



Research on Visual Teaching Strategy of Chemical Declarative Knowledge in Middle School

Tianmeng Jia

College of Chemistry and Molecular Sciences,
Henan University, Kaifeng, Henan, 475004, China

Chenyu Wang

College of Chemistry and Molecular Sciences,
Henan University, Kaifeng, Henan, 475004, China

Lin Sun

College of Chemistry and Molecular Sciences,
Henan University, Kaifeng, Henan, 475004, China

ABSTRACT

The rapid development of information technology has a strong impact on the traditional chemistry teaching mode. According to the teaching status of Chinese middle school chemistry classroom, the thesis combines declarative knowledge and visual teaching in junior high school chemistry textbooks as a subject for in-depth research. By elaborating the concepts of declarative knowledge, knowledge visualization and visual teaching, taking knowledge classification theory, visual thinking theory, double coding theory and information processing theory as the research basis, this paper deeply analyzes and summarizes the chemical declarative knowledge and visual teaching methods, and puts forward feasible visual teaching strategies to promote students to master knowledge and develop ability. According to the research and design of the teaching case of the section "Solubility" in the junior high school chemistry textbook, the purpose of this teaching case is to improve the teaching mode, help students understand and build a new system of knowledge, and cultivate students' innovation ability and core accomplishment of the subject.

Keywords: middle school chemistry, Declarative knowledge, Visualization, Teaching strategy, solubility.

INTRODUCTION

It is pointed out in Chemistry Curriculum Standards for Compulsory Education (2022 Edition) that students should learn to use scientific methods such as comparison, classification, analysis and synthesis when solving chemical problems, and cultivate the thinking ability to deduce evidence, build models and speculate about substances and their changes based on experimental facts [1]. In junior chemistry, declarative knowledge is the majority, and it is also the premise and guarantee for students to learn procedural knowledge, which is the part that teachers need to focus on. Chemistry teachers need to master the concept, characteristics and representation of declarative knowledge, and use visual tools to visualize, visualize and

crystallize it in teaching, so as to deepen students' cognitive impression of declarative knowledge, help students understand the logical relationship between fragmented abstract knowledge and the overall knowledge system, and memorize chemical knowledge more deeply, so as to optimize the course teaching. Get better teaching effect. In addition, appropriate teaching strategies should be formulated according to its characteristics to arouse students' interest in exploration and take the initiative to participate in class, deepen students' understanding and memory of chemical declarative knowledge, and cultivate students' scientific literacy.

CORE CONCEPTS DEFINITION

Declarative Knowledge

Knowledge can be divided into three types: declarative knowledge, procedural knowledge and strategic knowledge. Declarative knowledge studied in this paper refers to the knowledge used to answer "what is the world", and also to answer questions about what something is, why and how to do it, and to reflect the status of things and the relationship between things. It is mainly represented internally by propositions and concepts existing in human brain and the connections between them, and it is knowledge that can be directly described by language [2].

Therefore, declarative knowledge is also called descriptive knowledge. The declarative knowledge of junior high school chemistry specifically includes chemical symbols, concepts, definitions, reaction equations, properties of substances, the relationship between substances and other knowledge.

Knowledge Visualization

The term "knowledge visualization" first appeared in the studies of foreign scholars M.J. Eppler and R.A. Burkard [3], and then domestic researchers formally defined knowledge visualization based on the theoretical basis provided by the two scholars: The field of knowledge visualization studies the application of visual representation to improve knowledge creation and transfer between two or more people [4]. Therefore, knowledge visualization can be simply understood as the process of presenting the previously invisible knowledge structure by using visual representation means with the help of visual tools. Knowledge visualization can strengthen the brain's ability to process and process information, promote people's reconstruction and memory of knowledge structure, and help groups realize knowledge innovation and transmission.

Visual Teaching

Visual teaching is a new teaching method carried out by using knowledge visualization theory under the development of information technology. In the process of teaching activities, it is embodied in the use of visual representation and visual AIDS (such as graphics, animation, etc.) to gradually internalize classroom teaching content into the knowledge cognitive structure constructed by students themselves.

In addition, the internalized knowledge is externalized into visual language after cognitive processing by the brain, so as to realize the dissemination, application and innovation of knowledge by teachers and students in the teaching process [4].

