

# Mind mapping promotes the application of flipped classroom teaching model in the teaching of inorganic chemical elements compounds

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*The research is supported by Yancheng Teachers University Education and Teaching Reform Project (2021YCTCJGY005)*

## Abstract

The application of mind mapping combined with flipped classroom teaching model in the teaching process of inorganic chemical elements is conducive to the cultivation of comprehensive abilities of chemistry students, such as logical thinking, creative thinking and problem inquiry. Mind map is conducive to connecting the fragmented knowledge points in the flipped classroom teaching process and stimulating students' learning initiative. In class, the teacher tested the effect of students learning first through the designed mind map framework and guided students to improve the filling. Mind map helps students to construct an whole knowledge structure, promotes knowledge functionalization and programming. Using mind map as the carrier, it promotes flipped classroom teaching to achieve the goal of knowledge systematization and literacy.

**Key words:** Flipped classroom, Mindmap, Elemental compounds, Inorganic chemistry

**DOI:** 10.7176/JEP/13-30-15

**Publication date:** October 31<sup>st</sup> 2022

## 1. Introduction

The textbook used in the course of Inorganic Chemistry in our school is compiled by the Inorganic Chemistry Teaching and Research Office of Dalian University of Technology, China, the 6th edition. Figure-1 is the association diagram of the three modules of the textbook and the subsequent three courses of analytical chemistry, physical chemistry and structural chemistry. Learning inorganic chemistry well plays a crucial role in the subsequent study of professional courses. The knowledge of elemental compounds is offered in the second semester of freshman year, and the corresponding experimental courses are offered in the first semester. When teaching experimental courses, because students come from different regions, the theoretical basis of their elemental compounds is very different. In order to carry out the course effectively, the teachers of experimental courses have to "meddled-in", not only to explain the relevant theoretical knowledge briefly, but also to tell the relevant content of the experiment. Both teachers and students are under great pressure, the students' experimental skills are weak, and the experimental course time is tight, which seriously affects the effect of the experimental course. The theoretical course is disconnected from the experimental course, and the content of element compounds is too much, the class hours are tight, and the high-intensity classroom teaching makes the relationship between teachers and students tense, and the learning pressure is great.

## 2. Problems existing in the teaching of inorganic chemical element compounds

### 2.1 Teaching content analysis is not transparent and learning situation analysis is insufficient

There are huge differences in the learning requirements of chemistry in different learning stages. For example, in junior high school, the research objects are representative substances, the research questions are mainly about the properties of substances, and the ability requirements can be memorized, observed and described. High school chemistry is part of the elements or elements of the material group, not only to understand its properties, but also should be familiar with its transformation, preparation and use, and can be separated and identified. In addition, high school chemistry also requires the ability to generalize and demonstrate, explain and predict, design or prove, solve complex problems, and conduct systematic exploration, etc. Compared with junior high school

chemistry, high school chemistry is more difficult and more demanding. In addition to the requirements of senior high school chemistry, college inorganic chemistry pays more attention to the interpretation and induction of the knowledge of elements and compounds using the principles of chemical reactions and the basis of material structure, and respects the facts of chemical reactions. To fully understand the hierarchical development and cognitive construction of the knowledge of elemental compounds in different stages is the premise of completing the teaching of inorganic chemical elemental compounds with high quality. Cognitivism holds that the effective construction of knowledge system is closely related to the knowledge reserve of learners. It is necessary to fully understand the existing knowledge system of students and develop and breed new knowledge based on it, so as to further develop and broaden the knowledge system.

## 2.2 It is difficult for students to adapt to the high intensity and fast pace of university teaching

Middle school chemistry usually adopts the traditional teaching mode of lecture-based teaching. Middle school teachers carefully prepare the lessons, and the teaching content is clear, from the superficial to the profound, which is easy for students to accept. In recent years, the teaching hours have been reduced obviously, and the rhythm of inorganic chemistry classes is tight. Compared with the middle school class of "eating slowly", college class is quite "whole" like. In order to solve the contradiction of inorganic chemical elements compound content and tight class hours, it is necessary to change the traditional teaching mode, stimulate students' interest in learning actively, and complete the teaching task of answering questions, solving questions and solving problems in the university classroom. Much of the knowledge of elements and compounds comes from the summary of experimental facts or life facts. Classroom teaching should combine theory with practice, so that students can realize that what they have learned is not without practical significance.

