Using contemporary education strategies to improve teaching and learning in *General Chemistry*

Wang Xiaojie
School of Chemistry
The National University of Defence Technology
Changsha
Hunan province
People's Republic of China
410073

yj605@sina.com

Abstract

Based on an analysis of the background, some problems have been identified in the teaching and learning of *General Chemistry*. Contemporary education strategies are used to solve these problems. Strategies which can be practised immediately are discussed. Three approaches are considered in this paper: case studies, concept mapping and problem based learning. Building up a Virtual Learning Environment to encourage online learning is expounded at the end of the article as an area that needs more research work before implementation.

Background

Description of the course
General Chemistry is a common fundamental course to all the students who are not majoring in chemistry in the National University of Defence Technology. The aim of this course is to ensure that students gain a wide knowledge of all areas of our disciplines at a higher education level.

Today, science and technology has penetrated through all aspects of our modern society. Chemistry as a central science has become more and more important. Although almost all the students who are undertaking this course will never become a chemist, it is essential for all the undergraduate students to grasp some knowledge of chemistry. This is one of the strategies that can help students develop a science-oriented basis for making future decisions. It can enhance their comprehensive ability of problem solving.

Current teaching approaches
As a common course supplied for all the university, *General Chemistry* is considered important and has been undergoing reform for several years. Some measures have been taken with the course, such as using the new textbook; applying computer aided instruction (CAI) to improve teaching efficiency; developing a web site to encourage online learning.

Although some changes have been introduced to this course, the main method of teaching is still the lecture. Students do not spend much time studying independently, but rather spend their time listening to lectures and taking notes. There are seldom tutorials and no seminars. Outside the lecture, students are only required to complete assignments. At the end of the semester, they have to pass the final examination.

Problems encountered

According the aim of this course, the most important aspect of this course is increasing students' interest in the course and making them more active learners.

All the changes to the course have significantly improved the teaching and learning, however these changes are not enough. Some important features of student-centred strategies have not been achieved. In particular the traditional teaching strategies, which do not encourage problem solving ability and creativity, result in students seeing the course as boring.

It is vital and necessary to further and significantly reform the structure and teaching style of the course.

Modifications of teaching and learning in *General Chemistry*

There are many things that can be done immediately to improve the teaching and learning in *General Chemistry*.

Redesign the contents

The main concepts and theories that should be taught to students have been fixed by the syllabus, but the details are flexible. A good design of content can promote the student's interest greatly.

Many concepts and theories in *General Chemistry* have been developed decades or even hundreds of years ago. The students often don't treat them as science, but as history. They don't know how to apply them in modern society. Adding some of the most up-to-date research in chemistry into the lecture can help the students know the significance of the chemistry.

Interesting examples related to real life are indispensable. This is one of the best ways to promote the interest of learner. These examples should be based on everyday life and should be used as often as possible. From the examples, the student will find that the difficult concepts become easier to understand.

Using contemporary teaching approaches

There are many theories about teaching and learning. Each of them has its advantages. Using them correctly can greatly improve teaching and learning. The following strategies are some contemporary teaching approaches that can be used in *General Chemistry*.

Concept mapping

Ability to apply knowledge requires a stable conceptual framework. One effective way of establishing a framework is to create 'concept maps'.

Concept maps are diagrams in which various forms or lists of information are classified and their links are shown. Usually, a concept map is divided into nodes and links. Nodes represent various concepts, and links represent the relationships between concepts. Words are used to label the links in order to depict relationships more explicitly.

Much of the content in *General Chemistry* can be designed into concept mapping: atomic structure; molecular structure; coordination compounds; nitrogen fixation and circulation; carbon dioxide circulation are some examples. An example of concept mapping of colligative properties is shown in Figure 1.

A colligative property is one of a set of physical properties of a solvent, which depends on the number, not the identity, of the solute particles in a solution. To explain the concept of colligative properties, we should use the concept of phase. The colligative properties include four items. They are: vapour pressure lowering; boiling point elevation; freezing point depression; and osmotic pressure. Each property can be calculated by a formula. Colligative properties have practical applications in everyday life and in biological systems. Two examples are using salt to melt ice on a footpath (this causes the freezing point of the water to decrease) or an artificial kidney machine. There are many concepts associated with this topic, and many students become confused with the different concepts and formulae. From this concept map, students can build an outline of colligative properties.

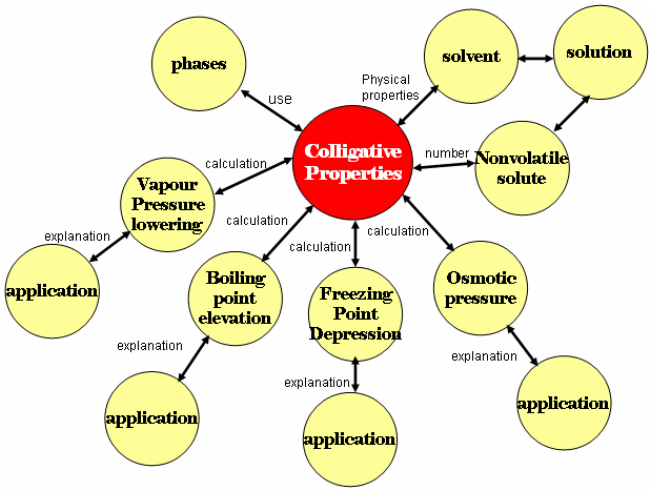

Figure 1. The concept map of colligative properties

In real teaching, the concept map will be introduced step-by-step. After all the content relating to colligative properties is learned, the whole map will be displayed and the links completed.

