes people begin to doubt that the concept teaching is just a fake style with a coat of core competency. Therefore, this study puts forward the "teaching chemistry based on game"(TCBoG) teaching construction model by the integration of big concepts and triple representation theory, hoping to promote the cultivation of chemistry core competency and improve the learning effectiveness. and use chemistry education games to assist in the efficient achievement of

knowledge and ability goals. Among them, the teaching model also uses chemical education games to assist the efficient achievement of knowledge and skill goals.

2. Research Background

At present, it is recognized that the ideas of concept-based curriculum design originates from Bruner's educational psychology. However, it was not until the 20th century that a systematic exposition of it appeared, that is, the book "Understanding by Design" by Wiggins and Mike tiger. Since then, many scholars have systematically discussed it. Professor Li, a Chinese scholar, believes that the big concept is an abstract concept that has the function of connection and integration and can be widely transferred (Songlin Li,2020). From the type of big concept, it can be divided into discipline core concept, interdisciplinary concept, thinking and skill concept and discipline essence concept (Lijie Lv,2020). Brain science research has proved that "the brain processes not scattered information, but concepts, which are at the center of cognitive mechanism." (Andre jourdang, 2015).

As for the basic research on the triple representation theory of chemistry can be traced back to Johnston. He clearly pointed out that the concepts in chemistry curriculum include three levels: macro, micro and symbol. These three levels can not only explain the composition of chemistry discipline and the level of chemistry curriculum content, but also be applied to students' chemistry learning. If it is difficult for students to master these three levels at the beginning, they will have difficulties in learning chemistry (Johnstone A H,1993). However, it is Gilbert who clearly put forward the term "triple representation", and he also emphasized the fusion of macro-representation, micro-representation, and symbolic representation (Gilbert J K, Treagust D. Multiple ,2009). Chinese scholar Hualin proposed that "triple representation" is a unique way of thinking in chemistry discipline (Bi Hualin, Huang Jie,2015). Then Hualin and Xuanxiang constructed the mental model of triple representation of chemistry, and put forward the corresponding chemistry teaching strategies (Bingxiang Zhang, Hualin Bi,2013). However, it is found that each representation level is a partial or one-sided understanding. A complete understanding can be formed only by connecting the three representations (Ainsworth S,1999). Yani, Yuanrong and Qiang also conducted an empirical study combining with eye tracking technology. It proved that the transformation between different representation levels has a significant impact on the learning effectiveness (Yani Wu, Yuanrong Li, Qiang Wang,2021). In 2021, Professor Hualin's team defined the triple representation ability of chemistry, that is, students learn and understand chemical knowledge from the macro, micro and symbolic representation levels as well as achieving transformation between different representations flexibly. They analyze and solve the personality psychological characteristics related to chemistry problems successfully (Hualin Bi, Shanshan Lu,2021).

From the existing research on big concepts, researchers believes that teaching and learning based on big concepts is an important channel to cultivate students' core competency. In recent years, triple representation has also become an important research theory of chemistry education. It has become the consensus of researchers to use it to guide chemistry research, chemistry teaching and chemistry learning. Big concept teaching is an important way to implement the core literacy. Triple representation is the unique thinking of chemistry. The suitable and full integration of the two is conducive to the implementation of big concept teaching in chemistry discipline, which help students to cultivate discipline thinking and develop core competency. Based on above two theories and 10 years of teaching experience, the author puts forward the teaching proposition of "teaching chemistry based on game (TCBoG)" and constructs the corresponding teaching model.

3. Construction Model for Teaching Chemistry based on Games

The first part meaning of this concept is "walking calmly everywhere." Based on the previous discussion, it can be found that the study of chemistry cannot be restricted to a single knowledge, but to build a network structure from the perspective of a big concept. The understanding and learning of chemistry cannot be limited to the static representational levels. And it is necessary to pursue flexible transitions between triple representations. So it means the learner's thinking can move between big concepts and triple representations. Another part meaning of this concept refers to games, and games are only a supplement to the training of knowledge goals, not the main content of each class. The purpose is to use the game mechanism to accelerate the secretion of neurotransmitters in the brain, so as to regulate the concentration of students and enhance the memory ability of learning. These learning tasks allow students to get a pleasant learning experience, and constantly improve the self-construction of knowledge and the high-level development of thinking in the process of the game. This education concept includes four processes: firstly, learning big concepts, triple representations, and discipline thinking; secondly, forming fluent subject thinking by repeated practice; thirdly, thinking habits can be developed after repeated practice; fourthly, carrying out the evaluation of learning including procedural evaluation and summative evaluation.

Based on the interpretation and discussion of the meaning of "teaching chemistry based on game", and following the consistency principle of teaching-learning-evaluation, the author tried to construct a teaching model for TCBoG (see Figure 1).

