Developing Professionalism in Engineering Students Using Problem Based Learning

Jianguo Wang [a,*], Yew Chan Fong [a], W.A.M. Alwis [b]

[a] School of Engineering, Republic Polytechnic
[b] Office of Academic Affairs, Republic Polytechnic,
1 Kay Siang Road, SINGAPORE 248922

Abstract

This paper discusses the professionalism of engineering and its meaning to engineering education. Through evaluating the traditional ways of engineering education in universities and institutes of high learning, the paper shows the need for an engineering education strategy that enable students to evaluate a given scenario, identify, search & gather relevant information, work in teams, reason & justify to form opinions, apply various known tools, convince others and reflect regularly on whatever they do. The paper introduces problem based learning (PBL) approach for professional development in engineering education. It elaborates on the design and implementation of RP-PBL (Republic Polytechnic –PBL) approach within the School of Engineering, Republic Polytechnic, Singapore. As a part of the curriculum, collaboration with the industry and engineering professional bodies like Institution of Engineers Singapore (IES) and Singapore Industrial Automation Association (SIAA) to nurture the professionalism of engineering students is also discussed.

Keywords: Problem based learning (PBL), Holistic Education, Engineering Profession, Teaching Methodology, PBL Implementation

1. Introduction

The aims of engineering education inevitably include the learning and understanding of fundamental engineering concepts and the development of appropriate solutions to the problems related to the topics in the curriculum. The problems in the course should cover the process of observing engineering related phenomena, understanding of concepts, statement and the search of different alternatives as solutions to the problem at hand. However, engineering education is more than that.

In the famous article about engineering education written by Prof. Dym [1], he had asked a few questions about present engineering education. “Can we create educational environments in which students learn more about engineering, and with greater interest and enthusiasm? Can our graduates be more sensitive to a wider range of needs than simply ‘technical’ issues? Can they enjoy a broader range of intellectual activity, both as engineering students and as lifelong members of the profession?” [1]

He had summarized his observations to engineering education into the following 5 points [1]:

1. Engineering curriculum has been designed to be highly structured, locked in too long, serial course sequences.
2. This curricular organization has been institutionalized within an engineering science model of engineering, and is delivered within academic cultures that clearly conform to the scientific research enterprise.
3. We seem to convey to all students the idea that mathematics is the language of engineering.
4. We have done a much better job teaching analysis than we have done teaching design.
5. We conduct the engineering education enterprise in an environment in which each student’s performance is largely assessed in individual terms, often in styles that encourage each student to see herself as being in competition with her peers.

* *Corresponding author: Tel: 6510-3107 Fax: 6415-1310; Email: wang_jianguo@rp.edu.sg*

The consequence of such engineering education is that the engineering graduates feel frustrated when they found it is so hard, if not impossible, to formulate mathematically a real-life problem they face in their job. They are uncomfortable to make decisions based on qualitative factors. They are good at analysis but can not synthesize a solution, which is more important for an actual engineering job. Because they study different subjects in silos and are assessed individually, engineering graduates are not good at communicating and collaborating with others in their work. Basically, they are unprepared for the engineering profession they need to practice when they leave the education system.

Although Prof. Dym's article is regarding engineering education in US, the observations and questions are similar for engineering education in Singapore and many other Asian countries [2]. The existing conventional lecture-centric engineering education system would not be able to provide satisfactory answers to those questions.

Many of calls for engineering education reform from industry have focused primarily on issues related to the attitudes and skills required to prepare engineers generally for the profession, such as communication skills, teamwork, lifelong learning and ethics. These efforts have also been supported by initiatives to change the learning environment in which engineering is taught and to rely less on traditional lecture formats and increasingly on the creative aspects of engineering using active learning [3] and problem based learning [2] to more effectively engage students [4].

2. Engineering as a Profession

To understand why the engineering education needs to be changed, we first have to understand engineering as a profession. The key for engineering education is to prepare students as an engineering professional instead of providing them with an entry-level certification for the profession [1]. Before answering the question "What do engineers really do?", students should know engineering practice does not resemble engineering in school, with its never-ending lab reports, mathematical manipulations and books, books, books [5].