The concept mapping approach can serve as a key plan for the teacher in determining the best way to teach a topic. It can train students to build up relations among concepts by themselves, and help students to clarify differences between related concepts and motivate them to think more deeply. It also can be used to help students know what it is they have learned and what it is they still do not understand and retain a mind map of the information they are studying.

Problem based learning

Problem based learning (PBL) is a curriculum design and a teaching/learning strategy and is about learning subject knowledge whilst using that knowledge. This approach 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.

Problem based learning is powerful because it is a learning environment that embodies most of the principles; it encourages active learning and self-directed learning and forces the students to learn the fundamental principles of the subject in the context of needing these principles to solve a problem; it focuses on thinking skills (problem solving, analysis, decision making, critical thinking) and develops lifelong learning skills; and it offers an opportunity to practice and to use many processing skills .

It is important to ensure that the problem satisfies the curricular goals of the course and that the course fits within the curricular framework of the undergraduate program. In PBL classrooms, the choice of problem determines the

probability of success of this pedagogy. The premise of PBL is this: if we give students a challenging task that engages them, they will learn to solve problems and they will acquire the associated knowledge in order to solve the particular problem at hand. Their learning will be deeper and more meaningful and will last longer, since it is knowledge that they have constructed themselves within a context and in response to a need.

Once a suitably compelling problem has been chosen, it is important to bring the problem home to the students—to engage and excite them through the use of simulations, videos, newspaper or popular magazine articles, dramatisation, and so on. It is also important that the students identify with the problem. The problem has to offer a clearly defined role for the students to adopt. The problem statement should also specify the deliverables. These project outcomes should be chosen with the class or curricular need in mind and should also appear to be a natural outcome of the problem itself.

There are many real-life problems that need to be solved in the field of chemistry, such as:

- Why do more and more people suffer from skin cancer?
- Why, in summer, do we feel hotter than we did in years past?
- What can be done about diminishing oil reserves?
- How can we purify our water? and
- Why must an iron structure be painted?

All of these problems are suitable for the course of *General Chemistry*.

Case study

A case study is different from problem based learning. It tells a real and complete story, is usually interdisciplinary, has academic and professional significance, and has social implications. As the teaching strategy is interesting, relevant, and motivating for students, it is widely used in teaching.

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 and/or as part of a team. What we should give them is guidance and encouragement, not an absolute direction.

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.

Develop online learning

Online education can be defined as an approach to teaching and learning that utilises Internet technologies to communicate and collaborate in an educational context. This includes technology that supplements traditional classroom training with web-based components and learning environments where the educational process is experienced online.

With the development of the Web, online learning will become more and more important in modern education. Most of The National University of Defence Technology currently engages in some form of online learning. Using the Web as a medium for integrating computer-based learning into an organised course has proved to be an interesting and beneficial exercise. Educational advantages that arise when supplementing a course with web-based tools include:

- enhancing student-to-student and faculty-to-student communication;
- enabling student-centred teaching approaches;
- providing 24/7 accessibility to course materials;
- providing just-in-time methods to assess and evaluate student progress; and
- reducing 'administration' around course management.

The use of the Web is fantastic. It is not only The Resources Room, but also The Virtual Learning Environment. The web provides a learning environment accessible 24 hours a day. It is convenient 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. All students can work at their own pace.

The advantages of online education make a significant impact in higher education today and, as technology evolves, promise to deliver even greater benefits in the future.

This is a work still in progress. The more services offered from the web site, the higher is its value. The web site should offer a wide knowledge of all areas of chemistry to cater for the differing needs and interests of students. We should keep on developing online learning.

Acknowledgements

I would like to express my thanks here to the Chinese Scholarship Council and The University of Sydney for their support. I also want to send my thanks to Associate Professor Anthony Masters, Associate Professor Michael King, Associate Professor Mary Peat and Dr Siegbert Schmid for their successful teaching, their help on a daily basis and their encouragement.

References

Anderson-Inman, L. and Zeitz, L. (1994) Beyond note cards: Synthesizing information with electronic study tools. *The Computing Teacher*, **21**(8), 21-25.

Billett, S. (2002) Workplace pedagogic practices: coparticipation and learning. *British Journal of Educational Studies*, **50**(4), 457-481.

Blackboard Inc. (2000) Educational Benefits of Online Learning. [Online] Available: http://www.blackboard.com/.

Kinchin, I.M. (2001) If concept mapping is so helpful to learning biology, why aren't we all doing it? *International Journal of Science Education*, **23**, 1257-1269.

Kinchin, I.M. (2002) Why professional development should challenge teachers' core beliefs. *School Science Review*, **84**, 77-82.

Lanzing, J.W.A. (1997) *The concept mapping homepage*. [Online] Available: http://users.edte.utwente.nl/lanzing/cm_home.htm.

Ram, P. (1999) Problem-Based Learning in Undergraduate Education. *Journal of Chemical Education*, **76**, 8.

Woods, D.R. (1994) Why PBL? Improving learning and selecting a version of PBL that is suitable for you. In D. Woods (Ed.) *Problem-Based Learning: How to gain the most from PBL*, Ontario.

Woods, D.R. (1996) *Problem-based learning: helping your students gain the most from PBL*. (3rd ed.) Canada: Waterdown.