

**One Day, One Problem: PBL at the Republic Polytechnic**  
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**Abstract**

*This paper outlines how PBL will be adapted to suit the needs of an educational institution focused on developing technical manpower. The core organising principle for the design and implementation of a fully integrated first year PBL curriculum is a one-day one-problem approach. This approach entails students working exclusively on one problem per day. Over the course of a week students will work on five different, but related, problems that incorporate problem solving (and other cognitive and meta-cognitive processes), personal development, technical communication, enterprise skills, basic sciences, and basic numerical and computer applications. Students will be encouraged to apply a common methodology and schedule in their day-to-day interaction with the problems, learning resources, faculty and peers. In addition, a number of devices like on-line learning journals and learning tests will be employed to facilitate reflection, integration, coherence and achievement of desired learning outcomes.*

The Singapore ministry of education, Singapore states that: “Polytechnics were set up with the mission to train middle-level professionals to support the technological and economic development of Singapore. Reflecting the wide range of abilities, aptitudes and interests of their students, the polytechnics seek to train students with relevant and specific skills for the workplace to give Singapore a competitive edge as we move into a knowledge-based economy. Today, polytechnic graduates are valued as practice-oriented and knowledgeable middle-level professionals, much sought after by industry”<sup>1</sup>.

The Republic Polytechnic (RP), the newest of the five Polytechnics in Singapore, aims to achieve this mission of developing practice-oriented and knowledgeable middle-level professionals by leveraging on PBL. The educational philosophy of RP is that acquiring subject knowledge and development of professional skills needs to be underpin by strong foundational thinking and inter-personal abilities. Furthermore, the application of knowledge to solve problems in professional settings, requires students to believe that learning is simply a process of “knowledge accumulation”. Traditional approaches to Polytechnic education, namely lectures and tutorials primarily function as ways of disseminating information and demonstrating methods and therefore tends to promote learning by accumulation. Another problem with traditional approaches to teaching is the belief that professional wisdom can be both articulated and transmitted in the form of symbols or language. According to recent cognitive and psychological literature even the most skilled teacher or practioner can only at best “confabulate” when asked to make up a linguistic account for their behaviours or actions (Lakomski 2002). Hence, at RP the belief is that the traditional lecture-tutorial approach to education is not the most suitable

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<sup>1</sup> <http://www1.moe.edu.sg/tertiarye.htm>

means of engaging students in the process of deeper learning (Biggs 1991). The expectations upon Polytechnic graduates to be responsive to the technical demands of a highly technological society that is constantly evolving is such that RP cannot afford to produce graduates who merely imitate learning and fail to practice or apply knowledge to novel or difficult situations (Ramsden 1992). In this context we consider PBL is well suited to training technical manpower.

PBL is an educational strategy where learning is driven by a problem. The problem could be a challenge or a description of a difficulty, a curious outcome, or an unexpected happening, it could also be an incident where there are interesting elements, or an episode or happenings that requires either a solution or some explanation. PBL as a theory of learning contends that students do not learn by simple accumulating knowledge, they need to construct a personal understanding of concepts. This is best done by allowing students to: explore knowledge concepts within different contexts (Spiro 1992); connect new information with prior knowledge (Barrows and Tamblyn, 1980; Boud and Feletti 1997); experiment on how to use knowledge in various contexts; determine the viability of ones' conceptions (von Glasersfeld 1995); and come to appreciate how they personally construct knowledge and become meaning makers (meta-cognitive) (Mayer 1996).

Problem based learning is learning by reflective thinking:

Reflective thinking is not what students do after they finish the lesson, not a different order of intellectual activity that is permitted only after the students have acquired specific content. Rather, reflective thinking is what students do in order to acquire content." (Shermis 1992: 29)

As a teaching and learning methodology the problem from a real world context becomes the catalyst for students to achieve both knowledge and process outcomes but only in as much as students engage with the processes of reflective thinking. Adopting PBL as a method of instruction does not guarantee favourable student outcomes, it is only through careful (reflective) application of PBL that students can learn in a deeper fashion content knowledge, professional skills and cognitive and meta-cognitive processes.