Profession is defined as a calling requiring *specialized knowledge* and often long and *intensive preparation* including instruction in skills and methods as well as in the scientific, historical, or scholarly principles underlying such skills and methods, maintaining by force of *organization* concerted opinion *high standards of achievement and conduct*, and committing its members to *continued study* and to a kind of work which has for its prime purpose the rendering of a *public service* [5]. Engineering is a profession by this definition.

Profession occupations possess the following characteristics [2, 5]. First, entrance into a profession typically requires an extensive period of training, and this training is of an intellectual character. That is, a member of a professional community must master certain theoretical and technical knowledge that the general public cannot easily acquire. Second, professionals' knowledge and skills are vital to the well being of the larger society. Third, professions usually have a monopoly or near monopoly on the provision of professional services. Fourth, professionals often have an unusual degree of autonomy in the workplace. Last, professionals claim to be regulated by ethical standards, which are usually embodied in a code of ethics. Because of the nature of engineering profession, engineering ethics is more preventive ethics [6]. In today's world, economization converts professional-client relationships into ones based on financial incentives, allowing market forces to determine the quality of the professional-client interactions. This is one way where the moral duty of professionals to the society can get overshadowed by financial considerations.

In the eyes of the public, employers and students, the university provides a kind of certification that entitles graduates to certain privileges. A fundamental question then is, "what exactly do the universities certify?" The faculties in the university that conduct programmes leading to so-called professional degrees tend to consider the education they provide as a form of training. Professional organizations, which license professionals and issue practicing certificates, formally recognize university degrees as if university degrees certify certain abilities. On the other hand, some look at university education as the development of intellectual maturity. One can view both provision of training and development of intellectual abilities, as ways of certification for admitting individuals to a certain set of communities. In this sense, university teachers are agents from a community who nurture and help others in getting admitted to their community, be it a community of intellectuals or a community of practitioners or both [2].

That means educating someone to become a professional is a special responsibility. For engineering education, holism is a necessity. We need an education strategy that will make students regularly evaluate a given scenario, identify, search and gather relevant information, work in teams, reason and justify to form opinions, apply various known tools, convince others and reflect regularly on whatever they do.

The concerns to higher education for profession are not limited to engineering school in universities. Medical school and law school are the first two schools who moved away from traditional lecture centric educational system to problem based learning pedagogy. Even in business school, there is a call to change the business education from “scientific model” to “profession model” recently [21].

3. Change of Engineering Education

In response to the requirements to the change of engineering education, Accreditation Board of Engineering and Technology (ABET) has implement fundamental change to its accreditation philosophies, criteria and processes. Accreditation criteria now focus on what the engineering graduates have learnt and can do, instead of seat times they spent in classes [7]. Following this change, Pen State University had developed “World Class Engineer” concept for their curriculum reform. The attributes for a world class engineer build on the basis of a solid grounded, technically broad, versatile engineer who is aware of the wider world, effective in group operations and customer-oriented [4]. Many universities and high learning institutions have moved away from traditional lecture-centric pedagogy to more open-ended pedagogies, such as studios for engineering in Illinois Institute of Technology (IIT) and Worcester Polytechnic Institute (WPI) [8], engineering clinic in Harvey Mudd College [9], problem based learning (PBL) in many universities [2][11]-[19].

3.1 Studio for engineering

Studio for engineering is for students to immediately practice the techniques they learn from the courses. The universities to adopt this approach review engineering as an art [8]. Studio experience makes student realize that they need to learn techniques in order to obtain satisfactory results. Students are required to work in teams in studio. To create engineering devices and make it a success, students need to acquire sufficient knowledge of business, law, design, manufacturing, marketing, and many others. The difference between studio for engineering and problem-based learning is that a rigorous set of classroom-based courses incorporating the latest educational techniques is still maintained in the universities practicing studio for engineering.

3.2 Engineering clinic

Engineering clinic approach is developed in Harvey Mudd College (HMC) in US. It started in 1965 in which students work on real, external sponsored design and development projects. Like the "clinical" experience at medical school where students learn the practice of their profession by working with real patients and real problems, in the Engineering Clinic students are exposed to the art and practice of engineering profession by working on real problems for real clients. Students work in project teams of four or five juniors and seniors. The teams work on professional design and development projects for clients from industry, government, and the community. The clients pay a fixed fee ($41,000 for 2005/2006) for student teams to work on current problems which the company or agency needs solved [9].

