

Reforming a course in *Horticultural Science*

Gao-Zhihong*

College of Horticulture
Nanjing Agricultural University
Nanjing 210095
People's Republic of China
gaozhihong835@hotmail.com

Charlotte E Taylor

School of Biological Sciences
University of Sydney
New South Wales 2006
Australia
cetaylor@bio.usyd.edu.au

*Corresponding author

Abstract

Most educators teaching in tertiary science tend to pay more attention to theories and application of science. Few focus on the introduction of modern teaching strategies that help the students to actively and independently study. This paper begins with an introduction to Nanjing Agricultural University and to *Horticultural Science*, which is an applied science. The syllabus of the course in *Horticultural Science* and current teaching methods are described and conceptual changes in teaching and learning are introduced. The authors then focus on how to apply modern teaching strategies, such as problem based learning (PBL), case study and online learning, to encourage students to be more active in their learning. The possible problems in applying the proposed reforms are also discussed.

Introduction

Nanjing Agricultural University (NAU) is a national key university of higher learning directly administered by the Ministry of Education, and one of the earliest higher education establishments for agriculture. The current President is Professor Zheng Xiaobo. The main campus of the university is situated in the picturesque eastern suburbs of Nanjing and is near the impressive and world-renowned Sun-Yat-Sen's Mausoleum. There is another campus in the suburb of Puzheng and an Experimental Farm in Jiangpu County. Within a total area of 540 hectares and 40,000 square metres of building space, there are a great number of up-to-date laboratories and considerable equipment. The well-stocked library contains a collection of 1,200,000 volumes. The present student enrolment at the university is more than 22,000, among whom are about 3,000 postgraduate students. While agriculture is the dominant field, NAU also has diverse branches of learning such as sciences, economics, engineering and the arts. At present, the university consists of 19 colleges, which offer 45 Bachelor degree programs, 64 Masters degree programs and 34 PhD programs. In addition, the university has nine postdoctoral programs, eight national key disciplines and 14 provincial key disciplines. Besides seventy-one research institutes and laboratories, the university has the national key lab of Crop Genetics and Germplasm Enhancement, the national centre of engineering and technology of Soybean Improvement, seven provincial key laboratories and an engineering and technology centre of Jiangsu Province. The present university staff stands at 2400, including three academics of the Chinese Academy of Engineering, 150 PhD supervisors, and 500 professors and associate professors. As an important base for agricultural education and research in China, NAU, together with its predecessors, has trained more than 20,000 qualified personnel in the fields of agricultural education, research, science and technology, finance and trade, and administration, who are working at home and abroad (<http://www.njau.edu.cn/>).



The college of Horticulture serves horticultural professionals, students, the nation, and the world, by generating and extending knowledge about fruits, vegetables, flowers, ornamental and Chinese traditional medicinal plants, for the purpose of sustaining the environment, enhancing economic vitality, and improving the quality of life of individuals and their communities. *Horticultural Science* is not

solely the application of science. Indeed it is a combination of practical, aesthetic and philosophic ideas. Changes in the higher education system have led to more students being admitted to the university and as a consequence more classrooms and dormitories are needed. Many orchards and gardens on campus for teaching have been destroyed as new buildings have appeared, while at the same time it is difficult for students to grasp what they learned in lectures and apply it to such situations in the real world. During the four month program in Sydney, *Teaching Science in English*, I have learned a series of contemporary teaching strategies, which provide possible solutions to solve the type of learning problem discussed above. By introducing new teaching strategies to the Horticulture course I feel that I can make improvements and thus guarantee the quality of education.

There are three main views on teaching and learning, and these are the behaviourist, developmentalist and constructivist views. With the development of society, the concepts of teaching and learning are changing: from a behaviourist to developmentalist and constructivist view; from teacher-centred to student-centred; and from 'how to teach' to 'how to learn'. Every discipline has its own content, knowledge and philosophy, which require a particular teaching approach to achieve teaching objectives. Based on above theories, the authors combine teaching strategies specifically selected and to give a feasible learning outcome for the course of *Horticultural Science*.

