Applying contemporary teaching strategies to improve the teaching quality in *Organic Chemistry*

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Abstract

Some new teaching strategies are reviewed in this paper. Concept mapping, case studies and online learning will be introduced to modify the teaching of *Organic Chemistry* in Northwest University in China. The intention is to try to improve the quality of teaching and promote lifelong learning by students.

Introduction

In our modern, high technology society, everything moves at a fast pace. How can we keep up with the pace and improve the access to new technologies? As teachers, we can't teach students everything they will need in the future. The most important task for us is to direct students to develop lifelong learning skills. It is important to let students know that the responsibility for learning is with the learners themselves. In China, the traditional teaching approaches still dominate in most of the universities. Teachers give formal lectures to transmit knowledge. They focus on the knowledge they teach, or on how they teach. But they don't pay enough attention to developing students' generic skills and concentrate less on how students learn. Students are passive learners; most of them put their emphasis on the passing of examinations and getting a higher mark rather than on what they learn. So it's necessary to introduce some teaching reforms.

Organic Chemistry is one of the most important courses for second year undergraduate students majoring in chemical engineering and technology, biochemical engineering, pharmaceutical engineering; and food engineering at Northwest University in China. In our college, organic chemistry for the engineering students is only one semester and consists of only 54 hours of lectures and 36 hours of experiments. It is hard for the students taught by traditional lectures and experiments to get a basic understanding of some organic principles; the characteristics of several kinds of organic compounds; designing and synthesising some important organic compounds in such a short time. With this teacher-centred approach, students only employ surface level processing. So the main goals of the improvements to the course are to enable the students to master the principles and technologies more deeply, applying the knowledge to engineering, developing the ability of independent thinking and learning skills. There is a need to apply some new teaching strategies to improve the teaching quality.

New tendencies in organic chemistry teaching at universities

In western countries, there are some new theories and changes to teaching and learning in science. These include the developmentalist theory, the constructivist theory and student-centred approaches. Within the developmentalist view, concept mapping is a very important strategy. As a theory of learning, constructivist theory places emphasises on: learning as an active process; all knowledge as socially constructed; and learning as essentially a process of making sense of the world. These concepts suggest that effective learning requires meaningful, open-ended challenging problems for the learners to solve (King, 2005). Many teaching strategies are integrated to get a more constructivist approach. Personal development; independent group work; reflection; learning by doing, case studying and problem based learning, workshops and the use of online teaching are commonly used to stimulate deep learning. These student-centred approaches put more emphasis on the student's activities in learning and teaching. They can promote deep level processing of knowledge and encourage lifelong learning.

These teaching strategies were unfamiliar to me. All these teaching theories and teaching strategies are very helpful in our teaching in organic chemistry in China. The contemporary teaching approaches can be integrated to modify and improve the traditional teaching approach, resulting in a move from teacher-centred to student-centred learning.

Design of the curriculum and the application of teaching skills in the *Organic Chemistry* course

Some of the main modifications in my teaching of the *Organic Chemistry* course are outlined below.

Concept mapping

Concept maps are tools for organising and representing knowledge. They include concepts, usually enclosed in circles or boxes, and relationships between these concepts or propositions, indicated by a connecting line between two concepts. Words on the line specify the relationship between the two concepts. 'Concept maps harness the power of our vision to understand complex information "at-a-glance".' (Love, 2005) They provide a visual image of the concepts under study in a tangible form which can be focused very easily. This is why a picture is worth a thousand words. During the formulation process it consolidates a concrete and precise understanding of the meanings and inter-relations of concepts. Thus it makes learning an active process, not a passive one. It could dismiss the rote learning and encourage active meaningful learning (Chinese University of Hong Kong, 2005*)*.

Organic chemistry has many different functional groups, different reactions and mechanisms in different conditions. It is difficult for students to get a comprehensive understanding of all these concepts and to understand how to relate this knowledge to real life. Using a concept map can facilitate this process. Figure 1 is an example of a concept map in the teaching of aldehydes and ketones. Students can find the relationship between different compounds clearly. It will help students to develop a deep level learning of the characters and reactions of the organic compounds.

