

A problem based learning course for fostering generic skills

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Abstract

A problem based learning (PBL) course aimed at developing generic skills in undergraduate students is designed, and the reason behind it is offered in the context of a Chinese university and Chinese students. Detailed course information including: the real-world problem; learning events; resources needed; the assessment structure; materials used in the course; and timetable is provided along with the expected benefits for the learners. The design process for PBL based courses is also summarized for reference. Finally, further work needed for the future is outlined. The article will be useful in teaching innovatively in the higher education sector in China.

Why do we need such a course?

Generic skills, which include oral communication, writing, practical, team work and leadership skills, are considered essential for undergraduate students (Sheffield University 1996). Since many of these skills are an indispensable part of the lifelong learning process, some even consider them more valuable than subject matter. Despite their importance, these skills are not well covered in our university. Though generic skills are explicitly described in our curriculum (see below), they have been ignored for decades. The results are devastating. Students tend to lack confidence, and the ability to work as part of a team, have poor written and oral communication, and few practical skills. Considering that most of our students will become engineers after their graduation, the impact can be even worse.

Students should be capable of information retrieval, should grasp the basic methods of information acquisition using modern information technology; they also should know experimental design, observation, data collection and results analysis, and be capable of scientific writing and academic communication. (Lanzhou University 2003)

On May 25th, 2004, during our last teaching methodology class in the University of Sydney, each of us was asked to answer the following question:

What particular idea (or ideas) amongst the things we have discussed over the last 10 weeks do you think will have a lasting effect on the way you think about your teaching?

The most frequently mentioned ideas were (Figure 1): generic skills (especially oral communication skills); student-centred activities; and team work.

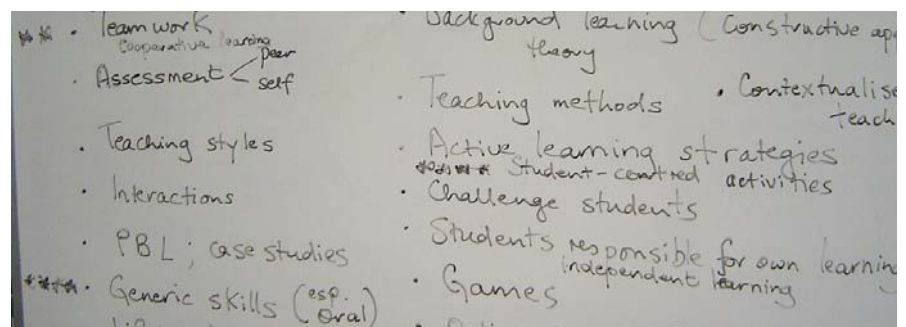


Figure 1. What do we need to change?

When we are asked to give the reason, it is simple: we seldom use such techniques in China and are in desperate need of these changes.

Besides this, students often complain that lectures are boring, the subjects are tedious and the professors are disappointing, so much so that they have lost interest in their major. The decreasing number of students in the lecture theatre and

the sharp contrast between their surprisingly high entrance marks a few years ago and their poor academic performance now, shows that teaching deficiencies are impacting upon student learning. You can say that students are just lazy, but my experience tells me that it is not their fault.

It seems something must be done to solve the problem! Being the person who is responsible for the curriculum design of the undergraduate courses in our school, it's my responsibility to take some measures.

Our solution to the problem

The solution is a problem based course for fostering generic skills. Education research tells us that problem based learning embodies most of the principles we know to improve learning, and provides an opportunity to practice various skills (Woods 1994). Given this information, our idea is to design a new course for generic skills for undergraduate students. The course is deliberately designed so that it:

- is student centred;
- covers the generic skills mentioned above;
- is based on modern teaching methodology;
- uses PBL as the main approach; and
- is relevant to students.

Education research suggests that students involved in PBL are more active, more motivated to solve real world problems, and also learn more throughout the process (Williams and Duch 1996). Bearing this in mind, we choose the following problem:

PCs in our laboratory have been stolen several times and two of our undergraduates have been dismissed from the school because of theft. In addition to this, the LCD screen in the general office has also been stolen, together with a few hundred Yuan. To make things worse, the computer projectors in the lecture theatre have disappeared too. Can you design an alarm system to protect the laboratory?