## 2.3 The theory course is disjointed from the experiment course, and students lack sensory knowledge

Chemistry is a natural subject based on experiments. The phenomenon of chemical experiments is vivid and interesting, which is helpful for students to understand the chemical changes of substances and explore new knowledge. It is helpful to cultivate students' practical ability, observation ability and innovation consciousness. Due to the high school pressure and the limitations of experimental conditions, there is a lack of experimental skills training in middle school. In addition, the theoretical courses of elemental compounds in some universities are opened in the second semester of freshman year, while the corresponding experimental courses are opened in the last semester. The theory course is disjointed from the experimental course, and the knowledge of elements and compounds is informative and not clear enough. In order to catch up with the teaching progress, the students' listening efficiency is low. In the first semester of the freshman year, according to the contents of the students' experimental courses, the relevant theoretical knowledge of elemental compounds was introduced in advance in the inorganic chemistry class, which laid a theoretical foundation for the students to carry out experiments smoothly. In the experimental class, students are required to shoot the experimental process with each other, and teachers will screen and edit the video materials shot by students in the experimental class, which will be used to systematically explain the theoretical knowledge of element compounds in the second semester of freshman year, fully reflect the important concept of combining theory and experiment, and stimulate students' interest in learning.

## 3 Theoretical basis

### 3.1 The characteristics of mind maps

The mind map is invented by Tony Buzan, the British father of memory (Fun and Maskat 2010; Fu, Lin et al. 2019). Mind map is a revolutionary learning tool, which is to draw the thoughts in our brain on paper with colored strokes, combine the image thinking with abstract thinking well, fully develop the left brain and the right brain, and greatly improve our intellectual skills and wisdom level. A mind map starts with a central theme and expands and bifurcates to form an orderly divergent thinking map with logical relationships among levels and branches. Mind maps can guide and document thought processes (Sun, Wang et al. 2022). The process of drawing a mind map, in which fonts, sizes, and colors vary as needed, provides a colorful visualization of the radial thought process and results. Mind map can organize and process information, assist the brain to think, correspond to the learning stage, help students to organize knowledge logically, promote knowledge memory, understanding and so on. Mind map is helpful for students to sort out the learning content independently, organize and master the learned content as soon as possible, stimulate students' learning enthusiasm, and

cultivate students' practical ability through knowledge categorization and organization(Wu and Chen 2018; Yang, Chen et al. 2022; Zhao, Liu et al. 2022).

### 3.2 The advantages of flipped classroom teaching model

The flipped classroom was created by Jonathan Bergmann and Aaron Sams, two chemistry teachers from Colorado, in 2007(Akçayır and Akçayır 2018). The flipped classroom is produced under the background of the great development of computer information technology. It emphasizes that education informatization is an endogenous variable of the systematic reform of education, which supports and leads the development of education modernization, and promotes the update of education concept, model reform and system reconstruction. Different from teaching before practice in traditional teaching, flipped classroom emphasizes learning before teaching, which highlights students' self-directed learning before class under the guidance of teachers(Athavan Alias Anand 2021). Flipped classroom pays more attention to or relies on the application of modern educational technology. Micro-video and rich text assist students to carry out independent learning, communication and reflection, group discussion, etc(Hao and Lee 2016; Awidi and Paynter 2019).

## 4 Mind mapping incorporated into the instructional design of flipped classroom

### 4.1 The teaching process

According to the flipped classroom teaching process shown in Figure 2, the main characteristics are that teachers analyze textbooks before class, get familiar with the knowledge system, and the application of element compounds in life and production. Teachers should also fully understand the knowledge base, thinking ability and learning level of students before class. Through the preparation of textbooks and students, after understanding the facts, as needed to consult the information, recording micro-class video(Kim, Kim et al. 2014; Loo, Eifler et al. 2016). According to the self-study task list drawn up by the teacher before class, the students read the textbook, study the literature and video materials provided by the teacher, and complete the self-study test. The essence of flipped classroom is "learn first, teach first", learn before class, teach during class. After class, teachers and students internalize their own, teachers internalize the teaching process, further optimize. Students internalize what they have learned, ask new questions, communicate with teachers online, and further flip the classroom. As the basic knowledge of "flipped classroom" is mainly learned outside the classroom, its method is to use short videos of micro-lessons in chapters. This method has the disadvantage of fragmenting knowledge, and mind mapping can make up for this disadvantage. Through the use of mind map, students can sort out and integrate the knowledge they have learned, reflect the systematization of knowledge, and avoid the deficiency of key knowledge(Fun and Maskat 2010; O'Flaherty and Phillips 2015).

