# Contemporary teaching strategies in general chemistry

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## Abstract

The use of contemporary teaching strategies in teaching general chemistry can be incorporated in new developments in science education. Case method teaching can increase students' interests in studying chemistry, concept mapping deepens student understanding, Predict-Observe-Explain (POE) strategy increases the level of classroom interaction, workshops and problem-based learning provide students with an opportunity to acquire effective problem solving techniques. This paper illustrates their advantages.

## New tendencies in general chemistry teaching at university

### *Student-centred approaches*

The purpose of teaching is learning. A lecturer only teaches what he or she considers important and difficult in the lecture. We have neither the time nor the energy to teach everything. However, students want and need to know everything. To paraphrase the old saying, we should be teaching them 'fishing' not giving them a 'fish'. We should encourage students to become active and lifelong learners. We need to focus on students' characteristics and their learning styles. When we prepare a lecture, we need to understand what students want to know and what they need to know.

In the lecture, students need to move from passive to active learning and from dependence to independence. We should accept the realisation that different people learn the same things in different ways, and we need to move learning from teacher-centred to student-centred. We should be aware of, and incorporate into our teaching, the development of science and technology in our society. In order to attract students to study chemistry, we should adopt modern methods of flexible delivery such as multimedia, computational simulation and the Internet thus reforming the traditional 'chalk and talk' teaching approach.

### *Generic science education approaches*

The meaning of science is 'to know'. Baroness Margaret Thatcher, the first female Prime Minister of Great Britain and Northern Ireland (1979-1990), earned degrees in Chemistry at Oxford University. After graduating, she worked as a research chemist for four years, but, eventually she became a successful lawyer and a politician. It is important to understand the aim of education. Science and technology is always evolving in our modern society. It is very important for chemists to develop and synthesise new materials to satisfy the needs of human beings, however, what most of us need is a background to understand science and technology. In other words, we should help students develop a science-oriented basis for making future decisions. It isn't necessary that every student in our schools of chemistry becomes a chemist. Consequently, in my view, what we teach in general chemistry should be based on everyday life and fundamental items related to real life.

### *Interdisciplinary approaches*

Learning is not only active and cumulative, but also integrated and connected. Chemistry is a central science and in the 21st century, it has become more and more important. In other words, chemistry is increasingly permeating other sciences. At the same time, current and future problems become more and more complicated. In order to solve these questions an interdisciplinary approach is necessary. For example, more than 1000 scientists from five countries (China, France, Japan, the UK, and the US) participated in the Human Genome Project. The chemists, geneticists and others worked together to create the genome map. Chemistry has played an important role in the completion of this great task. To clone the DNA sequences and generate proteins requires the task of crystallising the proteins and determining their structures by chemists. At the same time, studying protein structures and functions has become the basis by which pharmacists design many drugs with consequent alleviation of much human pain and suffering. Consequently, in the process of teaching general chemistry, we should develop in students a range of interdisciplinary learning, teamwork and inter-personal skills.

## Resolutions in teaching general chemistry

### *Case study method of teaching*

The case study method of teaching is very popular in medical, business and law schools. These disciplines have had a long tradition of using real or simulated stories as cases to teach students about their field. In recent years, more and more chemistry teachers have implemented case method teaching in chemical education. A good case study should integrate many disciplines and relate to the real world. The case study method involves learning by doing, developing students' analytical and decision making skills, and integrating knowledge skills and learning how to deal with real life problems.

In a case study, students must spend some time studying independently, and learn to work both individually or as part of a team. What we should give them is guidance and encouragement, not an absolute direction. In a traditional lecture, students do not spend much time studying independently, but rather listening to lectures and taking notes. Out of the lecture, students only complete assignments. At the end of semester, students simply reproduce what they have learned onto the examination papers.

Consequently, the case study method of teaching can improve students' interests in actively learning the knowledge required by the case study and facilitate their deeper understanding of the relevant concepts.

The following is a case study about the discovery of Cisplatin.
*The compound we call Cisplatin was first synthesised by M. Peyrone in 1844 and has been called Peyrone's chloride. Its structure was first elucidated by Alfred Werner in 1893. The compound then enjoyed several decades of relative obscurity. In the early 1960s, a series of experiments in the laboratories of Barnett Rosenberg at the Michigan State University found some peculiar results. An experiment designed to measure the effect of electrical currents on cell growth yielded Escherichia coli that were 300 times the normal length. This effect was not due to the electrical fields themselves but to a chemical agent that was formed in a reaction between the supposedly inert platinum electrodes and components of the solution. The chemical agent was later determined to be Cisplatin. Further tests revealed that the compound had prevented cell division, but not other growth processes in the bacteria, leading to the elongation. This effect prompted Barnett's group to test Cisplatin against tumours in mice. It was found to be highly effective in eliminating tumours. Human trials produced positive results, limited, to some extent, by toxic side effects. Once the side effects could be made bearable through the use of adjuvant therapies, the compound's effectiveness was proven. It was approved for use in 1978.*

*Study Questions*

1. *What is Cisplatin?*
2. *How is Cisplatin formed?*
3. *What is the structure of Cisplatin?*
4. *What are some of the health risks of Cisplatin?*
5. *What is meant by the term 'cell division'?*
6. *What is the most probable mechanism of action against cancer?*

Through questions 1, 2 and 3 related to basic chemistry, students understand the formula and structure of Cisplatin, and learn how to synthesise Cisplatin. At the same time, they must review the concepts of coordination compounds, such as coordination number and geometry. Question 4 is related to bioinorganic chemistry and helps students learn the role of transition metals in the human body. Questions 5 and 6 are required fundamental biological knowledge.

