PROBLEM BASED LEARNING: A USEFUL APPROACH IN TERTIARY EDUCATION?

Roland Yeo

Temasek Engineering School

Problem-based Learning (PBL), as an emerging pedagogical approach in tertiary education, has caused considerable controversy in its level of implementation and the benefits it brings. In 1998, the Engineering School of Temasek Polytechnic in Singapore started PBL, but it still encounters resistance from staff and students today. Findings from an exploratory study conducted in Temasek Engineering School through focus groups, surveys and interviews, reveal a number of positive implications for PBL, contrary to general sentiments. One of the key issues is that of the right mindset which is appropriate to the School's PBL environment. An underlying discovery of the study is that PBL, if executed appropriately, will bring benefits beyond one can imagine. Most respondents agree that it has long-term benefits, possessing great potential for their personal growth and development in areas where conventional teaching approaches are unlikely to achieve similar results. However, these positive outcomes appear "imagined" more than "emerging" as many find PBL a stressful process, one that still needs to withstand the test of time.

INTRODUCTION

Much has been said about Problem-based Learning (PBL) and the long-term benefits associated with it. But what does it take to ensure the successful implementation of PBL in tertiary education? As opposed to conventional teaching approaches, PBL requires that the teacher re-examine his/her role as content expert and reconsider the delivery power which takes place in class. In a PBL setting, the boundaries between the teacher and learner are also noticeably reduced. This provides opportunities for the learner to be empowered in raising pertinent questions to challenge teachers on existing issues in relation to a PBL problem (Lahteenmaki, 2001).

The shift in emphasis from traditional teaching to an emerging method like PBL is largely triggered by the changing external environment, which is the "global" workplace for which institutions are preparing their students. In recent years, PBL has taken a greater prominence

in tertiary education with curricula directed at independent and team learning through a variety of methods: peer teaching, group presentation, self-reflection and tutor consultation (Creedy & Hand, 1995). However, PBL can be said to have an adverse effect on some learners and even teachers, who have to make a shift in their mindset, since learners now need to explore rather than merely receive content knowledge. Similarly, teachers now need to manage closely the learning process instead of simply giving information.

Some might even argue that Asians, as compared with Western learners, are far too reticent and passive for PBL (Dixon, 2000; Walker *et al*., 1996). As a result, both learners and teachers struggle, as in the case with a number of Asian institutions, to maintain equilibrium in managing PBL: on the one hand to maintain integrity in the PBL process, and on the other, to give students sufficient assistance in guiding them along. As a consequence, frustration sets in and the level of resistance to PBL intensifies. A case in point is Temasek Polytechnic (TP), a higher learning institution in Singapore, which introduced PBL in the late 1990s. However, this approach has not been fully implemented in all courses as of today due to the various challenges experienced by administrators, lecturers and students.

Against this backdrop, this paper discusses the various PBL challenges encountered at the Temasek Engineering School in TP and explores several pertinent issues and paradoxes that are of considerable relevance to tertiary education today.

Background

TP, as a progressive institution, aims to provide quality education relevant to the economy and industry, and create a conducive and stimulating environment that encourages total development, continuous improvement and lifelong learning. TP's vision is "to prepare school-leavers and working adults for a future of dynamic change, with relevant knowledge, lifelong skills, character and a thirst for continuous improvement". It is with this vision that TP constantly evaluates its teaching approaches to keep abreast of the emerging needs of the learners as well as industry. PBL was first introduced to the Temasek Engineering School in 1998 with several subjects piloted and taught partially in this learning mode. In 1999, PBL was implemented in the entire curriculum of the Diploma in Computer and Engineering, and in a smattering of subjects in the other Diploma courses.

OVERVIEW OF THE PBL LITERATURE

Over the past five decades or so, research into the interrelation between the notion of apprenticeship and learning science has begun to contribute to learning approaches and processes in education (Barrows, 1985). PBL is based on the notion of learning by doing, which is predicated upon the learning science concept of learning and acquiring an expertise. A teacher, who was conventionally skilled as a guide to learning, is now akin to a master in an "apprenticeship" environment likened to PBL (Barrows, 2000).

PBL has its roots in several different educational institutions. It primarily began with medical school curricula, such as the McMaster University Program developed in Hamilton, Ontario over 30 years ago (Albanese & Mitchell, 1993). In the medical field, it has been found that learning is most effective when scenarios of clinical situations are used as catalysts for

discussion. These scenarios, as opposed to traditional clinical case studies often used in small-group conference teaching, consequently become the trigger problems in PBL, which are referred to as 'Health Care Problems' (HCP) (Kwan, 2000; Barrows, 2000). It must be noted that the primary aim of the HCPs is not to solve clinical problems. It is to generate a variety of issues pertaining to these HCPs for further analysis. As such, PBL should not be confused with problem-solving skills, although such skills are often the byproducts of PBL (Alvarstein & Johannesen, 2001; Woods, 1994).