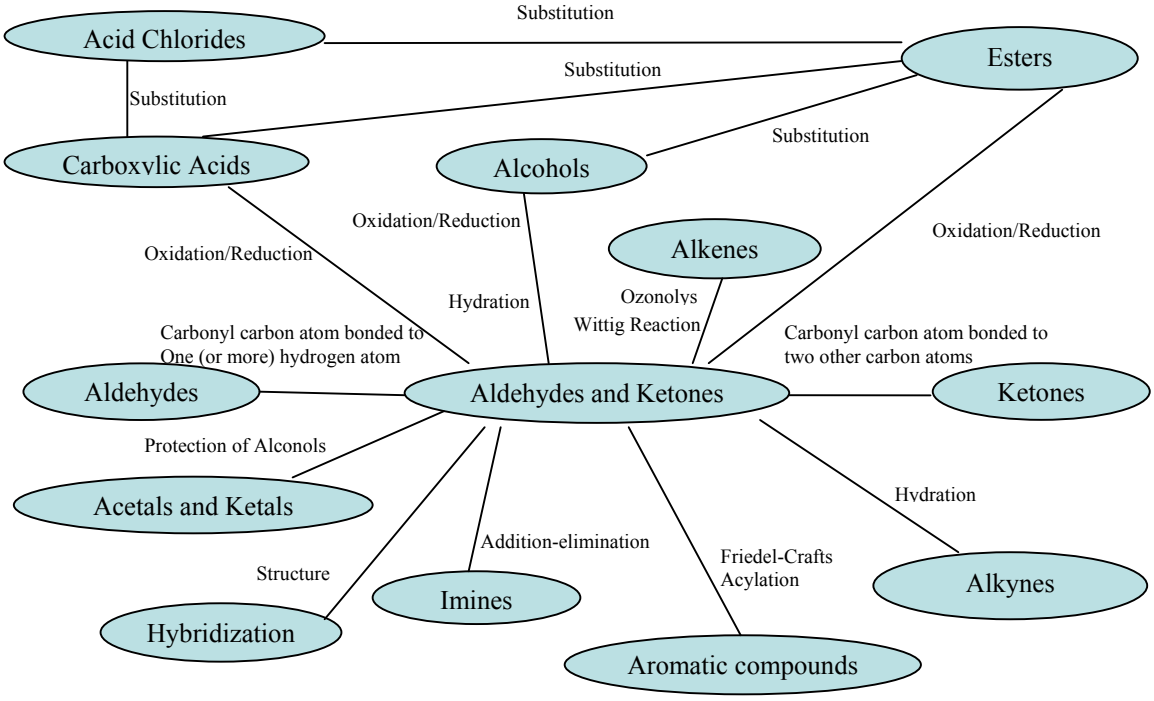


Figure 1. Concept map of Aldehydes and Ketones

Problem based learning and case studies

Problem based learning (PBL) is a curriculum design and a teaching/learning strategy which simultaneously develops higher order thinking, disciplinary knowledge bases and practical skills by placing students in the active role of practitioners (or problem solvers) confronted with a situation (ill-structured problem) which reflects the real world (King, 2005). Problem based learning has two distinct goals: to learn a required set of competencies or objectives and to develop problem solving skills that are necessary for lifelong learning (Engel, 1991). The central concept to PBL is that students will learn content at least as effectively as through lectures by attempting to solve realistic problems. It focuses on thinking skills (problem solving, analysis, decision making and critical thinking). Learning is self-directed. It requires integration of inter-disciplinary knowledge/skills/behaviors. It is shared in small groups. Learning occurs in the context in which the knowledge and skills will be used. In teaching organic chemistry, PBL will be a very useful strategy. It will help students learn the theory of organic chemistry by lectures combined with problem solving projects rather than by just getting information from lectures. It will be very useful in making students become more independent, lifelong learners and active learners.

The use of case studies is another increasingly common way to engage students in science learning. As with PBL, it is a case based learning style and has a real world problem but it is more specific, more highly focused and well defined. The cases are selected by the lecturer and therefore allow for more careful control of student learning. They can be used to encourage the learner to be active in developing specific ideas further. Students may find it interesting, relevant, motivating and related to their professional and real world.

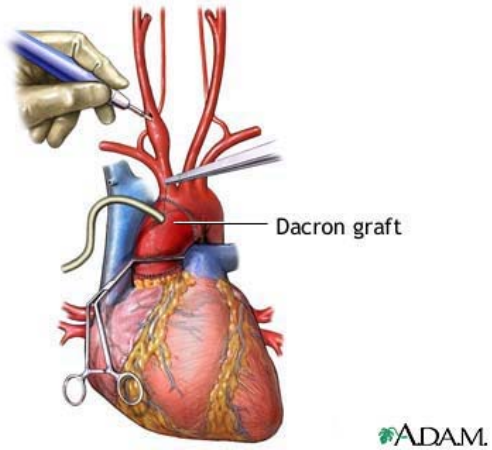
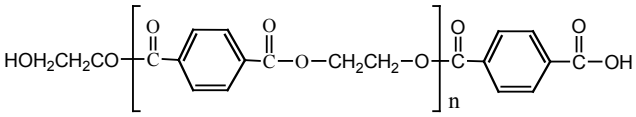


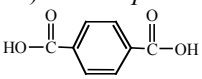
Figure 2. Dacron Graft

In China, students are used to listening to common lectures and taking notes rather than learning independently. Changing the learning style is not an easy thing. As it will be difficult for the second year students to solve a problem without specific focus and disciplines, case studies will be more suitable for them. The development of self-directed learning can take place step by step. The following case study is to introduce the concept of esterification and polymerization.