The students can be divided into three interest groups, then each group is asked to research one of the questions by reference to notebooks, library or Internet resources outside of the lecture time. In the next lecture, 2 or 3 students from each group would present their group's results and conclusions. This approach has the advantage of students leading students. Students learn well from other students. Finally, all of the student-generated material can be integrated to explain the mechanism of action.

This case study, develops students' problem solving skills and interdisciplinary knowledge.

**_Concept mapping_**

Chemistry is a pure and mature discipline. It has a systematic knowledge base. The use of concept mapping can help students begin to understand interrelationships among concepts. This method can arrange concepts through interacting systems, in this system, all relationships between concepts are made clear. This method is suitable for developing students' cognitive structures. It can also contribute significantly towards meaningful learning in the mind of the student.

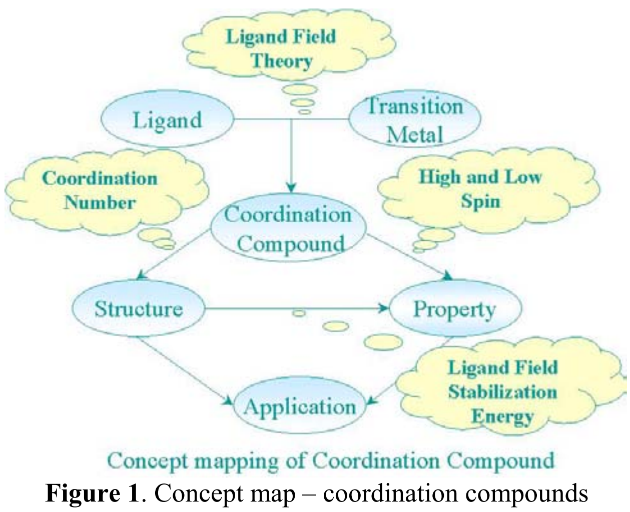


**Figure 1**. Concept map – coordination compounds

Figure 1 is an example of the concept mapping in the process of teaching coordination compound.

A ligand plus a transition metal can produce a coordination compound. In this process, there is the concept of 'ligand field theory'. This theory can explain the mechanism of the coordination reaction.

The concept of 'coordination number' links the compound with its structure. When the central atom has a different 'coordination number', the compound has a different structure.

Between a compound and its properties, 'high and low spin' causes the transition compounds to have diverse colours. At the same time 'high and low spin' determines the property of magnetism.

The value of the Ligand Field Stabilization Energy (LFSE) influences the stabilisation of the compound and the rate of ligand exchange reactions.

Coordination compounds have wide applications in industrial chemistry and medicine. Most catalysts are transition metal complexes, platinum and gold compounds are used in medicine.

### *Predict-Observe-Explain strategy*

Chemistry is a molecular and an experimental science. In order to explain an abstract concept, a demonstration experiment or a model is often necessary to the strategy of arranging the demonstrations. When performing a demonstration, we should follow the Predict-Observe-Explain strategy. Firstly, ask students to predict the result of the demonstration. By this strategy, students are given the time and opportunity to actively think about a question which in turn gives them more motivation to study. Then, students can observe the demonstration and contrast the outcome with their prediction(s). Finally, the result is explained. The performance of demonstrations, helps the students to learn to think constructively and critically.

### *Workshops and problem-based learning*

There is no better way of learning than by 'doing it yourself'. In my view, workshops and problem-based learning are suitable for practicing chemists. But resources are limited, including staff, money and laboratory, so workshops and problem-based learning are open to a small group. The top 5% to 10% of students are entitled to participate in the two programs.

The aim of workshops is to give students an opportunity to perform research in an area of chemistry. Firstly, a student will select a chemistry problem in which they are interested and will choose a faculty member as mentor. The student will then perform library research to collect information related to this question and exchange information with the mentor. Under the direction of the mentor, the student performs experiments, compiles and analyses the results. Finally, the student submits a written report on the findings. In this way, students acquire information technology skills, time management skills and data-handling skills.

With problem-based learning, learning begins with an ill-structured and open-ended problem. In this way students know why they're learning. In the traditional lecture, students do not know why they were learning. All the information they gather for a certain problem is for the purpose of resolving the problem. Problem-based learning places the emphasis on what knowledge is needed and how to use it in a given situation.

## Conclusion

Using contemporary teaching strategies such as the case study method of teaching, improves the quality of teaching general chemistry. At the same time, students will be attracted to study chemistry. These strategies enable students to become proficient in problem solving, critical thinking, self-directed learning, team participation and acquire lifelong learning skills. If we are to see a greater future then it is likely that these should be the purposes of contemporary higher education.

## Acknowledgements

I would like to thank the China Scholarship Council for funding the program of 'Teaching Science in English'. I also wish to thank the University of Sydney for its considerate arrangements. In addition, I am great grateful to Associate Professor Mary Peat, Associate Professor Mike King, Associate Professor Tony Masters, Dr Siegbert Schmid and those who have put lots of effort into this program.

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