Syllabus and current teaching methods of the course of *Horticultural Science*

Horticultural Science is a selective course for students who major in biological science, agricultural science, environmental science and information science. The course is for third year students. Two types of teaching are used, approximately 40 hours of lectures and about 20 hours of practical (Table 1). Each lecture takes about two hours. Few lectures use modern teaching techniques such as multimedia instructional materials, *PowerPoint* slides or computer simulations. Most lectures consist of speech and writing on the blackboard. No handouts are provided. The students focus their attention on writing down what the teacher writes and says. They therefore have no time to think about what they learn and accept the academic knowledge passively. After the class, few students go to the library or Internet for further study. Instead they memorize what they wrote down. Every student has the textbook, but even by the end of semester, most students have not used the textbook for learning. The goal of learning is focused on passing the examination. The assessment has three parts: final examination (70%), mid-semester examination and quiz (20%), and the attendance rate and performance in class (10%).

Table 1. The syllabus of *Horticultural Science*

Contents	Lecture (40 hours)	Practical (20 hours)
Introduction: Concepts of horticultural science, horticultural plants and horticultural industry	2	0
Classification of horticultural plants	6	6
Characteristics of horticultural plants	8	2
Horticultural variety and variety improvement of horticultural plants	8	4
Propagation of horticultural seedlings	8	4
Cultivation of horticultural plants	8	6

Overall, the style of teaching in the course is absolutely teacher-centred and pays more attention to how to teach, with a behaviourist view being the main teaching strategy.

In recent years, some valuable reforms and practices in the teaching of horticultural science have been taken by educators in universities (Xu et al. 2001; Huang 2001; Liao 2000) such as textbook construction, measures of improving teaching and study quality and student training. However, no reform concerning the application of contemporary teaching strategies in the teaching and learning of horticultural science has been made.

Changing concepts

Changing the concepts from teacher-centred to student-centred, and 'how to teach' to 'how to learn'

Accomplished teachers will have a rich understanding of the subject knowledge they teach and appreciate how knowledge of their subject is created, organised, linked to other disciplines and to real-world settings. They need to

enable their students to appreciate the richness of their subject. The teacher must also develop critical and analytical capacities in their students.

The only person who can change the existing understanding in the mind of the learner is the learner. Previous studies show that the students grasp 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 and 90% of something they say as they do (Lagowski 1990). Thus participatory learning provides a powerful process whereby students may improve their understanding of concepts in *Horticultural Science*.

Learning has five dimensions: 1. positive attitudes and perceptions about learning; 2. thinking involved in acquiring and integrating knowledge; 3. thinking involved in extending and refining knowledge; 4. thinking involved in using knowledge meaningfully; and 5. productive habits of mind. These require learners, rather than teachers, to take the final responsibility for their own learning.

Developing the students' skills: problem solving skills and lifelong learning skills

A traditional saying is that 'the role of the teacher is to propagate the moral rules, deliver the knowledge, and explain the questions', but in fact, the main task of the teacher is to deliver the specific subject to the students. In modern teaching theories, the task of the teachers is not only the delivery of knowledge, but also training in the skills needed to find, analyse and understand new knowledge. These skills include:

1. Knowledge skills
 - to be able to make creative use of their scientific knowledge
 - to be able to apply theory to practice in familiar and unfamiliar situations
 - to have statistical and numerical skills
 - to be an independent learner
 - to be able to classify information
2. Thinking skills
 - apply critical thinking and make judgments
 - to be capable of rigorous and independent thinking
 - to be able to account for decisions
 - to be able to link and combine disparate material
 - to be a creative and imaginative thinker
3. Personal skills
 - to be able to brainstorm ideas
 - to cooperate with others
 - to have good observation skills
 - to have the ability to make prediction and form hypothesis
 - to be good at finding problems and trying to solve them
4. Practical skills
 - to design and carry out experiments
 - to be able to interpret data
 - to be able to apply experimentally obtained outcomes to new situations
 - to be able to test hypotheses experimentally
5. Communication skills
 - to communicate effectively using oral, written and graphical skills
 - to structure and present a logical argument
6. Computing skills
 - to be able to obtain information from digital sources
 - to use software competently
 - to analyse data using suitable software.

