



## Exploration of Foreign Pre-Concept Shift Teaching Model

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***Abstract***—In the process of conducting science education, preconceptions have been an important challenge in the transformation of science concepts. At present, scholars in China and foreign scholars have conducted systematic research on pre-concepts, analyzing the nature, characteristics and causes of pre-concept formation from various perspectives. Among them, teaching models of pre-concept transformation are also an important part of the process of concept transformation. The study of foreign teaching models of conceptual transformation in science can provide references and suggestions for the development of science education in China.

***Keywords***—*pre-conceptual, science education, conceptual shift, teaching strategies*

## I. INTRODUCTION

Regarding the definition of preconceptions, scholars in the academic community hold different views. The first scholars advocated the use of "misconceptions" to represent "preconceptions", which is the earliest idea proposed in the academy and refers to "It refers to "vague, imperfect, or mistaken (understanding) understanding of things" (James H Wandersee, Joel J Mintzes, Joseph D Novak, 1994). The preconceptions have also been defined by our scholars: they are considered to be the non-essential perceptions that learners form through the phenomena they perceive in their daily lives and through discriminative learning

before learning science education. This paper defines preconceptions as follows: preconceptions are the concepts and views of the objective world that students form in their daily lives before learning systematic science education, and they are concepts formed by accumulating personal experiences.

## II. CHARACTERISTICS OF THE FORMER CONCEPT

### *A. Stubbornness*

Pre-concept is closely related to students' daily life, it is formed based on people's perceptual experience and subjective intuition, and it is not easy to change. From a psychological point of view, preconceptions are a stable cognitive structure in students' minds that cannot be easily changed. From a pedagogical point of view, constructivists believe that students have formed their own views and opinions about things from their daily life practices and have their own unique cognitive way of thinking before learning.

### *B. Negative Mobility*

Scientifically unproven misconceptions in preconceptions may also negatively affect subsequent learning and impede knowledge understanding and mastery. Teaching is based on students' prior cognitive experiences, and students first have to touch their own prior concepts before learning science, so pre-conceptions inevitably have some impact on learning.

### *C.Spontaneous*

Students' pre-conceptions are acquired through their observations and perceptions of daily life; they are neither fabricated nor forced, but are spontaneously formed and internalized into their own cognitive structures and ways of thinking.

### *D.Complexity*

The stages and differences of students' physical and mental development cause variability in their understanding of the same issue or objective things, and different students see different aspects of things. Their understanding of things can change due to the influence of the external environment, so students' preconceptions are complex and diverse.

## III.REASONS FOR THE CREATION OF THE FORMER CONCEPT

### *A.Faculty Level*

The first is that teachers ignore the accumulation of students' prior knowledge and experience in the teaching process and teach blindly, so that the misconceptions held in students' minds have a negative transfer to the learning of later knowledge. The second is that teachers do not understand and think about science concepts on their own, and are influenced by their own prior concepts in the teaching process, which affects the effectiveness of teaching. Lastly, teachers lack the necessary professional training or have a poor understanding of their own expertise .

### *B.Student Level*

Firstly, there is a biased way of thinking, where students have insufficient intellectual experience and tend to form superficial perceptions of scientific concepts; secondly, there is a preconceived life experience, where students are influenced by a priori perceptions and develop superficial and fragmented understandings and concepts in their daily lives . Finally students are also influenced by specific linguistic and cultural contexts that lead to preconceptions.

### *C.Subject and material level*

In terms of subjects, different subjects can interact with each other and affect students' understanding of science concepts. In terms of textbooks: Firstly, textbooks are often written with an emphasis on explaining science concepts, but ignoring students' prior cognitive level and their own concepts. Second, in terms of textbook content, some textbooks often include pictures or examples to facilitate students' understanding, and the implicit knowledge contained in these textbooks may indirectly affect students' acquisition of science concepts.

## IV. RESEARCH ON THE TEACHING MODEL OF PRE-CONCEPTUAL TRANSFORMATION ABROAD

Conceptual transformation in science mainly refers to the process of assimilating, conforming and reconstructing between students' previous concepts acquired from daily life and new knowledge through the learning of science courses, further improving their cognitive structures, and finally acquiring correct concepts consistent with scientific concepts. Among them, the teaching model of conceptual transformation is an important part of teaching conceptual transformation, and the research of foreign scholars on the teaching model of conceptual transformation has been very mature. According to the main teaching strategies used in the teaching models of concept change and the applicable teaching scenarios of these teaching models, the teaching models of concept change can be divided into five categories: 1. teaching models based on cognitive conflict; 2. teaching models based on specific situations; 3. teaching models based on constructivism; 4. teaching models based on theories of concept change; 5. teaching models of science applicable to the teaching of concept change.

### *A.Cognitive conflict-based teaching model*

Cognitive conflict refers to a certain difference or contradiction between the learner's existing knowledge and the new knowledge, producing a cognitive imbalance. This cognitive imbalance

requires learners to assimilate and conform to the new knowledge and reconstruct their cognitive structure.