HMC’s engineering curriculum is quite unique [10]. Unlike other universities which offer degrees in chemical, civil, electrical, mechanical, and industrial engineering, HMC offers only a single, broad, unspecialized degree in engineering. That means the projects in engineering clinic can be truly multi-disciplinary without the restriction of specializations.

3.3 PBL for engineering

Problem-based learning (PBL) is an learning methodology used in response to the challenges posed by today’s professional education. Contrary to the conventional model that places an application problem after concepts or topics have been introduced, PBL uses the problem to initiate learning. Besides promoting the construction of knowledge, it also contributes to the development of skills and attitudes deemed important for engineering professional and practice. Although the studio for engineering and engineering clinic mentioned above have the same objective to develop the professionalism in engineering students, the main difference between PBL and other types of active, student-centered learning processes is its emphasis in introducing concepts to students by means of challenges in the form of problems relevant to their future practice[11]. It has been proven that students are better engaged in a PBL class through the measurement and analysis of student engagement in university classes where varying levels of PBL methods of instruction are in use [12].

There are many different ways to develop PBL engineering curriculum. Fink describes project organised problem based learning concept [13]. It normally has a real-life engineering problems to solve. Each problem based project work comprises problem analysis and problem definition in engineering terms, problem solving, and documentation in terms of a report or a scientific paper and poster. Each problem takes months, if not weeks to solve. Cirstea introduces problem based learning (PBL) for full-time and part-time engineering courses, like microelectronics [14]. Fruchter and Lewis describe P5BL-problem, project, product, process, people based learning, a program in Stanford University [15]. Carravilla reports their pedagogical experiment to teach logistics without a formal class in FEUP. Student learning is organized around 5 themes in logistics. Although problem based learning is not mentioned in this report, their method is similar to PBL in nature [16]. Other PBL engineering curriculum published include PBL for civil engineering in Brazil [11], seven-step problem-based learning for an interaction design course [17], and implementation of the problem-based learning approach in the Department of Electrical Engineering, University of Malaya [18], a student-centered, concept-embedded problem-based engineering thermodynamics in Kettering University[19], and many others.

At Republic Polytechnic (RP), Singapore, problem based learning takes one-day one problem approach [20]. The one-day one-problem approach is RP's strategy to apply PBL to meets its specific mission of training technical professionals out of secondary school graduates. The strength of the approach is that it offers students opportunities to daily reflect about how they are learning. It also exposes students to concepts in an iterative manner and helps students be able to apply knowledge to unique situations by virtue of their familiarity with dealing regularly with the context of real world problems. For engineering school in RP, the challenge is to nurture professionalism in engineering students through the use of PBL.

4. RP-PBL for Engineering

In the School of Engineering at Republic Polytechnic, problem based learning (PBL) has been adopted to deliver the engineering curriculum. The curriculum of an engineering course seems to be naturally designed around the solution of problems, where the main goal is to ensure that the student develops enough abilities and skills. These abilities and skills are related to the analysis, abstraction, interrelationships between the main factors of the problems to be solved, inductive reasoning and analogy, synthesis and design. The problems in engineering curriculum should be real world problems in the best of the cases. However, a good problem does not have to be real-life problem, if it is realistic, interesting and meaningful [2].

The School of Engineering in RP adopts the same one-day one-problem approach as other schools in RP. The daily routine of one-day-one problem approach at RP is brief described below [2], [22]:

- There are three meetings and two break-outs within a day of problem solving.
- The first meeting starts at 8:30am and lasts for about an hour. In the first meeting students receive a problem as a trigger for learning.
- Students with the help of a facilitator in five teams of five (total of 25 students in a class) examine the problem and clarify what it is they know and don't know and formulate possible hypotheses.
- Teams identify learning issues they will investigate.
- After the first meeting, teams employ research strategies to collect relevant information during the first break-out time.
- The second meeting normally starts at 10:30am. During the second meeting before lunch the teams of five meet with facilitator to briefly discuss their progress.
- During the second break-out time after the second meeting, students continue in their team of five to review resource materials and peer teach what it is they have learnt from their research.
- The team develops an outcome for the problem before the third meeting. They present their findings to the other four teams and the facilitator for evaluation during the third meeting in the late afternoon, normally between 2-4pm.
- During third meeting presentation, students defend and justify their outcomes.
- After student presentation, facilitator presents the sixth presentation (after five presentations by students) to show his/her solution to the problem.
- Students complete a 15 min quiz to test what they have learnt during the day.
- After the whole day class, students reflect on the way they have learnt in their teams and write a reflection journal.