Since students are eager to solve the problem, they will try various ways to find the solution. However they go about solving the problem, they will learn. The lecturer's job is 'easy': they should only help students whenever they desperately need it. So, we see that the course is student-centred and the teacher's role is greatly reduced. Through careful design, we can integrate as many generic skills as possible into the course, hoping students will learn them enthusiastically.

Because this is the first time we have taught a generic skills course, and also because it will be given in English and the teaching method has changed dramatically, this unit of study will be elective and enrolment limited. As experiences accumulate and the course becomes well accepted, we can then make it compulsory and accessible for all.

Objectives of the course

The objective of the course is clear cut, i.e. to foster generic skills, which include:

- oral communication;
- writing;
- team work;
- communicating in English;
- practical skills;
- information seeking and assessment;
- applying the knowledge to the real world;
- confidence development;
- brainstorming; and
- project planning.

At the same time, it's our hope that we can set up a model course for the teaching staff in our school, which is totally student-centred, and thoroughly different from traditional lectures. The expectation is, that one day, more teachers will change their courses to be totally or partially student-centred. What's more, students are expected to find in this course that they can learn through other ways than lectures, which will provoke their thinking and make them more creative in their self-directed studies.

Some may argue that generic skills should be integrated with subjects, and taught along with professional skills. Although it seems sensible, this doesn't actually work. Generic skills have been listed in our curriculum for years, but no one has ever tried to teach them. Each thinks somebody else will do it. Though disappointing, it is understandable. That is why we will set up a standalone course for the students.

Detailed description of the course

Learning events analysis

To serve the students well during this problem-solving process, lecturers should identify the most difficult part of the course and give corresponding support. These are essential to the success of the course and are called 'learning events' in the literature. Listed below are the learning events involved in the course.

The lectures are deliberately minimised and the lecture approaches are diversified. On the other hand, modern teaching methods, including group discussions, brainstorming, tutorials, peer instruction and excursions are given a high priority. The philosophy is to get students immersed in an artificial environment, in which they have to learn not only by reading, but also by seeing, hearing, saying, and saying while doing (Lagowski 1990).

The planned assignments for the course are as follows:

- i. time management module: each group should submit their schedule for the project;
- ii. market survey module: each group should give an oral report on their survey;
- iii. peer instruction module: before the event, each group should familiarise themselves with one software program; and
- iv. peer instruction module: after the event, each group should be taught how to use a different software program by their peers.

Table 1. Learning events for the course

No.	Learning Events	Description	Teaching approaches
1	Problem introduction	Using video to present the problem to the students, arouse their curiosity, and make them feel confident	Video demonstration, discussion
2	How to write a paper	Help students to learn to write scientific papers	Mini lecture, group discussion, brainstorming
3	Time management	Help students to manage their time	Mini lecture, group discussion, brainstorming
4	How to give a presentation	Make the students prepared for the oral reports in this course	Mini lecture, group discussion, brainstorming
5	The laboratory tour	A tour around the laboratory	
6	Market survey	Help students find the right place to buy some devices needed in their design	
7	Lecture: sensors	The core part of the alarm system and most challenging one for the students.	Mini lecture, hands-on experiments
8	Peer teaching events	How to use the following software: <i>Office, Pspice, Protel.</i>	Peer instruction
9	Demonstration: how to make a PCB board	Postgraduate students give the demonstration on how to fabricate simple a PCB.	Demonstration
10	Demonstration given by the librarian.	Information retrieval skills and web resources evaluation skills	
11	Visit	Arrange a visit to a local electronic company	Mini lecture, demonstration
12	Tutorials	To be developed	
13	Showcase and final report	Showcase the prototype of each group, demonstration and report given by each group	Presentation, peer assessment
14	Analog and digital circuits lecture	The course is to be given in parallel with the courses listed at left. No dedicated classes for this subject.	Traditional lectures, laboratory work

Resources needed by the students

As we have mentioned above, students are the protagonists in this course, while lecturers only play supporting roles. To make the drama more successful, we need to identify what resources the students need to solve the problem. The following table lists all possible resources and whether they can be satisfied or not.