Although PBL began in medical education, it has been used in a wider spectrum of disciplines including Archaeology, Architecture, Art, Business and Management, Dentistry, Engineering, Information Management, Law, Music and Nursing (Eldredge, 2004; Kwan, 2000; Stonyer & Marshall, 2002).

The nature of PBL

PBL is predicated upon the belief that learning is most effective when learners are actively involved and learn in a context where knowledge is to be used for a specific purpose. In other words, PBL is learning with a particular relevance to prior objectives set – as opposed to conventional spoon-feeding and rote learning, evident in teacher-designed didactic settings (Walker *et al*., 1996). Of importance to PBL is the interactive dynamism among learners where the focus is on the process utilized by the learner rather than that directed by the teacher. In addition, PBL encourages focused learning based on relevance to the learner's identified objectives, ensuring that the process of knowledge acquisition is effective and efficient (Kwan, 2000; Wee, 2004).

Essentially, PBL involves people working in small groups with someone, usually the teacher, to facilitate their learning and stimulate their thinking through interactive discussions. Typically, learners are given an exciting and challenging problem at the start of the session to brainstorm relevant issues and discuss possible solutions with real-world implications. They are also given the challenge of assuming responsibility for their own learning, taking the given "problem" as a guide to indicate the scope of what needs to be learnt (Enger *et al*., 2002). This prepares them to be effective, self-directed learners who are able to handle new problems as they face the future. Armed with the "problem", learners are usually challenged to look for the relevant resources to enhance their learning through a variety of investigative means. These may include the search for books, online material and most usefully, content experts, usually teachers (Barrows, 1985 & 2000). By doing such research, students are able to acquire an integrative body of knowledge as well as a host of such skills as problem-solving, self-directed learning and group dynamics, necessary for personal growth and development (Wee & Kek, 2002).

Cognitive and behavioural perspectives

In PBL, the process of learning is largely influenced by the contextual boundaries of structures and routines. For instance, the classroom is no longer used primarily as a "knowledge-filling" place and the teacher no longer assumes the content-giving role. Knowledge gathering now requires a larger context, which takes place outside the classroom. The teacher-student relationship also takes on a different dimension. As such, any changes in these boundaries are likely to impinge upon the rate and degree to which individuals learn. In

the same way, the causes and effects of these boundary changes are likely to influence the way individuals behave and act. Of pertinence is the parallelism between the way individuals think (cognition) and act (behaviour), and the stimulus-response theory of learning (Skinner, 1972). The emphasis here is that individuals are inclined to repeat a certain set of behavioural patterns that has been tried and tested, and avoid any that is ambiguous and uncertain, as reinforced in Bateson's (1971) error-reduction theory with regard to learning. This assumption also suggests that individuals do not merely learn from their own background and experience; they do so from the external environment as well (Gagne, 1970; March, 1998).

PBL, as an emerging pedagogical paradigm in Singapore, tends to raise debates on why the conventional tried-and-tested teaching method is no longer applicable to today's educational environment. The main concern seems to be every educator's fear of error-increase (as opposed to error-reduction) in response to learning, as PBL necessarily calls for changes in structures and routines in the way lessons are conducted.

PBL IN TEMASEK ENGINEERING SCHOOL

In Temasek Engineering School, a PBL subject is generally structured around four hours of contact time per week with one hour set aside for lectures and three hours for either laboratory work or tutorials. Most of the PBL subjects are introduced in the second year of a course and do not require students to sit for an examination at the end of the semester. Instead, students are assessed periodically through project work, peer evaluation, interviews (on content knowledge by lecturers), teaching notes and class participation. Where the subject requires a semester-end controlled examination, the weightage for the examinable paper is usually 40% while the remaining 60% will come from the other PBL in-class assessments. As can be seen, the emphasis is on process outcomes assessed through continual work rather than the one-time pen-and-paper examination which normally evaluates a student's specific content knowledge. This focus on process-oriented assessment is deemed necessary and appropriate for the total development of a learner's intellectual and lifelong pursuit in 21st century education (Kofoed & Kolmos, 2001; Marincovich, 2000).

AN EXPLORATORY STUDY

This study is exploratory in nature and sets out with some broad questions about PBL in a tertiary context. In particular, the Research Problem is:

RP: How and why is PBL a useful approach in tertiary education?

In support of the RP, three research questions (RQ) have been formulated. They are:

RQ1: What are the factors affecting students' response to PBL?
RQ2: How can PBL be integrated into a tertiary curriculum?
RQ3: Why is PBL crucial to students' learning in a tertiary environment?