There are 6 key elements in the daily routine:

- Classroom setting and learning environment
- Three meetings and break-out time
- Problem statements and problem design
- Scaffoldings
- Presentation
- Assessment

4.1 Classroom setting and learning environment

Students will be learning in groups of 25 with the guidance of a facilitator. The classroom layout is designed in such a way that 5 students are sit face to face around a table. There are 5 tables in total in one classroom. Students are expected to share their own ideas, do research and develop possible solutions together with their team mates. Social bondings among students are developed due to a collaborative classroom environment.

Similar to a real working environment this days, all students in RP carry notebook computers to access their daily problem statement, do online research, share ideas through email and internet messaging, do their daily quiz, and complete understanding test. The whole RP campus is covered under wireless communication network and equipped with online resource access platform.

Depending on the engineering problems students face, they can conduct their meetings in laboratories to design and fabricate circuits and devices, or play games in classroom to simulate the real manufacturing operations, or go out of campus to observe and collect real data for analysis.

4.2 Three meetings and break-out time

There are three meetings every day for students to interact with facilitator of the class. While the first meeting is for students to understand the problem and figure out the knowledge they need to learn in order to attack the problem, the second meeting is giving a chance for students to move in the right direction. Normally this is done through the inquiries and leading questions from facilitator. The two breakout times between three meetings are for students to do self-directed learning. Students continue to learn through presentations during the third meeting. Challenging questions from facilitator and classmates force presenter and listener think more critically.

4.3 Problem statements and problem design

Problem statement is the key to trigger students to start to learn, and problem must be suitable for students to complete it within a day. The problem design and problem statement crafting become the most critical component for one day one problem approach. In Republic Polytechnic, the traditional topic-based curriculum is re-engineered to form a selection of key ideas that define the subject. For each key idea, a context is crafted that motivates a response dealing with the idea strongly. The subject content is secondary and shall get expressed along with the response. Each problem sets an achievable, meaningful & relevant target for the day to the students.

To get a feeling of problems in our engineering modules, an example from the module E214-Statistical Methods for Engineering is attached in Appendix 1.

4.4 Scaffolding

The students in RP are mainly secondary school graduates who have been so used to traditional lecture system invariably find themselves unfamiliar with the PBL environment. To help the students, well designed scaffolding is provided to nudge them towards developing a comprehensive response. Scaffolding is in the form of worksheet accompanying the problem statement. It can be released together with problem statement or in some cases, after the first meeting if facilitator does not want students to get clues from worksheet in the first meeting discussion. An example of worksheet for the problem in Appendix 1 can be found in Appendix 2.

4.5 Presentation

Students need to understand that they are like to work in a real small corporation as employers when they solve engineering problems daily. They need to defend their solution to problems in front of colleagues, managers and outsiders through meetings and presentation. Although powerpoint slides are most commonly used in presentation, students can present their solutions in many different format, including prototype of a simple devices, report generated from an enterprise application system, or even a quotation for customers. In Inventory Management module, students use Enterprise Resource Planning (ERP) software to manage a small, virtual company to produce selected product. They are required to setup company, product and processes, do daily planning and operations management through ERP software. Then they present through software demonstration and report generated from the system.

4.6 Assessment

In conventional lecture-centric educational system, examination is the major way of assessment. It drives students to learn for examination through memorizing the materials presented by lecturers in classroom, guessing the questions which may appear in exam paper, and drilling to finish an exam paper faster. In PBL approach, problem statement supposes to be the drive of the students' learning. However, research shows that in general assessment tends to drive students' learning [23]. Since the primary goal of PBL is to instill an attitude and character trait that will enhance the students' critical thinking and self-directed learning ability, assessment in PBL must be holistic.

At Republic Polytechnic, the assessment includes two main components: daily grade and understanding test grade. Daily grades capture the different facets of the broad perspective of problem solving in a team, convincing others on one's position and reflecting on the day's happenings. Multi-faceted information such as participation in team discussion, solution to problem, presentation skills, and daily reflection journal leads to the module grade. In addition to daily grade, facilitators also give feedback daily to each student. There is no assigned homework for students. Although daily quiz is conducted after each day's class, the quiz results play a very limited role in daily assessment. Understanding tests are conducted four times per semester for each module. They assess the level of understanding of students to the problems they solved in the past few weeks.