Reforming methods of teaching Horticultural Science – a proposal

Using problem based learning models

Problem based learning (PBL) is one of the most exciting and powerful educational options in the last 30 years (Woods 1994). PBL is a curriculum design and teaching /learning strategy which was created to help students develop higher order thinking and disciplinary knowledge based skills and competencies (Conway 1997). PBL is a learning environment that embodies most of the principles to improve learning: active, cooperative, prompt feedback, tailored to student's learning preference with student empowerment and accountability. PBL involves more than

just learning subject knowledge, since it offers an opportunity to practice, use and develop skills including problem solving, interpersonal, group and team skills, the ability to cope with change, lifelong or self-directed learning skills and self assessment skills.

While working on the problem, the students use a systematic working procedure to analyse the problem (Schmidt 1993). Students are actively involved in the learning activities, not passively listening to the lecture. The ability of the students to resolve problems depends not only on what the teacher delivers but also on what they understand themselves. In problem based learning, the problem may not have a solution, but much learning occurs by engaging in the process.

There are many real problems in horticultural science, such as the following examples: Why are plants green? Why should one cut beneath a leaf node when taking cutting? Why do plants need so much water? Why is light so important and what effect does it have on plant growth?

Here is a real problem from apple production.

A farmer asked us for help because he could not sell his apples which were small sized and of a poor colour. Your task is to search for the related information from your textbook, references or the web and provide possible solutions to this problem.

The teacher helps the students construct the map of related information (Figure 1), then the students design a series of experiments.

The questions are:

1. How can the indices of 'size' and 'colour' of apples be described?
2. What are the factors that affect the size and colour of apples, and among the factors, which are the main factors?
3. What are the mechanisms of 'thinning', 'bagging' and 'mulching'?
4. How do you thin, bag and mulch during apple production?

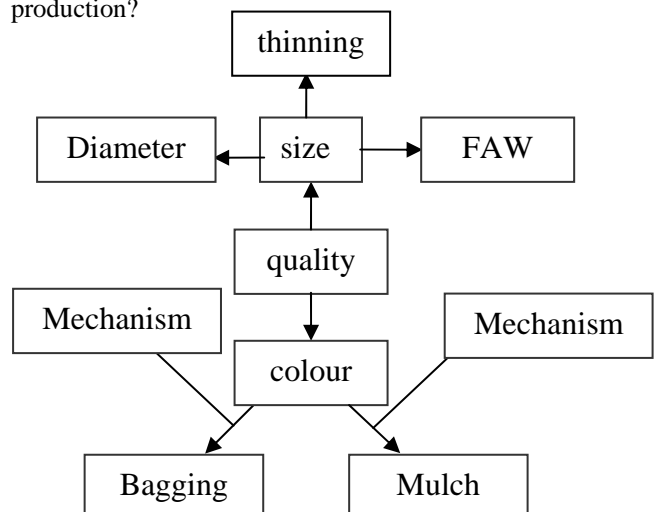


Figure 1. A map of quality-related factors in apple production

At the end of the experiments, the students give a solution to solve the problem and demonstrate the production of apples with good quality. From this procedure, the students can learn not only the subject knowledge in apple production, but also generic skills such as cooperation, experimental design, oral and written skills and data analysis.