Research methodology

A study was undertaken into students' and lecturers' experiences of PBL in Temasek Engineering School. The methodology utilised in this study was largely qualitative in nature and involved focus groups and semi-structured interviews. For triangulation purposes, questionnaire surveys were employed to collect some quantitative data to support the qualitative findings. Three stages of data collection were utilised in this study:

- The first stage involved focus group interviews involving three groups of six students each, who had experienced PBL for at least a semester (six months);
- The second stage was a triangulation phase, which involved a questionnaire survey comprising 15 questions on a five-point Likert scale sent out to 100 Engineering students, from which 71 sets of responses were received.
- The third stage involved semi-structured interviews with eight lecturers who had taught PBL in at least one subject within the Engineering School.

The focus group technique was utilised as it is the most important and popular qualitative research tool in any exploratory study (Denzin & Lincoln, 1994). Furthermore, this study investigated contemporary educational issues and aimed at understanding the underlying reasons and motivations of the learners' and teachers' attitude and behaviour in response to PBL (Malhotra, 1993). The underlying premise of focus groups is that individuals with a problem are more willing to share personal feelings among others who are experiencing a similar problem. It seems that the security and comfort of being in the company of others like themselves encourages sharing, and in the process creates a temporary social support group for these individuals. This leads to more detailed and in-depth information being shared openly by participants. This type of rich and real data is especially useful for researchers investigating complex human behaviour in the field of learning (Denzin & Lincoln, 1994).

A focus group is a controlled group discussion used to gather preliminary information for a research project, to help develop questionnaire items for survey research, and to gather other preliminary qualitative data as a foundation for further study (Stewart & Shamdasani, 1990). In this study, the focus group data helped shape the survey questions, used as triangulation in the second stage, either to confirm or disconfirm what had been presented in the earlier qualitative data. Also, the simple quantitative data served as an explanatory agent in enhancing the validity and reliability of this qualitative study (Malhotra, 1993). In the third stage, semi-structured yet focused interviewing was employed, as it allowed the researcher to probe deeply into the respondents' thoughts and feelings about issues they were most familiar with (Cunningham & Gerrard, 2000; Yin, 1994). The interviews also gave them an opportunity to be spontaneous in the way they reflected on issues they believed in. Additionally, non-verbal clues were observed, which contributed to the richness of the insights into the issues investigated. Overall, the sampling plan was one of purposeful sampling for the two qualitative stages, where the respondents chosen had to have sufficient background and experience in PBL to contribute to the richness and depth of the phenomena being studied (Perry, 1998).

Data analysis

A large amount of data was collected from the focus groups and interviews conducted for this study, and transcripts were made of the interviews. As the data was qualitative in nature, a certain amount of subjective judgment was used in the analysis (Morgan, 1993). For this research, a brief content analysis using the "scissor-and-sort" technique was utilized. A simple content analysis was appropriate if the purpose of using focus groups and interviews was for an in-depth exploration of a research topic about which little is known in a certain context (Stewart & Shamdasani, 1990).

The transcripts were scanned by the researcher for an overall feel of the qualitative data. This was followed by the comments on ideas, opinions or thoughts which were raised frequently by the participants or respondents. The common ideas were then categorized into themes. Grouping these ideas into themes or broad categories allowed the researcher to interpret the data adequately. This technique of analyzing qualitative data is known as the "scissor-and-sort" method and is the most common technique used by qualitative researchers (Denzin & Lincoln, 1994; Stewart & Shamdasani, 1990). In the presentation of the data, quotations from the respondents are indicated by inverted commas and identified by F1-18 for the focus group participants and I1-8 for the interviewees. As for the quantitative data, simple statistical representation in the form of percentages and bar-charts is used to provide an objective explanation of certain trends and views (Zikmund, 1997), as shown in Table 1 and Figure 1 respectively.

Table 1. Survey results on students' perception of PBL

	Rating: Likert Scale				
Questions	**1 (Strongly Disagree)**	**2**	**3**	**4**	**5 (Strongly Agree)**
Q1	5.63	16.90	42.25	23.94	11.27
Q2	2.82	25.35	32.39	22.54	16.90
Q3	1.41	14.08	35.21	39.44	9.86
Q4	7.04	22.54	38.03	15.49	16.90
Q5	5.63	16.90	50.70	21.13	5.63
Q6	8.45	18.31	22.54	33.80	16.90
Q7	4.23	16.90	38.03	28.17	12.68
Q8	9.86	14.08	38.03	23.94	14.08
Q9	2.82	11.27	26.76	33.80	25.35
Q10	4.23	7.04	30.99	21.13	36.62
Q11	9.86	21.13	42.25	16.90	9.86
Q12	1.41	14.08	45.07	29.58	9.86
Q13	4.23	18.31	42.25	16.90	18.31
Q14	8.45	14.08	40.85	22.54	14.08
Q15	8.45	15.49	46.48	19.72	9.86

Note: Cell figures indicate percentages (%) of responses. (Please refer to Appendix I for the questionnaire.)