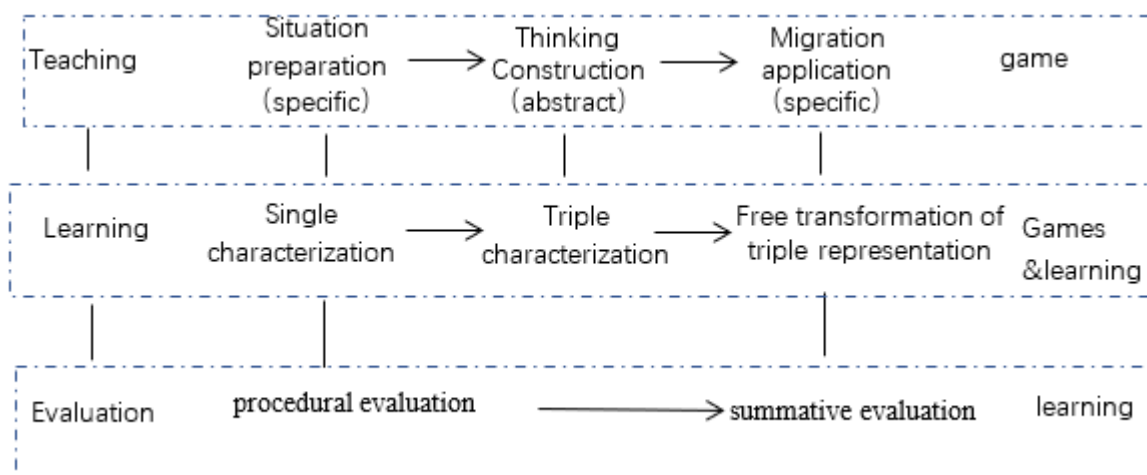


Figure 1. Teaching model for TCBoG

In this model, Cooper's learning cycle "preparation construction application" is embedded in the teaching link. In the learning phase, teachers pay attention to the mental model of students' triple representation. In the evaluation phase, procedural evaluation and summative evaluation complement each other. The first thing teachers need to prepare for the TCBoG is to establish situations. This situation should be real and have the attribute of big concept. Teachers can choose the teaching content and determine the teaching objectives after confirming big concept. Afterwards, teachers design situations, problems, activities and evaluations according to the teaching objectives, and start the teaching organization. After the teaching is implemented, teaching content and big concepts are revised through teaching reflection. In these phases, the extraction of big concepts may be the most difficult for teachers. In view of this difficulty, teachers try to break through from four aspects: the high-frequency words of the curriculum standard, the key words of core literacy, the grand concept of expert thinking, the key and

difficult points of learning. And then, teachers consult experts, which may be an effective strategy to extract big concepts. The construction mode of TCBoG has operation process and reliable basis (see Figure 2).

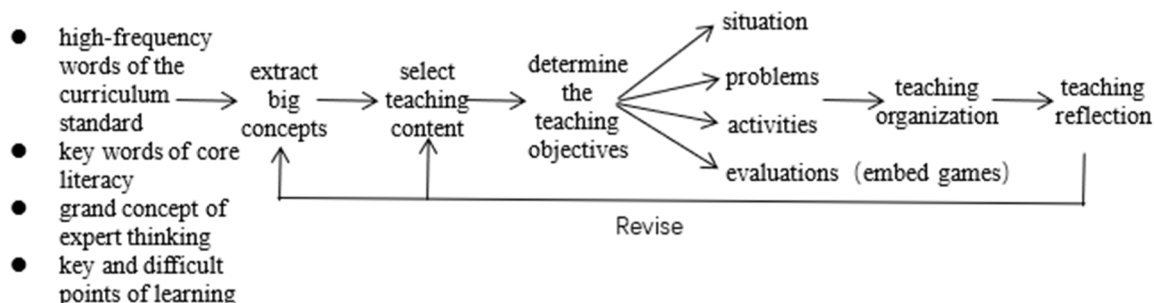


Figure 2. Operation process for TCBoG

In various disciplines, many people question whether it is too difficult for beginners to learn large concepts that reflect the thinking like experts. Bloom answered this question as early as the 20th century. He believes that education can actively intervene in students' cognitive development in appropriate forms. "Any discipline can be handed over to any child in a correct form" (Jerome Bruner,1989). Moreover, only when a large structured concept network is formed in the learning process, can the scattered facts, concepts, situations and other information be systematically constructed. This can promote in-depth understanding to form discipline logic and scientific thinking, as well as transferring the learned knowledge to another situations.

4. Conclusion

Big concept teaching has been recognized as an effective teaching method that can establish students' learning core views and discipline thinking. But it causes that the goal of knowledge and skill can't be achieved efficiently in classroom teaching because of its abstraction and generality. The idea "teaching chemistry based on game" put forward based on the concept of big concept teaching and the unique triple representation of chemistry. It is expected to have a certain reference for the teachers of chemistry education.

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