Through survey and reflection journals submitted by students, we found students are more independent, more realistic to the actual engineering work they will do in their future. In an answer to reflection journal question (Inventory Management module-Problem 12) "Do you think you are able to do the self-directed learning now? What are the difficulties you meet in the self-directed learning?", students believe they are trained to be independent, a good team player, problem solver and decision maker (full response can be found in Appendix 3).

While the teamwork, communication and life-long learning abilities for engineering profession are naturally nurtured through PBL, the engineering ethics and the concept of liability of engineering practice needs to be injected into engineering curriculum specifically. The most important concept that should be conveyed to prospective engineers is that, as professionals, engineers are personally responsible for the consequences of their work, even the work is assigned by their managers [24].

Engineering students should understand that they need to think beyond the immediate tasks they are assigned to any project. They also need to know how important it is to pay attentions to details in their work, especially where safety is a factor. To achieve this, some engineering problems are crafted based on the engineering disasters happened in Singapore or other countries. Students will understand ethics when they try to solve technical problems in these disasters. The School of Engineering also works together with local engineering professional associations such as SIAA-Singapore Industrial Automation Association and IES-Institution of Engineers Singapore to help our students to develop professionalism through running student chapters in school and giving engineering profession related seminars and talks to students.

5. Conclusion

1. Engineering professionalism can be developed for students in school through active learning and problem based learning.
2. Attitudes and skills required to prepare engineers for the profession, such as communication skills, teamwork, lifelong learning and ethics can be developed in one-day one-problem PBL approach.
3. Students immersed in the PBL methodology experienced improvement in the understanding of engineering practices, mature into independent learners and inevitably developed problem solving skills.

References:

[1]. C. L. Dym, "Learning Engineering: Design, Languages, and Experiences," *Journal of Engineering Education*, 88 (2), 145-148, April 1999, Online article: http://www2.hmc.edu/~dym/LearningEngrng.pdf , March 2003

[2]. W.A.M. Alwis, "PBL in Engineering: Issues and Strategies" *Keynote Speech*, PBL in Engineering Conference, KUITTO UNIVERSITY, Batu Pahat, Malaysia, 27 June 2005

[3]. Erik De Graaff & Hans Peter Christensen, "Editorial: Theme issue on active learning in engineering education", *European Journal of Engineering Education* Vol. 29, No. 4, December 2004, 461–463

[4]. Wormley, David N. "Challenges in Curriculum Renewal", *Int. J. Engng Ed.* Vol.20, No.3, pp.329-332, 2004

[5]. John D. Kemper & Billy R. Sanders, *Engineers and Their Profession*, 5th edition, Oxford University Press, 2001

[6]. C.E. Harris, Jr. , M. S. Pritchard, M. J. Rabins, *Engineering Ethics-Concepts and Cases*, 3rd edition, Thomson Wadsworth, 2005

[7]. John W. Prados, "Can ABET Really Make A Difference?", *Int. J. Engng Ed.* Vol.20, No.3, pp.315-317, 2004

[8]. Francisco Ruiz, "Learning Engineering as Art: An Invention Centre", *Int. J. Engng Ed.* Vol.20, No.5, pp.809-819, 2004

[9]. Harvey Mudd College,. *Engineering Clinic Guidelines Handbook*, http://www.eng.hmc.edu/ EngWebsite/Clinic/05-06ClinicHandbook.pdf , Dept. of Eng 2005

[10]. C. L. Dym, "Design, Systems and Engineering Education", *Int. J. Engng Ed.* Vol.20, No.3, pp.305-312, 2004

[11]. Luis Roberto de Camargo Ribeiro and Maria da Graça Nicoletti Mizukami, "Student Assessment of a Problem-Based Learning Experiment in Civil Engineering

Education", Journal of Professional Issues in Engineering Education and Practice, Vol. 131, No. 1, January 1, 2005. 13–18

[12]. Stephanie Ahlfeldt, Sudhir Mehta and Timothy Sellnow, "Measurement and analysis of student engagement in university classes where varying levels of PBL methods of instruction are in use", *Higher Education Research & Development,* Vol. 24 No. 1, February 2005, pp. 5-20

[13]. Flemming K. Fink, "Integration of Engineering Practice into Curriculum - 25 Years of Experience with Problem Based Learning", *29th ASEE/IEEE Frontiers in Education Conference*, San Juan, Puerto Rico, November 10 - 13, 1999, 11a2-7~11a211.