Table 2. Resources needed for the course

Resources needed	Can they be satisfied?
Library access	Yes
Internet access	Yes
Software (<i>Pspice, Protel, Word, Excel, Ssreader, etc.</i>)	Yes
Electronic books; (Ssreader Card)	Yes
Laboratory with the following configuration: function generator, oscilloscope, DC power supply, PC, multimeter, breadboard etc.)	Yes
Lecture theatre	Yes
Company visit	Yes

Assessment

Whatever strategies you use, the assessment system will have a powerful impact on students' approach to learning. The assessment method used in this course is carefully designed so that it:

- integrates assessment into the learning process and what is assessed is the total learning experience rather than a separate performance after learning has finished;
- assesses assignments which are impossible to tackle on the basis of memorization or through the repetition of algorithms or set procedures;
- employs assignments which involve interaction between students; and
- assesses tasks which are similar to 'real-world' situations and problems. (Gibbs 1992)

In addition to this, it also involves peer assessment and self-assessment, which makes it more objective and stimulating than other assessment systems. The assessment structure is as follows:

Table 3. The assessment structure of the course

Assessment tasks	Marks	Self assessment	Peer assessment	Supervisor assessment
Project schedule	10			10
Market survey report	10		5	5
Software skills 1 (before)	10		5	5
Software skills 2 (after)	10			10
Paper writing	10	2	3	5
Group presentation	10		5	5
Prototype demonstration	40	10	10	20
Total	100	12	28	60

Supporting materials for the course

To make students independent learners, materials are needed to support their learning process, broaden their horizons and encourage them to learn what you don't teach in class. By doing so, you also help them foster critical thinking and self-directed learning skills. Moreover, it is

important to maintain the motivation of students and avoid the so called 'rebellion' state (Elton 1996) (a state characterized by the conflict between the high intrinsic motivation of the students and the teachers' failure to provide positive extrinsic motivation). The following table gives the learning resources for the students.

Table 4. Learning resources of the course

Learning Events	Learning resources*
Problem introduction	Video1: Barbie; Video2: car; Video3: transfusion
How to write a report	Sample report: experimental physics manual, phys1003, physics1004, introductory circuits and projects; Scientific writing (Electronic version) http://fybio.bio.usyd.edu.au/vle/L1/ResourceCentre/GenericSkills/GenericSkills.html
Time management	PMBOK2000 (Electronic)
How to give a presentation	Handouts: seminar presentation (advanced mathematical discourse) Mini-presentation; checking understanding and summarizing; presenting a verbal summary; effective delivery; introducing a presentation; seminar skills; keys to a successful seminar presentation; signposting; body language; an introduction to presentations; signposts; using your voice; dealing with questions
The laboratory tour	Introduction to laboratory instruments: http://www.ee.usyd.edu.au/tutorials_online/labintro/labintro.html EE-database in University of Sydney: http://www.eelab.usyd.edu.au/ee_database/
Market survey	Handouts: Map of Lanzhou
Lecture: sensors	http://www.sensor.com.cn/
Peer teaching events	Excel: Experimental physics, phys1003, physics1004, introductory circuits and projects; Experimental physics, phys1001, physics 1 (regular); Experiment analysis (Electronic) Word: http://fybio.bio.usyd.edu.au/vle/L1/ResourceCentre/GenericSkills/Protel : http://www.altium.com/learningguides/protel99se/index.html <i>Spice</i> : http://bwrc.eecs.berkeley.edu/Classes/IcBook/SPICE/ <i>Pspice</i> : http://www.orcadpcb.com/default.asp
Demo: how to make a PCB board	<i>Protel</i> : http://www.altium.com/learningguides/protel99se/index.html
Demo given by the librarian	Lanzhou University library: http://lib.lzu.edu.cn/ How to evaluate web information: http://science.uniserve.edu.au/courses/scienglish/ Electronic books: (need <i>Ssreader</i> browser): http://www.ssreader.com/
Other useful websites	Generic skills website http://fybio.bio.usyd.edu.au/vle/L1/ResourceCentre/GenericSkills/GenericSkills.html http://bugs.bio.usyd.edu.au/studres/Generic_Skills/genskills_home.htm

*Many of the handouts listed here are provided by the Centre for English Teaching, School of Physics and School of Biology, the University of Sydney.