Establishment of *WebCT* in *Horticultural Science*

WebCT is the world's leading provider of e-learning systems for educational institutions, with over 2200 institutions in more than 80 countries currently reaping the benefits of the e-learning platform. *WebCT* is used by more institutions throughout the world than any other course management system (<http://www.webct.com/>). *WebCT* is a virtual learning environment for the students, and also provides a variety of tools and features that can be added to a course. The University of Florida, one of the nation's five largest universities, has selected *WebCT Vista* to support exponential e-learning growth and continually improve academic quality for more than 48,000 students beginning this fall. There are four advantages to *WebCT*. First, the teacher can display the lectures, enabling students to study before the lecture, so that they know what is difficult for them and what is easy. Students listen to the lecture, and identify difficult concepts. If they have questions, they can ask them during the lecture. For the teachers, use of *WebCT* can give them the opportunity to prepare better learning resources. Secondly, teachers can set up a resource room and more academic web sites or provide links, which can

save the students' time and make the web learning resources more convenient. Thirdly, the *WebCT* may include the duty tutor system, which is beneficial for the students in communicating with the teacher, since it is not necessary physically locate the teacher to ask questions. Finally, the students can answer the questions that are placed on *WebCT* and evaluate themselves. *WebCT* is thus a useful way to improve the efficiency of teaching and student-centred learning.

Use of *WebCT* in teaching can provide instant feedback, enhance research skills in students, provide interactivity and communication, visualisations, and distribution of teaching materials. The main advantage of online learning/teaching is to support lectures and laboratory classes and independent learning, to provide communication, class administration and to help staff improve the level of student learning.

Horticultural Science is an applied science, whereby theories of learning are combined with the application of theory, enabling students to make sense of the science and grasp the main ideas. Establishing a vivid, *WebCT* database is a good way to help students to recognize plant species via an image bank. Also, students can more easily understand specific techniques needed in the real world. In this way they can be encouraged to adjust their study objectives to meet the demands of society.

A map for the course of horticultural science is shown in Figure 2.