CRITICAL FACTORS AFFECTING PBL

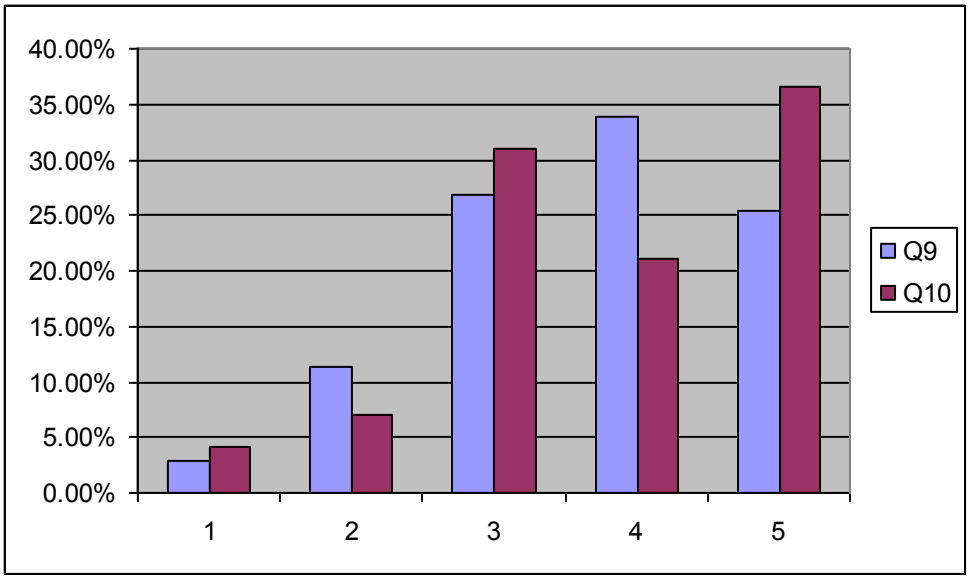
One of the main challenges that students from Temasek Engineering School face in their encounter with PBL is resistance to going through a learning process entirely different from the conventional approach where the teacher is the sole information provider. As recounted by a lecturer who has taught PBL for three years, the main difficulty is convincing the students of its positive outcomes. Many times, she (I1) encountered students muttering "give me the things to learn and I will learn only the things that will be tested." At the core is the students' preoccupation with doing well in the examination without wanting any other route to complicate their learning journey. Below are some possible answers to *RQ1: What are the factors affecting students' response to PBL?*

Mindset of learners

One of the fundamental and critical factors is the mindset of students. It does appear that a strong "buying in" to PBL is an essential first step for students and perhaps teachers, and should be facilitated through an introductory session. It is important that all parties understand PBL and their role(s) in this approach (Stonyer and Marshall, 2002). In particular, students may not identify with the rationale of going through a new learning approach when the alternative tried-and-tested didactic approach has withstood the test of time. As commented by F4, "After so many years of the same style of learning, students may not get used to it [PBL]. They are also very dependent on the teachers." All eight lecturers interviewed agreed that mindset is the leitmotif for positive learning and development. Without the proper mindset, students will not be convinced to take ownership of their learning and as a consequence, their accountability to their peers for their contribution ultimately diminishes (Skinner, 1971). It is no wonder PBL sometimes fails as those with the wrong mindset often end up contributing minimally, affecting the progress of the work group. This is reinforced in a response given by F7, "Students may not have the attitude to do PBL. They don't understand how PBL is carried out. Sometimes the teammates are absent [in a group meeting]." Given the entrenched behavioural patterns of students in didactic learning, a positive mindset has to be cultivated strategically and perhaps through time.

Learners' ability and readiness

In the survey conducted, 23.94% of the students agreed and 11.27% strongly agreed that "PBL is a suitable approach for learning now" (Question 1). However, many of them, as observed by the lecturers, may not be ready for it. This could be due to the fact that "we are plunged into PBL in the second year without any idea of how it works", as commented by F10. Even though students are exposed to a series of PBL preparatory lessons, known as "Problem Solving and Process Skills", taught in the first year at Temasek Engineering School, not many students feel that these lessons are helpful. The underlying issue seems to be that they cannot link the skills taught to the wider issues of PBL introduced later in their second and third years. As can be seen in Figure 1, the survey results show a remarkably high response for ratings "4" and "5" compared with "1" and "2" in relation to Question 9 ("Learners should be properly trained to handle PBL").