[14]. Marcian Cirstea, "Problem Based Learning (PBL) in Microelectronics", *Int. J. Eng. Edu.* Vol 19, No. 5 pp.738-741, 2003

[15]. Renate Fruchter, Sarah Lewis, "Mentoring Models in Support of P5BL In Architecture /Engineering /Construction Global Teamwork", *Int. J. Eng. Edu.* Vol 19, No. 5 pp.738-741, 2003

[16]. Maria Anto Nia Carravilla & Jose Fernando Oliveira, "Teaching logistics without formal classes: a case study", *European Journal of Engineering Education* Vol. 29, No. 4, December 2004, 571–580

[17]. Nette Schultz & Hans Peter Christensen, "Seven-step problem-based learning in an interaction design course" *European Journal of Engineering Education* Vol. 29, No. 4, December 2004, 533–541

[18]. S. M. SAID & others, "Implementation of the problem-based learning approach in the Department of Electrical Engineering, University of Malaya", *European Journal of Engineering Education* Vol. 30, No. 1, March 2005, 129–136

[19]. K. J. Nasr & C. D. Thomas, "Student-centered, Concept-embeded problem-based Engineering Thermodynamics" *Int. J. Eng. Edu.* Vol 20, No. 4 pp.660-670, 2004

[20]. Alwis, W.A.M. & O'Grady, G.. "One Day One Problem at Republic Polytechnic." *Paper presented at the 4th Asia-Pacific Conference on PBL*, Thailand. 2002, December

[21]. Warren G Bennis, James O'Toole "How Business Schools Lost Their Way" *Harvard Business Review***.** Vol. 83, Iss. 5; p. 96, May 2005

[22]. Centre for Educational Development, "Problem Based Learning @ the Republic" Republic Polytechnic 2005 http://discovery.rp.edu.sg/home/ced/students/learning.htm

[23]. G.G. Mitchell & J. D. Delaney, "An Assessment Strategy to determine Learning Outcomes in a Software Engineering Problem-based Learning Course" *Int. J. Engng Ed.* Vol.20, No.3, pp.494-502, 2004

[24]. Stephen H. Unger, "How Best to Inject Ethics into an Engineering Curriculum with a Required Course" *Int. J. Engng Ed.* Vol.21, No.3, pp.373-377, 2005

Biographical information

WANG JIANGUO: Dr. Wang graduated with Ph.D (Mechanical Engineering) from Tsinghua University, Beijing, China. Now he is Programme Chair of School of Engineering at the Republic Polytechnic. He is taking charge of curriculum development for the Diploma for Industrial & Systems Engineering and Diploma for Industrial & Operations Management using PBL approach.

FONG YEW CHAN graduated from the French Grande Ecole, ENSIEG, in 1987 with a Diplôme d'Ingénieur in Electrical Engineering. He subsequently obtained a postgraduate degree, Diplôme d'Etudes Approfondies, from the Grande Ecoles, Ecole Centrale de Lyon and INPG. He was at the Institute of High Performance Computing (IHPC) as its Director of Business Development.

W.A.M. ALWIS: Dr Alwis graduated with PhD from Monash University, Australia. Prior to taking up the appointment as Director of Academic Affairs at the Republic, Dr Alwis was a member of the academic staff at the Department of Civil Engineering, National University of Singapore, from 1982 to 2002, during which period he was engaged in teaching and research.

Appendix 1: Problem Statement

Problem Statement
Module: E214- Statistical Methods for Engineering

Title: Overbooking

Budget Hotel Singapore is a newly established 200 room Budget Class Hotel strategically positioned in the heart of the city. The hotel lobby lounge with its soothing ambience is a perfect place to unwind and relax. The cafe has a casual open-air setting which serves daily breakfast and meals. Conveniently located, the hotel proximity to facilities like restaurants, night-spots, travel agencies, clinics, banks etc made it a first choice accommodation for both businessmen and tourists.