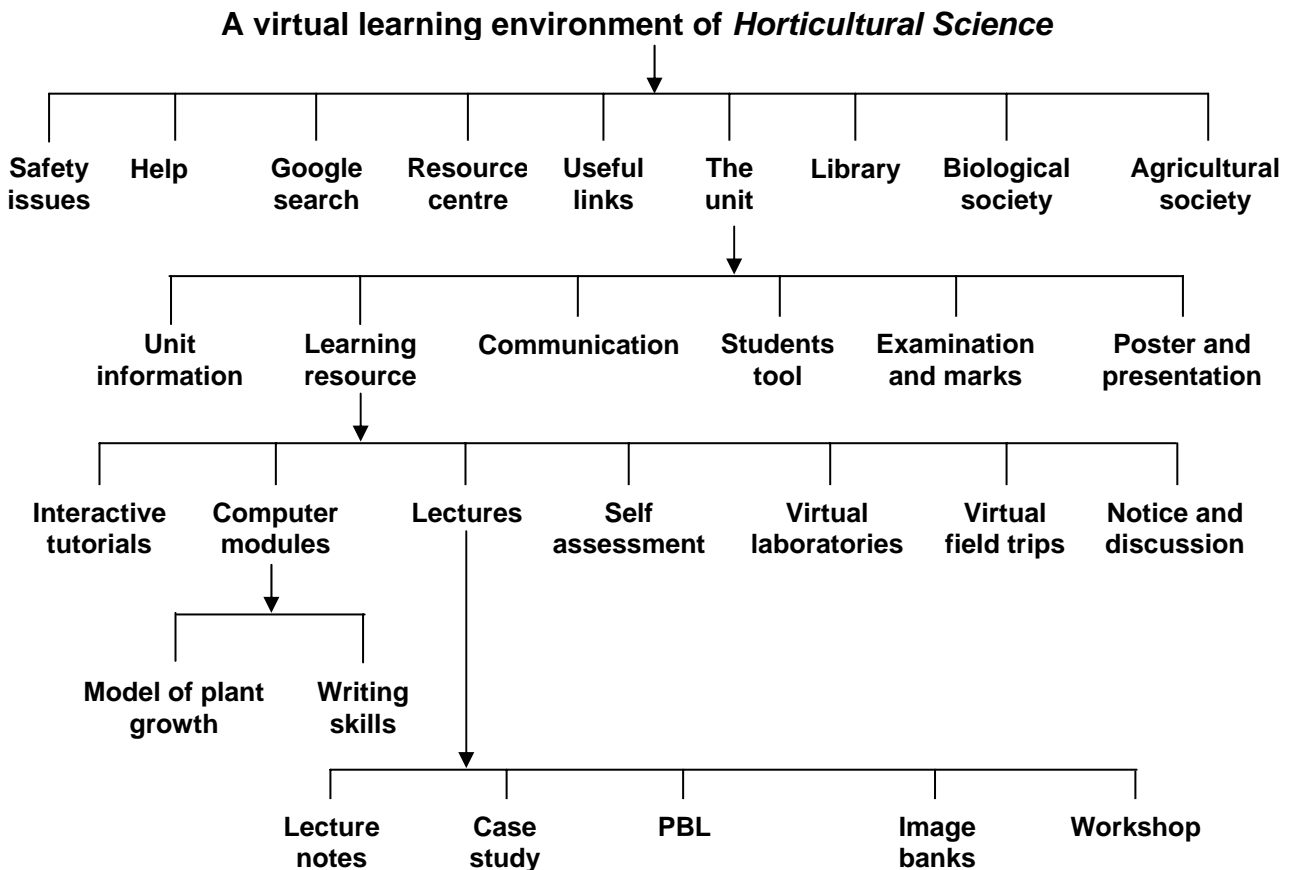


Figure 2. An example of a virtual learning environment for *Horticultural Science*.

Combining case studies and concept maps

The earliest use of case methodology can be traced to Europe, predominantly to France, and case studies have been increasingly used in education. While law and medical schools have been using the technique for an extended period, case study is now being applied in a variety of instructional situations. Schools of business have been most aggressive in the implementation of case based learning, or ‘active learning’ (Boisjoly and DeMichiell 1994). Harvard University has been a leader in this area, and cases developed by the faculty have been published for use by other institutions. The course is designed around cases that encompass various disciplines, but are presented in an integrated manner. The students are thus made aware of the interrelatedness of the various disciplines and begin to think in terms of wider problems and solutions. Later courses add the international dimension to the overall picture. Case studies have been used to develop critical thinking (Alvarez, Binkley, Bivens, Highers, Poole, and Walker 1990). There are also interactive language courses (Carney 1995), courses designed to broaden the students’ horizons (Brearley 1990), and even technical courses (Greenwald 1991), and philosophical courses (Garvin 1991). Concept mapping is essentially a technique for representing

knowledge in graphs, so that knowledge graphs are networks of concepts. These networks consist of nodes and links, with nodes representing concepts, and links representing relationships between concepts.

Here is an example of a case study in horticultural science.

Soilless culture is an artificial means of providing plants with support and a reservoir for nutrients and water. The simplest and oldest method for soilless culture is a vessel of water in which inorganic chemicals are dissolved to supply all of the nutrients that plants require. Often called solution culture or water culture, the method was originally termed hydroponics (i.e., ‘water working’) by Gericke in the 1930s. Over the years, hydroponics has been used sporadically throughout the world as a commercial-means of growing both food and ornamental plants. Today, it is used widely in research facilities as a technique for studying plant nutrition. To study this case, the students may be asked: why do people use soilless culture? What are the advantages and disadvantages of this technique? What is the relationship between greenhouse and soilless culture? What is the relationship between soilless culture and environment science?