A Dacron graft is a synthetic (man-made) material used to replace normal body tissues. It is usually made into a tubular form for use in replacing or repairing blood vessels. It causes very few reactions because it is chemically inert and easily tolerated by the body. Dacron grafts have recently been manufactured coated with protein (collagen/albumin) to reduce the blood loss and antibiotics to prevent graft infection.



Dacron is a condensation polymer obtained from ethylene glycol ($OHCH_2CH_2OH$) *and terephthalic acid.*



Its properties include high tensile strength, high resistance to stretching, and both wet and dry conditions, and good resistance to degradation by chemical bleaches and to abrasion. The continuous filament yarn is used in curtains, dress fabrics, high-pressure fire hoses, men's shirts, and thread. The staple fiber is ideal for mixing with wool in men's and women's suits, as well as in dress fabrics, knitted wear, and washable woven sportswear.

The following questions would be posed to students:

- What's the reaction between ethylene glycol and terephthalic acid?
- Do you know the reaction mechanism? What is polymerization?
- Can you get any other useful materials by polymerization?

Dacron is a main product of the DuPont Company. Can you propose a synthesis of this polymer from raw oil? How could the Dacron grafts be coated with protein (collagen/albumin) to reduce blood loss, and coated with antibiotics to prevent graft infection? Figure 3 illustrates a concept map of this case study.

The students will be divided into several groups (4 persons per group). The case will be introduced when the lectures on alcohols have been completed. In the following 6-8 weeks, students will receive the knowledge of the principle of organic reactions through lectures, laboratory work and seminars. They will try to solve the problems by group work and apply the concepts and theories to real world issues. Their critical thinking and self-learning skills will be enhanced before they finish the final reports.

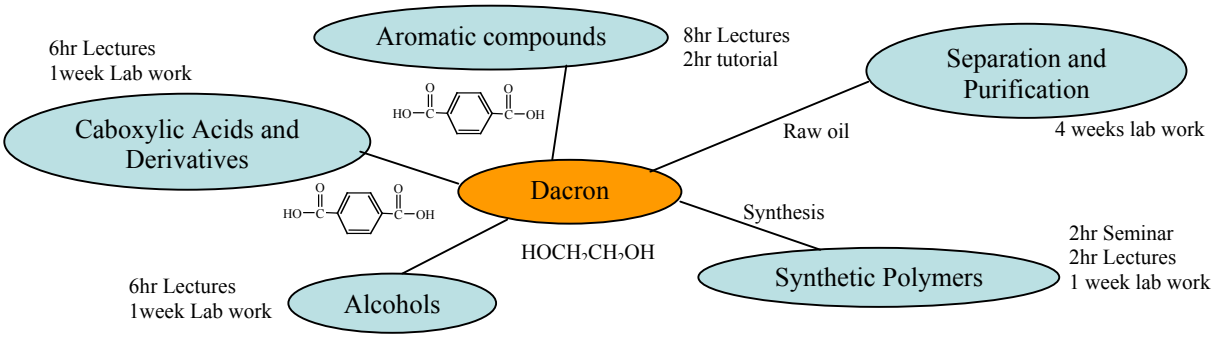


Figure 3. Concept map of the Dacron Graft

Online teaching and learning

With the development of the Web, the Internet has provided various opportunities and has greatly changed the way people communicate. Online learning will become more and more important in modern education. The Web provides a rich information learning environment accessible 24 hours a day. It is convenient, cheap and interesting for a student to learn new knowledge, seek information, gain feedback on assignments and communicate with teachers and other students via a web site. As far as students are concerned, students have personal control of information in the process of teaching and learning online. They can make use of their time more effectively. Easy access and learning at one's own pace are unique features of the Internet that offer exciting opportunities to learners for greater participation, interaction and collaboration in the education environment. It enhances student-to-student and faculty-to-student communication and enables student-centred teaching approaches (e.g., *WebCT*). The web site could offer a wide knowledge of all areas of chemistry for the different needs and interests of students. Without doubt; it will help us to develop student-centred learning strategies.

In my opinion, students are encouraged to get more information corresponding to the course from the Internet, but we can not put everything on the online learning systems without careful selection. To not be selective will make the students get too much information and forget the importance of the main concept. We should try to apply the online learning strategies for those aspects of a course we are unable to do by usual teaching strategies, such as provide links for enough information, explain a pure mechanism by videos, do some self help problems (e.g. *ChemCAL*) and so on.

Conclusions

Concept mapping, PBL/case studies and online learning may be helpful to develop student-centred learning. Some other strategies, such as workshops, reflection and learning by doing will also be helpful to improve the teaching qualities. We should recognise that students must be more active participants in the learning process wherever possible, in order to promote deep level processing of knowledge. But every change is uncomfortable. Change is challenging, change is interesting. There is no right time for change but now. Change from teacher-centred learning to student-centred learning can not be achieved in one day, but we can try to achieve these changes step-by-step.

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