Since their operations a year ago, the management of the hotel has realized that a certain percentage of guests will cancel their bookings at the last minute.

Last minute cancellation results in many of the rooms being left empty for the night. Thus resulting in lost of revenue for the hotel. The hotel being brand new has been fully booked for the whole of 2003. The table below shows the figures for March 2003. (Assume March figures to be representative of all the other months)

Week	Sun	Mon	Tues	Wed	Thur	Fri	Sat
1	42	39	43	37	42	44	38
2	36	41	37	43	40	41	36
3	43	40	42	46	37	42	33
4	37	40	44	42	41	38	39
5	36	42	39	40			

Table : Number of last minute cancellations per day for the month of March

To avoid having empty rooms, the hotel management decided to allow overbooking of the rooms and hope that the right number of guests will turn up at the hotel.
The hotel target to have at least 90% occupancy rate per day and also wants to ensure the possibility of having more guests than hotel rooms available to be as low as possible.

As part of the quality assurance team in the hotel. You are tasked to perform a statistical analysis and present a report with justifications for the recommendations, highlighting any risks that the hotel must consider.

Appendix 2: Scaffolding

Worksheet
Module: E214- Statistical Methods for Engineering
Problem: Overbooking

1. A coin is biased so that the probability of head is 2/3. What is the probability that a tail will happen in the next toss of the coin?
2. If the coin is tossed for 10 times, will the probability change for each of the 10 different times or will the probability remain the same? Will the probability change if the coin is tossed 100, 1000 times?
3. Let X be the discrete random variable that represents the event that heads comes up. What type of probability distribution do you expect X to have?
4. What is the probability that exactly four heads will come up when the coin is tossed 7 times?
5. Repeat the above calculations using Excel or Minitab or Binomial tables.
6. Find the probability for at least 3 heads.
7. Find the probability for at most 4 heads.
8. For Budget hotel Singapore, is the random variable of overbooking of hotel rooms binomially distributed?
9. For Budget hotel Singapore, with the current situation of no overbooking, but with the hotel fully booked and with the same probability of no show as during the March month, what are the probabilities of the following:
   a. More than 160 groups who booked the rooms turned up
   b. More than 180 groups who booked the rooms turned up
   c. At least 160 rooms were occupied
   d. At least 180 rooms were occupied
10. What can you infer from the answers to question 9?
11. What is meaning of allowing the guests to overbook? What problems or risks do you think happen when you allow overbooking?
12. What would be a good balance between overbooking and having more guest groups than available rooms?

Appendix 3: Reflection Journal

Reflection Journal Question:
Do you think you are able to do the self-directed learning now? What are the difficulties you meet in the self-directed learning?

One response from students:

In self-directed learning (SDL), responsibility on the part of the learner is a crucial characteristic. It is an important part where every team member plays his or her part in learning so that they can contribute and improve the team efficient level in solving the problem. It can cover both reading up of basic materials from books or the internet and exploration of advanced subject matter.

To date, I have been through 160 problems in my 1st year and 46 problems including today's one for my 2nd year which total up to be 200+ problems. Am I able to do the self-directed learning now? My answer is I do. However, for any learning, there are bound to be difficulties. As for SDL, one difficulty I have is with the finding the information. Sometimes, we are spoon-feeded with very good resources and this saves our time in searching. When we do not have resources, we began searching from the World Wide Web and this is when the problem arises.

I think searching for the right information is really an art, especially if we do not know the 'keywords' relating to the problem. Some of the modules now do include the 'keywords' and it is very helpful to us in terms of searching for the related information. And identifying the learning objectives by doing our GIT will also serve as an advantage for us in moving on the right track.

Choosing information is another tedious task. The World Wide Web may give me tonnes of information. Which to use? Are they reliable? These are some questions which I will ask myself and again, time is wasted here. As mentioned in my previous reflection journal, I prefer using book over information from the internet. It will save me from all the difficulties I met from finding information from the internet. A book goes through the several editing before being published and the information would be more reliable compared to those from the internet. The only downside is the quantities available are limited and I may not be able to borrow it.

But, we should not be dependent on textbook or resources from facilitator. Nobody will give us the information or tell us how to do in the real world and this is also why RP adopt the PBL method to train us to be independent, good team player, problem solver and decision maker.