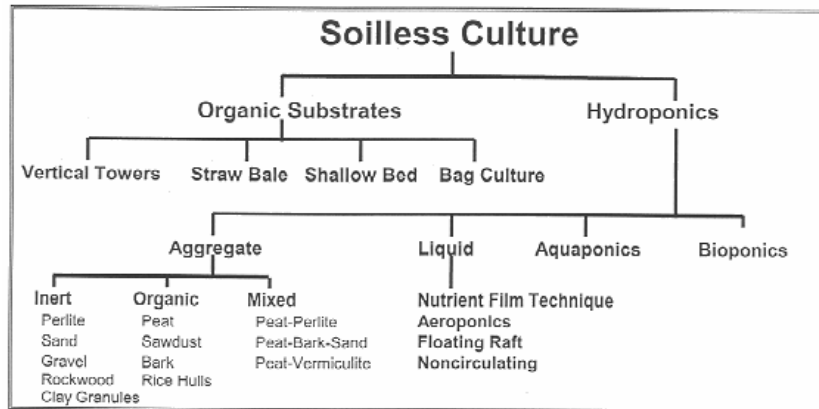


Figure 3. The concept map of soilless culture

How many international horticultural science companies are there in the world? The focal question is, how do you manage a company working with soilless culture? Based on these questions, a concept map can be created (Figure 3). From the resources provided by the teacher and the materials they get themselves, the students can get a schema on soilless culture, and greenhouses, as well as the related disciplines of soil science, environmental science and fertilization science.

Consequences of the proposed reform

Likely problems and possible solutions

There are three likely problems when this reform proposal is implemented in the course of Horticultural Science. One problem comes from the students because they are accustomed to the traditional way of teaching. They generally expect to be told what to do, and to have all the answers given to them. They may not understand why the teacher is encouraging them to learn in a different way. The second problem comes from the teacher. On one hand, the teacher needs a lot of time to design the PBL, case studies,

and especially to establish the *WebCT*. In addition, they must complete research work and activities, so that academics may have little time for the reform. The third problem comes from the teacher’s colleagues, since teaching reform is not an individual work, but a team effort. Colleagues may not understand what you want to do and may not cooperate.

A fundamental problem is how to assess the students. If other lecturers assess the students by examination, what should the reformer’s methods be? If the students have different levels of achievement, what do they feel? How can they compete with others? If they feel upset by these changes, then it may be difficult to continue the reform in the next semester. Other barriers to changing the teaching style are funds, appropriate textbooks, support from the program leader and the system of assessment, which the reformer must take into account before the reform begins. To solve these problems, we need to demonstrate evidence of how the students learn passively and how the contemporary teaching and learning strategies work to change these learning patterns. In addition, the reformer needs to implement change step by step with evaluation

integrated into the process. Outcomes of evaluations must be communicated to both the students and other colleagues in the discipline.

Benefits to the students

It is obvious that there are many advantages in applying the contemporary teaching strategies in the course of *Horticultural Science*, especially for students. Firstly, students should change from passive to active learners. They also learn specific knowledge and generic skills, which will benefit them in the future. Second, online learning and PBL can improve students' ability to solve problems such that they can adjust themselves to meet the changing demands of the society. The last benefit is that the students need not focus on passing the examination, because the assessment system will also change with the reform.

Evaluation of the reform

The criteria for evaluation are crucial if the reform is to be judged a success or not. The result of such a reform cannot necessarily be recognised in a few years. However, the learners will benefit from the reform in the future such that they develop a better ability to resolve problems, learn generic skills and acquire a positive attitude to lifelong learning and active learning. It may prove difficult to evaluate the reform and demonstrate improvements, but previous studies and experiences show that application of contemporary teaching strategies to particular courses are useful and successful in many famous universities. The reformer must clearly understand that no one strategy is appropriate to all learning contexts. No single method is superior to another in every situation, and strategies must be matched to learning objectives. Overall, the results of the reform depend on what and how you test the success of the reforms. A significant measure may be the extent to which students respond positively about the learning experience. While some students may struggle at first they will eventually enjoy and benefit from their learning.