TYPES AND REPRESENTATION OF DECLARATIVE KNOWLEDGE

After the new curriculum reform, in order to reflect the characteristics of chemistry, chemistry educators divide chemistry knowledge into four types: theoretical knowledge, factual knowledge, strategic knowledge and skill knowledge. In order to highlight declarative knowledge in chemistry textbooks, this study further refined the types of knowledge and divided them into factual knowledge, symbolic knowledge and theoretical knowledge. Chemical symbolic knowledge generally refers to a variety of abstract knowledge about the names or symbols of chemical substances, that is, chemical terms in the subject, covering a lot of information about chemical substances, which can be used to accurately represent the name, structure, composition and change law of a specific chemical substance special chemical symbols and other knowledge. In the ninth-grade chemistry textbook, symbolic knowledge of chemistry specifically refers to the names of substances, chemical diagrams, symbols of elements, names of instruments and symbols contained in chemical reaction equations. General factual knowledge is relatively simple chemical propositional knowledge or basic factual knowledge, which mainly describes the properties and applications of substances. In Grade 9, chemistry covers water, air, solution, acid, alkali, salt, and even includes energy, environment, food and health. These chemical facts are closely related to production and life. Theoretical knowledge of chemistry in textbooks refers to a series of logical proposition combination knowledge with significance that can fully reflect the chemical essence characteristics and internal laws of certain substances and their changes. In Grade 9 chemistry, the content generally includes basic concepts, principles and rules of various chemical theories. Among them, the basic knowledge of chemical principles and the knowledge of chemical rules are the further extension of the basic concepts of chemical theories, which are mainly composed of several basic concepts of chemical theories.

After putting forward the concept description of knowledge visualization teaching, many scholars at home and abroad have summarized a lot of representations that can be used in knowledge visualization teaching. Eppler proposed six representation methods: heuristic sketch, concept map, scientific diagram, knowledge map, knowledge animation and visual symbol [5]. Scholars Burkard and Michael Meyer briefly summarized visualization representations into the following seven categories: visual stories, images, charts, sketches, maps, interactive visualization and objects [6]. Jonathan summarized four representations of concept map, cognitive map, semantic network and mind map [7]. Qiu Ting and Zhong Zhixian carried out further detailed classification in their research, including 9 categories of knowledge map, picture, continuity chart, discrete chart, schematic diagram, flow chart, matrix diagram, tree diagram and organizer [8]. This study mainly introduces three representation methods suitable for visual teaching of declarative knowledge in junior high school chemistry: pictographic class, guiding class and symbolic class. Pictographic visualization methods tend to describe or represent things visually, including image method, real scene teaching, knowledge animation, etc. Guidance visualization pays attention to the logical relationship between a thing or idea, and uses the graphical way to show it, it has many kinds of charts, including concept map, mind map, Venn diagram, bubble diagram, flow chart, tree diagram, matrix diagram, fishbone diagram, etc.; Guidance visualization pays attention to the logical relationship between a thing or idea, and uses the graphical way to show, including concept map, mind map, Venn diagram, bubble diagram, flow chart, tree diagram, matrix diagram, fishbone diagram, etc. Visual metaphor is the main symbolic visual teaching method often used by middle school teachers in the teaching system of junior high school chemistry. In general, it refers to the visual

graphic means that people directly carry out visual representation through one or more representative items and the high similarity and internal relevance of the metaphorical objects they refer to.

VISUAL TEACHING STRATEGIES FOR DECLARATIVE KNOWLEDGE

Create Visual Scenarios That Provide Information Blocks

Scenario creation is the beginning of a lesson, and a good scenario can quickly draw students' attention to chemistry teaching. Good scenarios are created not only to stimulate students' interest, but also to include a wealth of information that is relevant to the teaching content. The scenario generally comes from students' study or life, so students can get a deep understanding of chemistry knowledge by extracting information blocks contained in the scenario. Meanwhile, it can also improve students' ability to extract and distinguish information and improve teaching efficiency.

Visualize The Microcosmic World and Promote the Construction of Four-Fold Representation

The study of chemical substances has gone deep into the level of atoms and molecules. Many chemical knowledge involves the changes of the microcosmic world, and people cannot observe the microcosmic phenomena, so they can only infer from the macroscopic properties, which brings difficulties to the teaching of chemistry. The visual teaching method can realize the visualization of the microcosmic world. By providing visual materials, students can see the microcosmic world intuitively with the help of illustrations, metaphors and other means, so as to enhance the brain's cognition of abstract things and subtly improve students' chemical thinking. At the same time, the "four-fold representation" (macroscopic representation, symbolic representation, microscopic representation and curve representation) of chemistry is the basic idea of chemical research. Visualization teaching shows the microscopic representation to students, which is conducive to the transfer and utilization of microscopic knowledge, and enables students to connect the four-fold representation and promote the construction of the four-fold representation. Understanding the nature of chemical phenomena and facts from macro, micro, symbol, curve four perspectives, memory knowledge more firmly.