Note: 1 – "strongly disagree", 5 – "strongly agree"

Figure 1. Importance of learners' and facilitators' PBL skills

In order to avoid a possible situation highlighted by F9 – "If one person leads the wrong way, the rest will lose the way and nothing will be learnt correctly" – it is important that students are adequately trained with the necessary application skills through simulated PBL role plays to further prepare them for PBL challenges (Eldredge, 2004).

Facilitators' personality, passion and enthusiasm

The performance of a PBL facilitator has a direct initial impact on motivating students to learn well in a PBL environment. If a facilitator is neither enthusiastic nor convinced about PBL, the students' learning process will be a frustrating and unbearable one. In the focus group discussion, a great many students commented on the importance of facilitators' effectiveness. One respondent (F12) recounted an incident when his lecturer blatantly uttered, *"You are the one taking the exam; why should I give you the answers?"* This affected the students' morale to a large extent. A similar response from the survey indicates that there is a strong agreement that "PBL requires strong facilitation skills from the teachers" (Question 10), as shown in Figure 1. The danger is that if every facilitator behaves in ways that are contrary to the principles of PBL – that of guiding and helping learners discover themselves – students will inevitably be discouraged and disappointed (Walker *et al*., 1996). An example from a frustrated respondent (F6) sums it up succinctly, "If the curriculum is entirely PBL, students need not come to school. They can form groups and learn anywhere, anytime." Hence, the role of a facilitator cannot be overemphasized. This delicate role is reinforced in Lecturer I2's comment: "Though students are ultimately the ones to be responsible for learning, the facilitator will provide the 'spark' to ignite the passion and interest of the students in the PBL environment."

DEVELOPMENT OF PBL IN TERTIARY EDUCATION

Data from the focus groups and interviews reveal several pertinent issues related to how PBL should be implemented in a predominantly didactic teaching setting like the Temasek Engineering School, answering *RQ2: How can PBL be integrated into a tertiary curriculum?*

Hybrid method

From the interviews, it appears that many of the facilitators are still grappling with PBL as an emerging approach. Many of them are trying to come to terms with the complexity and ambiguity PBL brings in the light of many other subjects still taught through the teacher-centred approach. One of the lecturers interviewed (I5) lamented, *"Of course, I must agree that it takes some time for students to adapt to the PBL environment, especially after so many years of didactic learning."* Views gathered suggest that a hybrid method is probably a viable initial step in the successful implementation of PBL in a tertiary institution. For instance, PBL could first be introduced as a concept in the first year of the curricula. Its approach to teaching and learning could be integrated into one or two foundation subjects, allowing students to partially experience the essence of PBL. As a result, when students are expected to handle a new subject in PBL, they will be better informed of the way it should be practiced (Creedy & Hand, 1995). This hybrid method is akin to such modes of curriculum practice as the shoestring approach, funnel approach and foundational approach, proposed by Savin-Baden and Major (2004). All these approaches aim at easing both students and teachers into PBL in a seamless manner to some extent. In addition, PBL can be implemented in subjects that are interrelated and offered consistently in all three years of the curricula. Otherwise, as reflected by F18, "It is very confusing for us [students] to switch from one mode in level one of a subject to another mode of learning in level two. If the school wants us to go through PBL, the same subject should be taught in the same way in the second and third year if it has three levels."

Grouping method

Group learning is commonly practiced in most schools today. Its importance can also be seen in the rating given to Question 14 ("It's more effective to learn as a group than to learn individually; that is, the knowledge gained is much more.") of the survey. Results in Table 1 reveal that 14.08% of the respondents strongly agreed with the above statement, compared with 8.45% who strongly disagreed. It has been observed that grouping was sometimes done haphazardly in a PBL setting and as a result, the process of learning became problematic. Students ended up being frustrated with their group conflicts, while teachers were drawn in to sort emotional issues out.

All this affected the overall morale and often, the PBL objectives were not fully met. As such, while it is important to have a good mix of members with different backgrounds and capabilities, it is even more essential to have them know each other first before the final grouping is decided (Dixon, 2000). A series of teambuilding and ice-breaking activities will serve its purpose at the start of the PBL course. If time constraint is an issue, it is suggested that either the timetable offer greater flexibility or that the teachers take time outside the schedule to build team spirit among the students. The importance of grouping has positive enduring effects as "a good mixture of students with different academic results will increase

the chances of interaction and help to bring up the overall performance [of the group]", as highlighted by Lecturer I4.