### 4.2 A combination of online and offline learning to teach

Self-study in advance requires teachers to spare a lot of time to collect materials and make videos. What is more complicated is how to achieve a targeted "teaching" in class. It is necessary to determine which students have mastered it and proceed to the next step; Which students need help taking on new challenges; Which students learn wrong knowledge and need to be corrected. This is an art of teaching, which needs to be experienced and grasped by the teacher carefully. In the era of "Internet Plus", the network resources are very rich, which guide students to check and fill the gaps in the limited learning time. Teachers should strengthen the interaction with students online, encourage and motivate students to complete the pre-learning task actively, raise questions boldly for discussion, and train students' comprehensive ability and higher-order thinking ability. Can't let the student feel independent study is to be able to deal with the teacher's inspection in the classroom, as time passes, the student feels boring, the teacher feels spent a lot of effort, the effect wins small.No matter in any link, the active participation of students is the premise of carrying out the flipped classroom teaching mode with quality and quantity. Therefore, teachers should stimulate students to participate in the classroom as much as possible, consolidate and deepen the knowledge system, and truly realize the effective teaching of "three-dimensional goals".

### 4.3 Autonomous learning before class combined with intensive teaching in class is conducive to students' digestion of knowledge after class

The knowledge of elemental compounds is mainly the introduction of experimental facts and their application in

life and production. Through the online and offline process of "learning first and teaching first", teachers can better grasp the knowledge and ability of students. However, due to the tight teaching hours in class, it is difficult to carry out "hierarchical teaching". After class, in order to allow students to further internalize what they have learned, students with strong comprehensive ability in the group can make micro-class videos under the guidance of the teacher, which can be used as materials for further internalization of the knowledge structure of the class. The related knowledge of elemental compounds is the basis for learning the principle of chemical reactions and the structure of substances. Of course, there is a bidirectional conductance relationship between the three. For example, when learning the related concepts and basic principles of chemical reaction heat, it is necessary to take specific chemical reactions as the research object.

## 5. Conclusion

In the early stage of flipped classroom, the teacher records the content to be told in the classroom into videos in advance, replaces books and other materials for students to complete pre-class preview, expects students to achieve the expected knowledge internalization, and checks students' preview situation through practice in class. In the flipped classroom teaching model, watching videos and traditional preview (reading textbooks or consulting relevant books) are learning before class, and they should complement each other. Flipped classroom is conducive to group mutual learning, strengthening the cohesion of students, and forming "mentoring pairs" among students. In class, when teachers and students jointly draw mind maps, when the relationship between knowledge nodes is consistent with the existing knowledge of elements and compounds, the new knowledge is connected with the existing knowledge. When the relationship between the knowledge nodes do not agree with existing element compound knowledge, stimulate students to explore, to use existing knowledge explain why the transformation relationship can not be established or looking for a new relationship, combines the new knowledge and original cognitive structure, by incorporating, reorganization and transformation, form a new cognitive structure, realize the knowledge construction.

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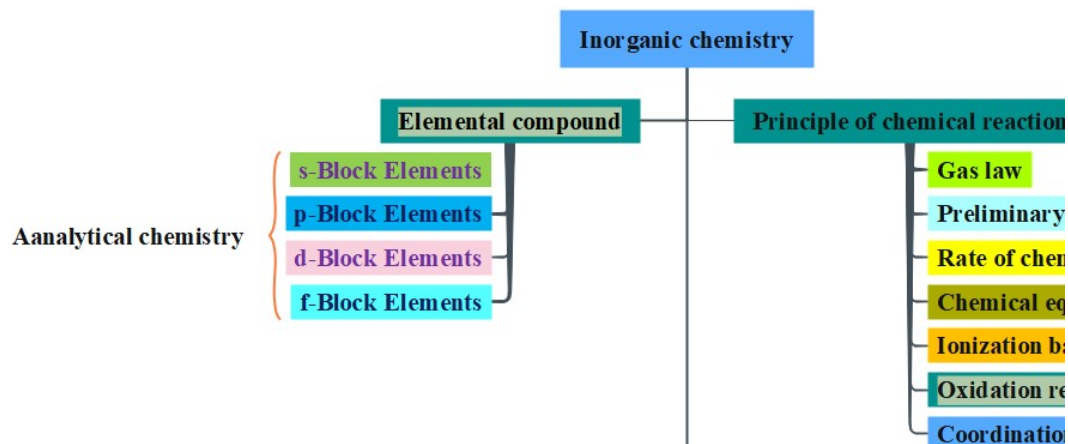


