

# Using new teaching strategies to improve teaching and learning in *Organic Chemistry*

Dai Yanfeng

Nanchang University  
People's Republic of China

## Abstract

This paper introduces some new teaching strategies. The author is planning to improve *Organic Chemistry* and the teaching of an organic chemistry experimental course by combining selected new teaching strategies with traditional teaching methods. These teaching strategies include student-centred learning, problem based learning, conceptual change teaching, case studies, and cooperative learning. The improvement of assessment methods is also discussed.

## Introduction

Chinese colleges and universities have been undergoing reform over the last twenty years. However the teaching methods have not changed sufficiently to satisfy the requirements of the education system reform. Traditional teaching approaches still dominate the campuses of universities in China. Teachers give formal lectures to transmit knowledge. Students receive it passively and are expected to reproduce it accurately in examinations. All students are different because each has a unique experience of the world. Giving the same piece of information to all students at the same time may only work for those whose schema can assimilate it (King 2004). Not all students are at the same level of understanding at the same time. This kind of teaching approach mostly leads to a surface level learning and an over-dependence on the lecturers.

In western society, there are some new trends and changes in education including a movement from a 'teacher-centred approach' to a 'student-centred approach', and a recognition that, wherever possible, students must be active participants in the learning process in order to promote deep level processing of knowledge. (Hendry, Cumming, Lyon and Gordon 2001).

A research study on student knowledge retention showed that students usually retain 10% of what they read; 26% of what they hear; 30% of what they see; 50% of what they see and hear; 70% of what they say; 90% of something they say while they are doing a task (Lagowski 1990). So the traditional approach to teaching science must be improved. I plan to introduce some new teaching strategies that I have studied at The University of Sydney to improve the traditional teaching approach and increase teaching quality. However these strategies are not replacements for the traditional teaching approach. Chinese people have their own characteristics and distinguishing qualities and I believe that it is not right to abandon the traditional teaching approach. The traditional teaching approach can be adapted, modified and improved by integrating a range of contemporary teaching approaches.

## Improving *Organic Chemistry* teaching

*Organic Chemistry* is a course for the second year undergraduate students who are majoring in chemistry, applied chemistry, biochemistry and material science at Nanchang University in China. *Organic Chemistry* contains 128 hours of lectures, 128 hours of experiments and 8 hours of tutorials covering two semesters. The traditional teaching approach is a teacher-centred teaching model. According to a survey, in a traditional course, students only listen, and they can only retain 26% of the knowledge the teacher presents (King 2004). Students learn passively and employ surface level processing. They are over-dependent on information selected and provided for them by their lecturers. But it is difficult to abandon the traditional teaching approach completely, because China has a very large population of students. The traditional teaching approach requires fewer teachers and teaches more students. So it is necessary to improve the traditional teaching approach step-by-step. The main goals of the improvements to the course are to

enable students: to master organic chemistry principles and technology more deeply, using organic chemistry knowledge; to analyse and solve chemistry-related problems; and to develop the ability of independent thinking. When I return to China I would like to introduce some new teaching strategies such as student-centred teaching, problem based learning, case studies, and group learning to my class to improve my teaching methods and increase my teaching quality.

### Using student-centred teaching

'Chalk and talk' is the predominant teaching style in the traditional teaching approach. Student-centred teaching is based on the hypothesis that students benefit by being given the freedom to study and search for solutions based on their personal interests (Hendry et al. 2001). Students are allowed to discuss and work together on the problem, to explore different paths for solutions without pressure in workshop tutorials. The responsibility for learning is with the students (King 2004). In order to overcome some shortcomings of traditional teaching approaches such as spoon-feeding and over-dependence on the lecturer, student-centred teaching is a useful method to improve traditional course teaching and adapt to the changes and trends in teaching theories and practice. The results of contemporary research in education theory have shown how students learn and how teachers teach students more effectively. This approach can give students flexibility, self-confidence, and social skills.

In student-centred teaching, the teacher teaches only what he or she considers important and difficult in the lecture. The responsibility of the teacher is not only to deliver skills and provide a conceptual map of the subject, but also to motivate students to be more active, adaptable, confident, creative, cooperative and inductive in their thinking. The teacher must help students make the transition from passive listeners to active participants, changing from a superficial to a deep learning approach, developing the students' abilities and skills for lifelong learning. We should teach them 'fishing' not give them 'fish'. Students need to move from passive to active learning and from dependence to independence.