Visualize Experimental Information to Reveal the Nature of Chemistry

Experiments are the main body of chemistry, and many chemistry knowledge needs to be summarized and verified from experiments. However, when students observe the demonstration experiments of teachers, the observed phenomena will be unclear or inaccurate due to the different seat angles, and the corresponding phenomena will not be observed for the experiments with not obvious phenomena, leading to the decline of the actual effect of teaching. On the other hand, due to the lack of teaching experimental equipment or the conflict between the teaching schedule and the actual teaching content, some teachers cannot do experimental demonstration in teaching, which is contrary to the cultivation of students' scientific literacy. In order to solve this problem, it is proposed to apply visualization in chemistry classroom, so that students can observe chemical reactions, understand the nature of chemistry and improve the teaching quality.

Select The Appropriate Representation Method According to The Characteristics of Knowledge

Chemical declarative knowledge is an abstract summary of chemical phenomena and facts, which has its own characteristics. The representation of visual methods also has its own characteristics and applicable scope. Therefore, it is very important to select appropriate visual methods according to the characteristics of knowledge. Taking part of the declarative knowledge content in the six modules of chemistry teaching in junior high school as an example, the commonly used and appropriate visual representation is selected, as shown in Table 1[9]:

Table 1. Visual representation of some contents in six modules

Six modules	Teaching content	Visualization mode representation
The chemicals around you	Carbon and its compounds	Concept map, mind map Visual metaphor
The mystery of the composition of matter	Element, molecule, atom	Visual metaphor Knowledge animation
The diversity of substance classification and substance change	Elements and compounds, acids, bases, salts, Oxides, reaction types	Concept map, mind map
solution	Calculation of solubility	Visual metaphor
Chemistry and life	Domestic fuel	Knowledge animation
Chemical experiment activity	Preparation of gases and separation of substances	Visual metaphor Knowledge animation

VISUAL TEACHING CASE OF DECLARATIVE KNOWLEDGE IN MIDDLE SCHOOL CHEMISTRY - SOLUBILITY

Textbook Analysis

This subject is the second period of the second subject of Unit 9 Chemistry (human teaching Edition) in junior high school. It is a further extension of students' learning of basic knowledge related to the chemical solution module. This lesson is based on the study of solution in Subject 1 and the first lesson in Subject 2. The limit of solute dissolution in water is studied quantitatively. The solubility knowledge learned in this class is part of the important concepts of junior high school chemistry. In the textbook, it is not only an extension of the knowledge of saturated and unsaturated solution learned in the last class, but also a bedding for the following "acid, alkali and salt" study. It is also closely related to daily life, which is very important.

Students Situation Analysis

Students have already understood part of the knowledge of solution, unsaturated solution and saturated solution through previous study, and know some simple conversion methods. However, most students are still in the stage of transforming from image thinking to formal logical thinking, and lack the ability of quantitative analysis of solution. At this stage, students accumulate a certain amount of life experience, which just does not relate well to chemical knowledge and needs proper guidance. They have a strong curiosity about chemical experimental phenomena, unknown fields and situations that conflict with previous cognition, so they can fully benefit students' curiosity in teaching.

Teaching Objective

- (1) Understand the meaning of saturated solution and unsaturated solution, know the concept of solubility, can obtain information through the solubility curve;
- (2) Cultivate students' observation and analysis ability of experiment by guiding them to draw solubility curve.
- (3) Through the study of solubility knowledge, students can understand the connection between internal and external causes of chemical knowledge, feel the wonder of the chemical world, and arouse the students' interest in chemistry exploration.

Teaching Focus and Difficulty

Know the concept of solubility and can get information from the solubility curve.