Strategic lesson plans

It is interesting to discover that the majority of focus-group respondents attributed the failure of PBL lessons to poor lesson plans and loose tutorial structures. It is no wonder the survey results support this claim, as apparent in Question 13 ("The lack of a systematic structure in a PBL subject discourages learners to learn.") where 18.31% of the respondents "strongly agreed" compared with 4.23% who "strongly disagreed". Because each PBL laboratory session lasts three hours in Temasek Engineering School, most participants adopt the take-and-stretch approach in their class discussions, in that, "instead of asking questions [about the PBL problem posed], they [students] tend to chat and slack", as commented by F2. Although this may not be typical of a PBL class in the Engineering School, it suggests that without a planned structure in each PBL session, it is difficult for the facilitators to monitor the students' progress. As a consequence, it will be difficult to ensure that each student play his/her part in the PBL process (Enger *et al*., 2002). A high degree of cooperation and reciprocity between the facilitator and students is of utmost importance to the success of PBL (Eldredge, 2004).

LINKAGE BETWEEN PBL AND STUDENTS' LEARNING

The rewards of PBL are manifold. Although many respondents reflected that PBL is a difficult process, they were nevertheless farsighted enough to envision its long-term benefits which relate to *RQ3: Why is PBL crucial to students' learning in a tertiary environment?*

Independent learning enhanced through team learning

Students who take PBL seriously have positive feedback about the approach. As an example, F13 commented, "PBL stimulates thinking and encourages us to learn by ourselves. We also get closer to friends because we make an effort to come together to share knowledge with each other." It is no wonder 16.9% of the survey respondents strongly agreed with Question 2 ("PBL is able to bring more out from a learner than the traditional teacher-centered approach."), compared with 2.82% who strongly disagreed. PBL does encourage students to be self-directed in their learning and motivate them to be resourceful. However, PBL is not an individual endeavour; it promotes knowledge sharing and expansion of knowledge bases. This can only be achieved through a synergistic team that knows the importance of delegation, power distribution and responsibility. At the core is each learner's accountability that ultimately contributes to the success of PBL (Polanco *et al.,* 2001; Savin-Baden, 2003). As F1 sums up, *"PBL forces us to be creative when it comes to self-directed learning and peer teaching.* We need to get to the right resources in the shortest time possible so that we will have time for the preparation of notes and handouts to be given during peer teaching sessions." The creative power of learning constantly surfaces itself in an authentic PBL experience (Wee & Kek, 2002).

Interaction dynamics

Students who have successfully gone through PBL have developed a gamut of skills that are necessary to meet the changing demands of the real world. It is the interpersonal aspect of learning that "makes it tick", helping one develop into a thinking and mature being. As testified by F15, *"It's actually quite fun to work in groups, which allows us to exchange views and question each other on our ideas. This helps to improve our communication skills."* The human dynamics experienced in a group setting allow one to discover certain hidden talents waiting to be unleashed. The various circumstances ranging from conflict management, knowledge sharing to power play all contribute to one's personal development in meaningful ways (Bateson, 1971; Kofoed & Kolmos, 2001). The fabric of interaction also reveals much of a learner's personality and adaptability to complex situations. Ultimately, as perceived by F17, "PBL acts as a filter to separate the good from bad students. The hardworking ones will benefit from the process; the lazy ones will not gain much." No man is an island; it is no longer sufficient for students to slog for their own sake without knowing what is going on in the world. The global environment requires that one keep abreast of one's surroundings by learning from others (Gagne, 1970).

Lifelong skills

The cumulative impact of PBL lies in the acquisition of skills which will manifest themselves in time to come. Several graduating students interviewed in the focus groups had high praise for PBL. As an example, F11 exclaimed, "PBL is a challenge in itself. It pushes us forward to take on new challenges in life." This is further reinforced by F16's view that "what we are going through in PBL are examples of working life and examples of how the things learnt are being used in real-life." Further evidence about PBL's practical usefulness is seen in the response to Question 8 of the survey ("PBL helps a learner to solve daily problems effectively too."). As apparent in Table 1, 14.08% "strongly agreed" and 23.94%, "agreed", compared with 9.86% who "strongly disagreed" and 14.08%, "disagreed". Evidently, investigations have shown that learners taught in project-oriented and problem-based programmes are evaluated by their employers to have an easier transition from the educational institution to the work life (Kofoed & Kolmos, 2001). In summary, the following is an excerpt of a testimony provided by a Diploma in Computer Engineering graduate of Temasek Engineering School in 2001. He underwent a full-fledged PBL curriculum for two years and had this to say:

> PBL has boosted my confidence in learning. Whenever there's something I need to know that I don't know of, I will try to figure how it works. For people who are embedded with PBL skills, their limit is boundless. There's nothing you can't do, unless you refuse to learn!

Learning is indeed a lifelong endeavour. What is learnt has lifelong impact.