The cognitive conflict-based teaching models are the three-step teaching model proposed by Nussbaum and Novick in 1981 and the four-step teaching model proposed by Joseph Krajcik (Krajcik) in 1998. The specific elements of their teaching models are as follows.

a. Reveal and clarify students' existing pre-science concepts. The teacher creates an "inconsistent event" and guides the students to explain it with their previous concepts. b. To elicit new concepts that conflict with the previous scientific concepts and encourage students to understand their own "conceptual framework" in the debate. "conceptual framework" versus those of their classmates. Students can generate cognitive conflict through cooperative learning discussions, dialogues, etc.; c. Encourage students to elaborate and detail new ideas and to develop new conceptual frameworks for the issues involved.

(2) a. Students try to explain and describe their understandings and perceptions; b. Students reconstruct understandings and perceptions through analysis and reasoning; c. Apply new understandings and perceptions and test the reasonableness and validity of new understandings; d. Compare existing understandings with prior understandings, elaborate and justify their ideas, and help others to make understandings.

The common feature of the above-mentioned teaching models is that they all focus on the transformation of the misconceptions in the former concepts. Both teaching models focus on revealing students' misconceptions, triggering their cognitive conflicts, and obtaining new concepts through a series of teaching tools (analogy and inference) that get the reorganization of students' cognitive structures. The difference is that Nussbaum's and Novick's three-step teaching model focuses only on

students' acquisition of new conceptual frameworks and not on their understanding and deepening of new concepts. Joseph Krajcik's (Krajcik) four-step instructional model emphasizes the dynamic modeling process of students ("Cognitive Strategies for Modeling") and considers the teaching of conceptual transformation as a dynamic, cyclical process. The teaching model focuses not only on the acquisition of concepts, but also on their application and development. Among these, Nussbaum's (Nussbaum) and Novick's (Novick) three-step model is the most representative and widespread, and Krajcik's (Krajcik) four-step model is the most applicable to current science teaching and learning, with certain feasibility and progressive significance.

#### *B. Context-based teaching model*

In a broad sense, it refers to the objective environment that acts on the learning subject to produce certain emotional responses; in a narrow sense, it refers to the process of eliciting students' emotional responses in a teaching. As a carrier of students' learning activities, the context has a certain influence on students' cognitive development and affective responses.

The context-specific based teaching models are the five-step teaching model proposed by Stofflett (1994) and Stoddart (1994), the four-step teaching model proposed by Bruun (1997) and Christiansen (1997), and the dual-context teaching model proposed by She (2014). The specific elements of their teaching models are as follows.

(1) a. learners are given a challenging situation in which they are encouraged to make individual predictions based on their existing experiential background; b. students expose their pre-scientific concepts by first discussing in small groups and then sharing their predictions and explanations together as a class; c. students work in small groups to design experiments to test their predictions; d. based on the results of the experiments and students' predictions based

on misconceptions d. Class discussion of the conflict between the experimental results and the students' predictions based on misconceptions, so that students are primed to accept the scientific concepts; e. The teacher provides some similar scenarios in time so that students can extend the scientific concepts obtained from the experiment to other scenarios to further consolidate the scientific concepts.

(2) a. Power transfer: The teacher distributes materials and unfolds the teaching environment and tasks. Students take ownership of the activity and the teacher needs to observe the learning process and understand what students should be aware of; b. Action: Students acquire information through imitative learning and the teacher pays attention to the kinesthetic feelings they experience; c. Formulation stage: The teacher encourages discussion from the student experience and allows students to combine language and images with kinesthetic experiences to develop their own ideas or thoughts and form certain rules. formulating certain rules; d. Validation: the students' own explanations are validated through student-student and teacher-student interactions .

(3) a. Examine the properties and characteristics of scientific concepts and identify the cognitive structures and information that learners need to construct scientific concepts; b. Explore students' misconceptions about scientific concepts in specific contexts; c. Analyze which thinking patterns students lack in their understanding of scientific concepts and teachers should provide them with information related to the missing thinking patterns in order to construct a more scientific view of the concepts; d. Design dual-context learning activities that design authentic situations in which students learn; e. Instruct students in dual-context situations in which students predict and explain unexpected situations to construct a more scientific concept; f. Provide students with a challenging situation that provides opportunities for students to apply new

thinking patterns to new situations to ensure that conceptual shifts have occurred .

The common feature of the above models is that they all believe that students' misconceptions are not static and that students may have different misconceptions in different contexts, and that we should encourage students to hypothesize, reason and deduce in the process of concept transformation in relation to their own learning contexts in order to obtain new concepts. The difference is that Stofflett's and Stoddart's five-step model focuses on stimulating students' curiosity in the context and promoting concept transformation and transfer through group work. Bruun and Christiansen's four-step model focuses on the acquisition of new concepts through teacher-student and student-student interaction. She's (She) dual-context teaching model emphasizes activating students' pre-concepts in dual contexts, facilitating the transfer of new concepts, and forming new cognitive schemas. Among them, Stofflett's and Stoddart's five-step model is the most representative, Bruun's and Christiansen's four-step model is the most applicable to classroom teaching, and She's dual-context model is the most conducive to students' conceptual transformation and transfer.