The view of how PBL should be applied at RP is derived from established practices and principles of PBL (Barrows 1976, 1988, 1994; Boud & Feletti 1997; Engel 1991; Woods 1985, 1994, 1995). From the review of the literature we believe PBL is a set of principles that can be applied flexibly to suit each unique educational context. While there is no evidence to support the claim that Asian students are more passive than western students and hence PBL needs to be modified accordingly (Lee 1997), there is a need to develop a PBL process conducive to the context in which it is to be applied (Maudsley 1999). Specific to RPs' needs is developing an approach whereby students would learn highly technical skills and subject matter so they can immediately enter into specific professional occupations and apply these skills with very little additional training, but at the same time be able to adapt to the quickly changing technological landscape. Another challenge for Polytechnic graduates is that many will seek to gain entry and advance standing into University programmes at home and abroad. For articulation purposes it is

necessary the curriculum outcomes of RP match the general requirements of many University academic programmes. We believe that PBL applied appropriately can be consistent with both the objectives of gainful employment in industry and taking up further higher education in the future. In applying PBL RP has decided to design a daily routine of educational activity for the first year curriculum. RP has called this the one-day one-problem approach. The approach entails students spending exclusively one whole day working on a single problem. Over the course of a week students will work on five different, but related, problems. In effect students repeat the process of learning with a problem on a daily basis (see a brief description of the daily routine below).

#### **Brief Description of the Daily Routine at RP**

- In the morning students receive a problem (scenario, interesting event etc) as a trigger for learning.
- Students with the help of a tutor in five groups 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.
- Groups identify learning issues they will investigate.
- Groups employ research strategies to collect relevant information.
- During the middle of the day the groups of five meet individually with tutor to briefly discuss their progress.
- Students continue in their group of five to review resource materials and peer teach what it is they have learnt from their research.
- The group develops an outcome for the problem and present their findings to the other four groups of five and the tutor for evaluation.
- Groups discuss, defend and justify their outcomes.
- Students reflect on the way they have learnt in their groups.
- Students are assessed individually for their learning.
- Students record key learning milestones in their learning journal.

This daily routine is developed to ensure a regular practice-feedback process. Developing competence in technical communication, enterprise skills, basic sciences, basic numerical and computer applications etc is not developed through receiving and storing content on these matters. Our brains do not simply retrieve information that transforms into ready-made behaviours applicable for every situation (see Rumelhart & McClelland, 1986; Churchland & Sejnowski 1994). To manage a situation our brains need to connect various nodes of information and concepts in such a way that it is relevant to the situation at hand. Therefore competence develops out of frequent exposure to problems that requires our mind to make the necessary qualitative connections involving the many concepts we know. Each unique situation can in turn cause new thinking or learning as the nodes in our brain connect in patterns unique to the situation at hand. The more regular the exposure to certain types of problems the more competent we become at linking ideas in order to respond to a situation (see "pattern activation" in Evers & Lakomski 1996 chap 9).

In doing PBL at RP students will be expected in their groups to be able to analyse a problem, conduct research and investigate new information, relate knowledge to problems, share their own ideas and be open to ideas of others in informal and formal settings, evaluate the quality of their solutions, reflect upon the ways in which they are learning and define how they have tried to solve or explain a problem. While the motivation for learning and engaging in these roles is created by the challenge of solving a real world problem, students are only likely to succeed in their learning if they successfully assume the roles identified above. Learning the role of an active team player, or a problem solver, or a teacher, or a decision maker, or a meaning maker and being able to take control of his/her own learning by setting goals and criteria, takes both practice and reflection on the part of the learner and careful planning by the curriculum developer.

AT RP the curriculum has been designed to allow students to repeatedly go through the process of working on a problem. This regularity will enable tutors to help students to reflect upon the many skills and roles that are implicit in working on real problems.