Acknowledgements

I appreciate the support of the China Scholarship Council. Special thanks go to Associate Professors Mike King and Mary Peat, who taught me modern teaching theory and strategies, which enhanced my understanding of how to teach well. Without the help of Drs Charlotte Taylor, Peter McGee and Jan Marc, I would not have finished this paper in time. I would like to say thanks to everyone whose lectures I attended, .My last thanks are to all of my friends in Sydney and my dear classmates; their friendship will encourage me to work hard in the future

References

Alvarez, M., Binkley, E., Bivens, J., Highers, P., Poole, C. and Walker, P. (1990) Case-based instruction and learning: An interdisciplinary project. *Proceedings of 34th Annual Conference*. College Reading Association. 2-18

Boisjoly, R. and DeMichiell, R. (1994) A business outcome model with an international component: A new

workplace dictates new learning objectives. In H. Klein (Ed.) *WACRA Conference*. Needham, MA.

Brearley, D. (1993) The case study: Threat or opportunity? *Counselor Education and Supervision*, **33**, 35-37.

Carney, C. (1995) Teaching with cases in the Interdisciplinary classroom: Combining business language and culture. In H. Klein (Ed.) *WACRA Conference*. Needham, MA.

Conway, J. (1997) *Educational technology's effect on models of instruction*. [Online] <http://copland.udel.edu/~jconway/EDST666.htm>.

Garvin, D. (1991) A delicate balance: Ethical dilemmas and the discussion process. In C. Christensen et al. (Eds), *Education for judgement: The artistry of discussion leadership*. Cambridge, MA: Harvard Business School, 287-304.

Greenwald, B. (1991) Teaching technical material. In C. Christensen et al. (Eds), *Education for judgment: The artistry of discussion leadership*. Cambridge, MA: Harvard Business School, 193-214.

Hessami, M.A. (1995) Using Problem-Based Learning in the Teaching of Analytical Subjects. In S. Chen, R. Cowdroy, A. Kingsland and M. Ostwald (Eds), *Reflection on Problem Based Learning*. Wild & Woolley Pty Ltd: Sydney, 373-389.

Huang, D. (2001) Reforming of course system and textbook construction of horticultural science. *Higher Agricultural Education*, **115**: 48-49.

Lagowski, J.J. (1990) Retention Rates for student learning. *Journal of Chemical Education*, **67**, 811.

Liao, M., Li, H., Zeng, W. et al. (2000) Paying more attention to the abilities training of the students in horticultural science. *Journal of Sichuan Agricultural University*, **18**(supplement), 68-70.

Nanjing Agricultural University, <http://www.njau.edu.cn/>.

Schmidt, H.G. (1993) Foundations of problem-based learning: some explanatory notes. *Medical Education* **27**, 422-432.

Tang, C., Lai, P., Tang, W. et al. (1997) Developing a Context-Based PBL Model. In J. Conway, R. Fisher et al. (Eds), *Research and Development in Problem Based Learning, Integrity, Innovation, Integration*, **4**, 579-595.

WebCT, <http://www.webct.com/>.

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

Xu, C., Zhu, S., Cui, Q. et al. (2001) Reform and practice to horticulture teaching and study of new period in institutions of high learning of China. *Journal of Nanjing Agricultural Technology College*, **17**(1), 68-73.

Appendix:

Some useful URLs for horticultural science are as follows:

<http://www.hort.cornell.edu/department.html>;

<http://www.uwex.edu/ces/wihort/>;

<http://www.horticulture.com.au/>;

<http://www.flemings.com.au/>;

<http://www.hcs.ohio-state.edu/hort/bio.html>;

<http://www.postharcest.com.au/>;

<http://bestplants.chicago-botanic.org/>;

<http://garden-gate.praireenet.org/>; and

<http://www.hort.net/>.