Teaching Process

It can be seen from the analysis of the textbook that the teaching material divides the teaching of Solubility into two parts. According to the characteristics of the chemical declarative knowledge content, appropriate visual teaching strategies are adopted. The teaching procedures are shown in Table 2:

Table 2. The teaching process ideas

Teaching link	Visual instructional design process	Visual teaching strategy selection	
(1) Review old knowledge and introduce new lessons	The solution knowledge is reviewed through multimedia animation and physical model, and the new lesson is introduced by judging whether the solution is saturated	Intuitive presentation, learning new knowledge	Create visual scene animation, object model
(2) Design experiments and form concepts	Through the design of experiments to compare and analyze the solubility of sodium chloride and potassium nitrate, stimulate students' interest in exploring, forming concepts	Concept map, mind map, tree map, table, etc	Animation, video demonstration experiment
(3) Link computing and deepen the concept	The concept is deepened by calculating the dissolved mass of different kinds of substances at different temperatures	Practice discrimination and internalize cognition	Imagine, assume, and make analogies
(4) Draw a solubility curve	Guide students to complete drawing solubility curve and obtain information from it	Build connections and combine understanding	Chart and table
(5) Class summary	Through concept map, mind map, matrix map and other visual methods to review and organize the knowledge of this lesson	Guide combing, improve the system	Concept map, mind map, tree map, table, etc

Review Old Knowledge and Introduce New Lessons

Teachers review old knowledge through animated videos and mock-ups: describe the concepts and relationships of solution, saturated solution and unsaturated solution respectively. At the same time, the table summarizes the experimental phenomena of last class and introduces the new knowledge of this class: the concept of solubility.

Design Experiments and Form Concepts

The teacher guided the students to explore the concept of solubility by comparing the dissolution ability of NaCl and KNO₃ in water through the design of experimental schemes, and guided the students to think about which variables to control in the design process to analyze the factors affecting solubility. After the discussion of feasible experimental schemes, the teacher drew a conclusion by demonstrating the experiment: There is a limit to how much solute can be dissolved in a given amount of water at a given temperature. Through the observation of the experiment process, students not only intuitively feel the concept of solubility, but also improve their ability to observe and analyze the experiment.

Practice Calculations and Deepen Concepts

The teacher listed a table. When the masses of different substances dissolved by 20g of water at the same temperature were known, the students were guided to calculate the masses of different substances dissolved in 100g at different temperatures. The definition of solid solubility was obtained after comparative analysis, so as to deepen students' understanding of the meaning of solubility.

Draw a Solubility Curve

According to the experimental results and the table in the textbook, the solubility of different substances can be known. Teachers guide students to use multimedia computer to draw the solubility curve, so that students know what the solubility curve is, and through the analysis of the curve, the influence of temperature on the solubility of substances, as well as the difference of the solubility of substances under the same temperature conditions, etc. Cultivate students' ability of information extraction, generalization and resolution. At the same time, through the application of solubility curve, from chemistry into life, let students learn to use solubility and solubility curve to solve problems in life.

Class Summary

With the help of concept maps, mind maps and other methods, students will first summarize the knowledge learned in this class, and then teachers will supplement and sort out the knowledge, so as to help students understand and master the internal laws among knowledge systems of various disciplines, build a scientific and effective knowledge learning system, form a knowledge network, and facilitate the memorization of the knowledge points.

Instructional Design Evaluation

The content of the section "Solubility" belongs to the factual knowledge in the classification of chemical declarative knowledge and has the characteristics of factual knowledge. It can be summarized by appropriate selection of some visualization methods of guiding class (including concept map, matrix map, mind map, etc.). Meanwhile, in order to intuitively understand the concept of solubility, the textbook recommends the method of experimental exploration. Teachers can make full use of students' visual senses and cultivate their ability of observation and analysis by using pictographic visualization to demonstrate experiments in teaching.

Most of the information obtained by students comes from visual perception. The application of visualization representation in teaching activities can greatly optimize teaching design and improve teaching quality. Therefore, the visual teaching design of "Solubility" uses image model to create scenes as the beginning of a class to attract students' interest and cultivate students'

ability of information extraction. Through knowledge animation exploration experiment, students can exert their subjective initiative, actively participate in exploration activities, and grasp the mystery of the chemical world. Using concept map, matrix map and mind map to help students sort out the knowledge structure and consolidate students' memory of the knowledge points can effectively improve the teaching effect.

CONCLUSION

The development of modern information technology has a great impact on visualization teaching. At present, most of the representations of knowledge visualization are based on modern information technology, and the deeper the development of modern information technology science, the more common and in-depth research on knowledge visualization will only become. Since the new curriculum reform, with the continuous implementation of the reform of teaching concepts and methods, the teaching model of chemistry classroom has also changed. The research on knowledge visualization teaching can improve the professional quality of teachers' education and teaching, enrich the classroom teaching environment, improve the teaching quality, promote the development of education, and provide a richer presentation way and more possibilities for the education field and knowledge transmission.

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