Figure 1. Correlation diagram of inorganic chemistry chapter distribution and other specialized courses

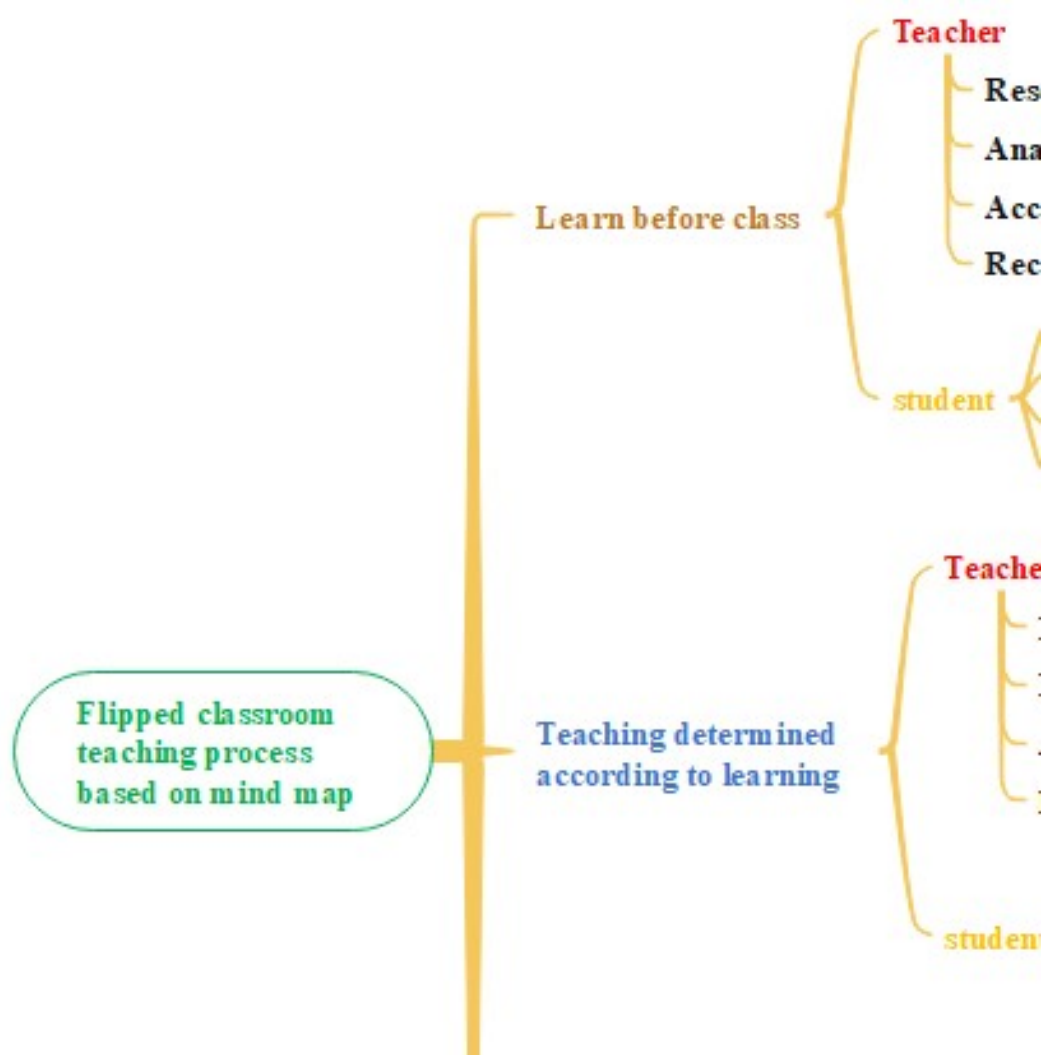


Figure 2. Flipped classroom teaching process based on mind map