Besides this, each student is able to access hundreds of thousands of electronic books through the Internet using *Ssreader* (*Super star reader*, a web browser used to read electronic books).

When will the course be given?

Since analog circuit theory and digital circuit theory are needed to solve the problem, we decided to run the course in parallel with these two courses, (not after), which are given in the second semester of Year 2. This will add four credit points to the students' workload. By adjusting the current curriculum a little, this impact can be eliminated.

About the students

In our school, we provide four majors, each of them has 70 students: Computer science and technology (CST); E-commerce (EC), Electronics and information science and technology (EIST); Communication engineering (CE). To cater for the talented students, we also have a special program, which has about 40 students (not included in the above majors). Since the designed course involves group discussion and group presentations, which are not suitable for large classes, the course will firstly be given to these talented students.

Timetable for the course

The timetable for the course can be provided as listed in Table 5.

Table 5. Timetable for the course

Week	Module	Description	Forms	Place
1	Problem presentation	Give real problems to the students	1. Real world problem (video) 2. Stimulation and motivation (video) 3. Grouping (10 group, 4 heads/group)	Lecture theatre
	Free			
2	Time management	Teach students how to manage time	1. Brainstorm 2. Group discussion	Lecture theatre
	Free			
3	Information seeking skills	Topics on how to retrieve information and evaluate web information	1. Various skills (Brainstorming) 2. How to use these skills (Demonstration) 3. <i>Ssreader</i> card	Library
	Free Assignment 1 due			
4	Market survey	Ask each group to do a survey, find as many shops as possible selling electronic devices	Field trip	
5	Market survey	Ask each group to do a survey, find as many shops as possible selling electronic devices	1. Oral report 2. Assessment	Lecture theatre
	Laboratory tour			
6	Sensors introduction	Mini lectures on various sensors and their usage	Lecture + demonstration	Lecture theatre
	Laboratory + tutorial			
7	Protel training	Teach students how to draw electronic schematic diagrams	1. Demonstration 2. Assessment according to the demonstration effects	Laboratory
	Laboratory + tutorial			
8	Pspice simulation training	Topics on how to use software for simulation purpose	1. Demonstration 2. Assessment according to the demonstration performance	Laboratory
	Laboratory + tutorial			
9	PCB fabrication skills	Various ways of making a PCB	Brainstorm + demonstration	Laboratory
	Laboratory + tutorial			
10	Company visit	Pay a visit to a local electronic company	Field trip	
	Laboratory + tutorial			
11	Scientific writing	Lectures on how to write a paper	Mini lecture, brainstorm	
	Laboratory + tutorial			
12-15	Laboratory work	Work in laboratories	Laboratory	Laboratory
16	Paper writing	Each group writes a paper about their work		
	Tutorial			
17-18	Showcase +Assessment	Each group report their work, give a presentation	Peer assessment + self-assessment + supervisor assessment	Lecture theatre

Each student should attend a one-hour lecture and a two-hour tutorial each week. The tutorial commences week 5. In total, there will be 18 weeks for the course.

Benefits for the students

Through careful design, undergraduates are sure to learn a lot from the course. Firstly, as the course is given in English, it will help students improve their spoken English and listening ability. Secondly, the number of lectures has

been reduced, to give students more autonomy in their learning, which is significant for self-directed learning. Even for the remaining lectures, modern teaching methods are used to make the course more exciting. Thirdly, all students work in groups and collaborate with each other to solve the problem, and this is beneficial for their team work skills. In addition to this, students are also given the opportunity to learn presentation skills and to lecture to their peers. They also have to write scientific papers to

make their ideas known by other people. By doing so, they improve their communication skills. Moreover, the students learn practical skills by solving a real world problem, and get the chance to showcase their products, which will make them more confident. In addition, the course will help stimulate students in their analog circuit and digital circuit learning.