### Using problem based learning

Problem based learning (PBL) is one of the exciting and powerful educational options that has appeared in the last 30 years (Ram 1999). PBL is a learning environment in which the problem drives the learning. PBL begins with tackling a relevant problem that usually covers most of the course knowledge. In PBL the problem may not be solvable, but students can learn much by engaging in the process. Students themselves decide what they need to learn by engagement in the problem solving. Of course, lecturers still retain their importance for course learning. But the

function is changed, switching from transmission of knowledge to a situation where teachers find out common difficulties in the problem solving process and give support via lectures (Woods 1994). So PBL is a strategy for encouraging critical thinking, cooperative learning, and enhancing problem solving skills through resolving real-world problems.

The main features of this strategy (PBL) are: relevant problems; creating a need to know; integration of academic and professional knowledge; and interactive and cooperative learning (Tang, Lai, Wang, Davies, Frankland, Oldfield, Walters, Leng, Tse, Taylor, Tiwari, Yim and Yuen 1997).

The following is an example for PBL lectures:

*Suppose a person breathed in a toxic gas that contains heavy metals such as mercury (Hg). The person will die if an appropriate medicine cannot be synthesised. The question is: how can we synthesise this medicine?*

In order to solve the problem, students must learn the following aspects of organic chemistry:

- metallic organic chemistry;
- alcohol R—OH and R—SH;
- halogenide; and
- SN Reactions.

After group discussions, finding the relevant knowledge and independent thinking, students may find a path like that illustrated in Figure 1 to synthesise the medicine.

Of course, the students may be unable to find a path to synthesise the antidote, but they can learn a great deal of chemical knowledge by engaging in the problem solving process.

### Using case studies

Case studies are different from PBL. They give real and complete stories with messages and questions, and teach through those stories. The case usually has both academic significance and social application (King 2004). A good case study should be interesting, relevant, motivating, integrating many disciplines and related to the real world.

Case studies enable students to understand the application of organic chemistry to real-world problems, to trace commercial innovations of well-known products from conception or an idea in the research laboratory to commercialisation and to realise the influence of organic chemistry on our environment. We can also use case studies to help students to: build analytical and synthesis skills; develop problem-solving skills, decision-making skills, judgment skills, critical thinking skills, and communication skills; and learn how to deal with real-life problems.

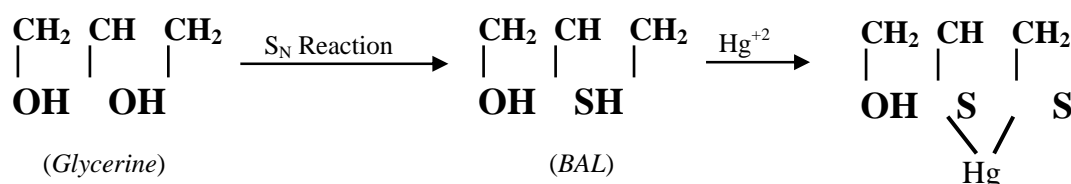


Figure 1. Possible pathway for synthesis of antidote



The teachers are still very important in a teamwork learning approach. Their duties are to ensure laboratory safety, to provide material and equipment for experiments, to assign group leaders, to assist group leaders in answering conceptual and technical questions of students, to supervise group activities, to assess group written assignments, and to evaluate each group's laboratory techniques.

In traditional teaching approaches, students do experiments without understanding why they are using the apparatus provided for them or understanding many of the experimental steps. The teamwork learning format has a definite advantage in overcoming this weakness. The teamwork learning laboratory will be more focused on research work and designing laboratory activities and requires more collaboration between students and the development of teamwork. Teamwork learning methods also require students to have more imagination, more planning and to accept more challenging tasks. It places more emphasis on active learning and extra skills development. Before the laboratory session, students need to plan and design the detailed laboratory steps. During the laboratory session, they need to check their plan and design and revise the laboratory project. After the laboratory session, they need to analyse the data and experimental phenomena and write the experiment reports (Hagen 2000). Encouraging students to become deeply involved in the laboratory work and develop their skills are the main purposes of the new teaching strategy.

## The improvement of assessment

A new teaching strategy needs a new assessment procedure (McDowell 1995). Assessment methods profoundly influence learning (Norton, Tilley, Newstead and Franklyn-Stokes 2001). In order to encourage active learning and meet the requirements of the new teaching strategy, I will use a combined assessment in the *Organic Chemistry* course. The final mark will consist of 5 parts: a formal written examination (final examination) which will be worth 50%; questions which will be worth 10%; assignments which will be worth 10%; laboratory performance and reports which will be worth 15%; and a mini-presentation which will be worth 15%.

## Conclusion

By improving the traditional teaching approach, I expect to achieve the following:

- assist in the reform of the education system;
- increase the students' motivation;
- increase students' interest in learning organic chemistry;
- improve the quality of teaching;
- emphasise that the responsibility for learning is the learner's, not the teacher's; and
- develop some important abilities and skills in students such as problem solving skills, communication skills, critical thinking abilities, creative abilities, lifelong learning abilities, etc.

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