CONCLUSION

This study does not ignore the limitations of the two qualitative methods used. Although focus groups and interviews are easy to set up, it is usually difficult for the researcher to moderate the process and even more difficult to interpret the data (Stewart & Shamdasani, 1990). The areas of reliability and validity in qualitative research are likely to be obtained as completely as in quantitative data. Problems associated with the interpretation of word choice used by the respondents, their unspoken thoughts, implied opinions and body language are perceived limitations. Also, a focus group discussion may be affected by someone who dominates the discussion or someone influential enough to sway others' views and opinions in a direction that is completely prejudicial to the topic concerned. Because such problems in interpretation exist, exploratory findings should be used as part of a preliminary study, as this research is. Quantitative methods can be used as a subsequent stage to test the findings from the focus groups and interviews used in this study.

On the conceptual front, PBL is not merely learner-centred; it is also application-oriented. The emphasis on the value of the practical also goes against the rudimentary requirements of academia, especially in terms of its power structures. PBL does not stop at the application; its goal is to use the practical to help learners better grasp the theoretical (Marincovich, 2000). This study explores, quite extensively, the role of PBL in Temasek Engineering School. It also sheds some light on the Research Problem: *How and why is PBL a useful approach in tertiary education?* Although faced with a certain degree of resistance from the students and perhaps lecturers in Temasek Polytechnic, PBL remains "imagined" as a useful paradigm with long-term benefits which only time can tell. For now, the Engineering School continues to fine-tune its PBL processes by creating a learning environment that is acceptable and conducive to all. Until then, it remains for us to decide whether this "imagined" paradigm in an "emerging" educational environment will stand the test of time.

REFERENCES

Albanese, M. A., & Mitchell, S. (1993). Problem-Based Learning: A review of the literature on its outcomes and implementation issues. *Academic Medicine*, *68*, 52-81.

Alvarstein, V., & Johannesen, L. K. (2001). Problem-Based Learning Approach in Teaching Lower Level Logistics and Transportation. *International Journal of Physical Distribution & Logistics Management*, *31*(7/8), 557-573.

Barrows, H. S. (1985). *How to Design a Problem-Based Curriculum for the Preclinical Years*. New York: Springer.

Barrows, H. S. (2000). *Problem-Based Learning Applied to Medical Education*. Springfield: Southern Illinois University School of Medicine.

Bateson, G. (1971). *Steps in an Ecology of Mind*. New York: Ballantine Books.

Creedy, D., & Hand, B. (1995). Determining Changing Pedagogy in PBL. In S. E. Chen, R. Cowdroy, A. Kingsland & M. Ostwald (Eds.), *Reflections on Problem-based Learning* (pp. 141-156). Sydney: Australian P.B.L Network.

Cunningham, J. B., & Gerrard, P. (2000). Characteristics of Well-Performing Organisations in Singapore. *Singapore Management Review*, *22*(1), 35-64.

Denzin, N. K., & Lincoln, Y. S. (1994). *Handbook of Qualitative Research*. Newbury Park: Sage.

Dixon, A. (2000). Problem-Based Learning: Old wine in new bottles? In O. S. Tan, P. Little, S. Y. Hee & J. Conway (Eds.), *Problem-Based Learning: Educational Innovation Across Disciplines – A collection of selected papers* (pp. 37-45). Singapore: Temasek Centre for Problem-Based Learning.

Eldredge, J. D. (2004). The Librarian as Tutor/Facilitator in a Problem-Based Learning (PBL) Curriculum. *Reference Services Review*, *32*(1), 54-59.

Enger, K. B., Brenenson, S., Lenn, K., Macmillan, M., Meisart, M. F., Meserve, H., & Vella, S. A. (2002). Problem-Based Learning: Evolving strategies and conversations for library instruction. *Reference Services Review*, *30*(4), 355-358.

Gagne, R. M. (1970). *The Conditions of Learning*. New York: Holt, Rinehart & Winston.

Kofoed, L. B., & Kolmos, A. (2001). Empowering Transferable Skills in Problem-based Learning. In P. Little & P. Kandlbinder (Eds.), *The Power of Problem-based Learning* (pp. 64-72). New South Wales: The University of Newcastle.

Kwan, C. Y. (2000). What is Problem-Based Learning (PBL): It is magic, myth and mindset. *National University of Singapore: Centre for Development of Teaching and Learning Brief, 3*(3), 1-2.

Lahteenmaki, M. L. (2001). Problem-basedLearning During the First Academic Year. In P. Little & P. Kandlbinder (Eds.), *The Power of Problem-based Learning* (pp. 73-84). New South Wales: The University of Newcastle.

Malhotra, N. J. (1993). *Marketing Research: An applied orientation*. New Jersey: Prentice Hall.