Is it possible?

Overall, this plan seems reasonable. But is it possible to implement such a course into our curriculum? The answer is definitely yes. First of all, quality education is greatly advocated in China these days. Various teaching methods are encouraged to stimulate student learning, and innovations in teaching are rewarded by the school authority. Secondly, the author is the head of the department, in charge of the teaching for undergraduates. It is his responsibility to do something new to improve undergraduate teaching. Third, the author stayed for four months in the University of Sydney, studying teaching methodology and English, which makes him theoretically fit for such work. In addition, we have the Young Teachers' Foundation in our school, so it is easy to get financial support to conduct education research such as this. Finally, we have a special program called 'Excellent Course' in Lanzhou University, and the lecturer who gives the course will be financially rewarded for his job. This means the university encourages its staff to improve their teaching. In short, the PBL-centred course for fostering generic skills can be implemented in our school.

The design process summary

By and large, to change your course by employing PBL strategy partially or totally, you need follow these steps:

- i. **Syllabus study:** review the syllabus carefully, identify the knowledge area or skills involved clearly and make sure you know the curriculum very well. In this article, since the author deals with generic skills that are not included in any course, the objectives of the course are listed as the guidelines.
- ii. **Problem design:** fight to find one or more real-world problems, try to make them interesting and relevant to students. Make sure all the knowledge or skills needed to handle the problem correspond to those listed in the syllabus. This is the most challenging part of the whole process.
- iii. **Learning Events analysis:** review the problem thoroughly, identify the most demanding part of the problem and schedule learning events accordingly. Remember to diversify the teaching methods.
- iv. **Assessment structure:** based on your own environment, design the assessment system that best fits your conditions, preferably including peer and self assessment in the system.
- v. **Resources preparation:** find out all the resources necessary for carrying out the course, prepare them in advance.
- vi. **Course Evaluation:** check the outcome of the course, for example, by monitoring students' performance in the examination, feedback and colleagues' responses, and recognize the unsatisfactory parts of the course. Unfortunately, this has not yet been done for this article, and is listed as our future work.

vii. **Course eXtension:** modify the course accordingly.

Putting the initial letters of the above process together, the whole process can thus be summarized as SPEAR.EXE, just like an MS-DOS executable file name. Figure 2 illustrates the process.

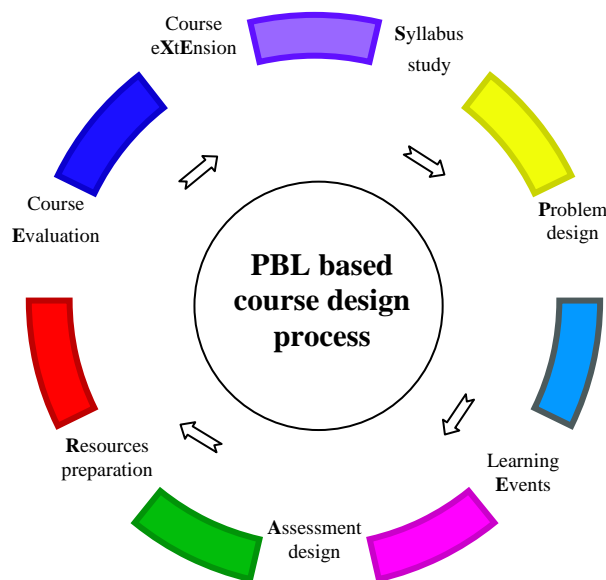


Figure 2. The SPEAR.EXE process

Further work

In this paper, details of a PBL-based course have been given, and the process involved for the design of such a course was also summarized. As we all know, no teaching methodology is universally successful and globally applicable. This is also true for the problem based learning strategy. Though we hope the PBL-based course will be helpful for fostering generic skills, we need evidence. So, future work should include: assessing the students' learning outcome after the course, testing the validity of the method and collecting students' responses. Whatever the results, we should keep the momentum of teaching innovation.

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