#### *C.A constructivist-based teaching model*

The constructivist view of learning is that students do not enter the classroom with an empty head; they have certain daily life experiences before learning science knowledge, which is what we call preconceptions. Based on their preconceptions, students express their own views and ideas with others, and in the cognitive conflict with others, they can promote their own conceptual transformation and cognitive construction.

The constructivist-based teaching models are the four-step teaching model proposed by Freyberg and Osborne in 1985 and the five-step teaching model proposed by Driver and Oldam in 1986. The details of their teaching models are as follows.

(1) a. Preliminary Stage: To understand the scientist's perspective and the child's perspective and his or her own view of the topic. Teachers can compare children's perspectives with scientists' perspectives to understand students' prior conceptions. b. Focus stage: Students are given opportunities to explore the context of the concept and to self-clarify their own perspectives in authentic learning contexts. Teachers can provide stimulating experiences that encourage students to think by asking them what they think and help them explain their responses; c. Challenge phase: This phase of learning is a critical one in which learners debate the pros and cons of their current views. Students can accept new concepts through debate and justify them by comparing the views of scientists and other students; d. Application Stage: Teachers diagnose students' existing ideas, encourage students to use new concepts to solve problems in new contexts, encourage students to adopt a reflective thinking approach to the proposed solutions, and raise the status of new concepts .

(2) The teaching model is mainly divided into five stages: Orientation, Elicitation, Restructure, Application and Review. The orientation stage: the teacher creates a problem situation, provides students with an opportunity to investigate the problem, and stimulates students' initiative to learn; the elicitation stage: the teacher purposefully guides students to use their own views to try to explain the problem, deepen students' thinking about the problem; the restructuring stage: students express their ideas, clarify concepts in discussion and communication with the group and the teacher, trigger cognitive conflicts, and think about scientific concepts under the guidance of the teacher. The application stage: students are encouraged to develop and use their ideas in different contexts to consolidate and reinforce new concepts; the review stage: teachers guide students to review their own conceptual changes

and to reflect on the process of conceptual change learning by comparing scientific concepts with their existing concepts.

The common feature of these teaching models is that they are all based on students' original conceptions. The difference is that Freyberg and Osborne's four-step teaching model emphasizes that learners are guided by the teacher to clarify their own views based on their existing cognitive experiences, to discover the deficiencies of existing concepts in the debate, and to justify the new concepts. Driver's and Oldam's five-step model emphasizes student initiative and reflection, guiding students to compare old and new concepts, review and reflect on their own shortcomings. The five-step model of driver and oldam is the most representative, while the four-step model of Freyberg and Osborne is the most applicable to cooperative group classroom teaching.

#### V. IMPLICATIONS FOR SCIENCE EDUCATION IN CHINA

##### *A.Science education in China should focus on students' pre-conceptions*

In the process of science education, the process of students learning knowledge is actually the process of reorganization and transformation of scientific concepts, of which pre-concepts are the basis of students' learning. Pre-concepts are usually formed from the personal subjective level of understanding and views of natural phenomena and things, some of which are correct, some are one-sided, and some are even completely contradictory to scientific concepts. It is usually fragmented, unsystematic, and lacks logical meaning. Therefore, teachers themselves must first achieve a correct understanding of scientific concepts to avoid being influenced by their own pre-conceptions, and secondly, to create a relatively fair environment for students to avoid being influenced by their social, linguistic, and cultural factors. Finally, teachers are required to use diverse methods to detect students' existing concepts in the actual teaching

process, to teach scientific knowledge not limited to textbooks, but also to use computer and media developments, customizing specific databases, semantic networks, visualization tools, etc. for students' conceptual construction and restructuring.

*B.The teaching model of conceptual shift provides a scientific basis for curriculum development and teacher teaching in science education in China*

Students' preconceptions are an important issue in conducting science education, and how to reasonably infer the impact of students' preconceptions on science education is reflected in the teaching model of concept shift. Therefore, before conducting science education, we should adopt a pedagogical model of when to understand students' preconceptions, develop curriculum and textbooks based on the preconceptions held by students, and focus on the logical connection between science concepts in the process of curriculum development.

According to the foreign conceptual shift teaching model, it is known that students' learning should be an active process of learning knowledge. Teachers' teaching should not be limited to some kind of theoretical guidance; teachers should teach step-by-step according to students' existing pre-concepts. In the process of guiding students to explore and communicate, teachers can create appropriate learning contexts based on students' changing concepts and

encourage students to evaluate and argue about concepts. In conclusion, by learning from foreign teaching models of conceptual transformation, our country can better educate science, and conceptual transformation is a long-term process. To do so, we must create authentic teaching contexts based on students' pre-concepts, enhance communication and interaction between teachers and students, and promote better completion of science education.

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