March, J. G. (1988). *Decisions and Organisations*. Oxford: Blackwell.

Marincovich, M. (2000). Problems and Promises in Problem-Based Learning. In O. S. Tan, P. Little, S. Y. Hee & J. Conway (Eds.), *Problem-Based Learning: Educational Innovation Across Disciplines – A collection of selected papers* (pp. 3-11). Singapore: Temasek Centre for Problem-based Learning.

Morgan, D. L. (1993). *Successful Focus Groups.* London: Sage.

Perry, C. (1998). Processes of a Case Study Methodology for Postgraduate Research in Marketing. *The European Journal of Marketing*, *32*(9/10), 785-802.

Polanco, R., Calderon, P., & Delgado, F. (2001). Problem-basedLearning in Engineering Students: Its effects on academic and attitudinal outcomes. In P. Little & P. Kandlbinder (Eds.), *The Power of Problem-based Learning* (pp. 111-125). New South Wales: The University of Newcastle.

Savin-Baden, M. (2003). *Facilitating Problem-based Learning: Illuminating perspectives.* Berkshire: Open University Press.

Savin-Baden, M. & Major, C. H. (2004). *Foundations of Problem-based Learning.* Berkshire: Open University Press.

Skinner, B. F. (1971). *Beyond Freedom and Dignity*. London: Cape.

Stewart, D.W., & Shamdasani, P. N. (1990). *Focus Groups: Theory and Practice*. California: Sage.

Stonyer, H., & Marshall, L. (2002). Moving to Problem-Based Learning in the NZ Engineering Workplace. *Journal of Workplace Learning*, *14*(5), 190-197.

Walker, A., Bridges, E., & Chan, B. (1996). Wisdom Gained, Wisdom Given: Instituting PBL in a Chinese culture. *Journal of Educational Administration, 34*(5), 12- 31.

Wee, K. N. L., & Kek, Y. C. M. (2002). *Authentic Problem-Based Learning: Rewriting business education*. Singapore: Prentice Hall.

Wee, K. N. L. (2004). *Jump Start Authentic Problem-Based Learning*. Singapore: Prentice Hall.

Woods, D. R. (1994). *Problem-based Learning: How to gain the most from PBL*. Waterdown, Ontario: Donald R. Woods.

Yin, R. K. (1994). *Case Study Research: Design and Methods*. California: Sage.

Zikmund, W. G. (1997). *Business Research Methods* 5th ed. Orlando: Dryden Press.

APPENDIX 1

A SURVEY ON LEARNING APPROACHES IN TERTIARY EDUCATION: PROBLEM BASED LEARNING (PBL)

Course/Year: _____ **Gender:** * Male/ Female

Have you done PBL before? * Yes/ No ***Circle all your responses**
(If **YES**, which subject(s)?_____)

*** Rating – "1" = Strongly Disagree", "5" = "Strongly Agree"**

1.	PBL is a suitable approach for your learning now.	**1**	**2**	**3**	**4**	**5**
2.	PBL is able to bring more out from a learner than the traditional teacher-centered approach?	**1**	**2**	**3**	**4**	**5**
3.	PBL is a refreshing change from the routine of day-to-day learning in the classroom.	**1**	**2**	**3**	**4**	**5**
4.	PBL works for almost all types of subjects such Engineering, Business, Design, IT and Applied Sciences.	**1**	**2**	**3**	**4**	**5**
5.	PBL is able to measure the depth of learning appropriately.	**1**	**2**	**3**	**4**	**5**
6.	Age group is not a barrier in PBL, e.g., primary to tertiary level.	**1**	**2**	**3**	**4**	**5**
7.	Personal reflection is an important element in PBL to help discover new things about the learner.	**1**	**2**	**3**	**4**	**5**
8.	PBL helps a learner to solve daily problems effectively too.	**1**	**2**	**3**	**4**	**5**
9.	Learners should be properly trained to handle PBL.	**1**	**2**	**3**	**4**	**5**
10.	PBL requires strong facilitation skills of the teachers.	**1**	**2**	**3**	**4**	**5**
11.	Learning from a problem is not the best way of learning.	**1**	**2**	**3**	**4**	**5**
12.	The power of questioning is the success factor in PBL, i.e. teacher questions learners, and learners question each other.	**1**	**2**	**3**	**4**	**5**
13.	The lack of a systematic structure in a PBL subject discourages learners to learn.	**1**	**2**	**3**	**4**	**5**
14.	It's more effective to learn as a group than to learn individually, i.e. the knowledge gained is much more.	**1**	**2**	**3**	**4**	**5**
15.	PBL is a necessary approach in meeting the changing needs of the learning environment.	**1**	**2**	**3**	**4**	**5**

THANK YOU FOR YOUR HELP