It appears in the literature that the notion of “time” necessary for learning from a problem is not really a major issue, what is important is that students are given enough time to engage in certain activities critical for their learning (Schmidt 1983). If we accede to the axiom that Rome wasn’t built in a day then it is unlikely real world problems are also easily “solved” in one day. However, PBL should not be confused with problem solving (Maudsley 1999), to equate the two is to misrepresent the epistemological underpinnings of PBL. In PBL when explaining or solving problems the goal is to derive a plausible explanation or a viable answer and not the determination of an ultimate solution (von Glaserfeld 1995). In PBL the purpose of the problem is to facilitate some understanding of a principle or concept that underpins the problem at hand not necessarily to solve problems per se. Hence, the key question for the curriculum developer in PBL is does the problem and the time allocated for students to investigate a problem sufficient to allow them to both discover and learn about the concept? If the objectives of the curriculum are clear and the developers have an appreciation of the learners they are designing the problem for, it is possible to design a problem appropriate for students to investigate over the period of one day.

We acknowledge at RP that some educational objectives that require students to investigate a concept in great depth may require significant periods of time to allow students to review the problem and the accompanying resource material in great detail before arriving at an explanation for the problem at hand. As educators we may like to think students will read copious amounts of texts if we spread the amount over a series of days or weeks and that students will spend many hours pondering over what is they have read. The bleak reality is that often students will only selectively read texts or in some cases leave the reading untouched, or neglect it until immediately prior to the relevant tutorial or assignment, where it is often painfully obvious to the tutor that the student has only approached the reading in a very surface manner. By focussing the problem around one day we hope that the immediacy of the problem will motivate students to carefully review the necessary resources and texts. At RP we hope that students will spend a substantive amount of time each day reviewing resource materials along with discussing

the problem in light of these materials. In some cases the amount of material needing to be read and discussed (and of course understood) in relation to a problem (and the underlying concept) may exceed what is possible in a day. However, this does not negate students being able to at the end of a single day arrive at some outcomes of learning and sharing this to others as a step towards explaining the problem they are working on. If learning can be considered as cycle where students constantly visit and revisit ideas (Kolb 1984) then there is a case for the problem designer to chunk a large problem into parts that can be addressed on a daily basis. By chunking larger problems into smaller one-day bite-size problems this will allow students to work through the process of learning (problem formulation, identification of learning issues, research, formulation of explanation) but in an iterative manner (Engel 1991).

By repeating the process of learning multiple times we hope students will more readily inculcate the processes that underpin learning in PBL because they will be regularly exposed to them. The role of the tutor or facilitator will be to help draw attention to the intricacies of the processes as well as encourage them to engage with these processes. For example we know that in PBL students learn when they teach each other. Most students recognise the benefit of having a “bright” student in the group who can share their wisdom with others, but what is the motivation for the brighter students to want to share? Some research has found good students are reluctant to work in teams (Slavin, 1989). However, as teachers we know there is a benefit for those that peer teach, in cognitive terms the benefit is called the self-explanation effect. Chi (1989) showed that asking students to explain aloud some physics examples (problems already solved), they proceduralised their declarative knowledge of physics, made explicit some implicit problem solving steps and as a result become later more efficient in solving similar problems. The role of the facilitator will be to help students realise these benefits and hence help students value the process of teaching one another. The point is that it is only through purposeful reflection about learning processes will the value of peer teaching become an explicit learning for students. Also to become good at the skill of peer teaching it requires frequent practice. A one-day one-problem approach with the repeated experience of working on different problems every day afford the tutor the luxury of focussing on many important processes that underpin PBL as well as encourage its regular practice.

A one-day one-problem approach requires an integrated curriculum. By integrated curriculum we mean the curriculum is designed top down with institutional objectives informing course objectives, which informs subject objectives which in turn shapes the daily learning activities. The curriculum developer at RP identifies the desired outcomes of a course of study and then develops a sequence of learning objectives and then concepts for each subject module. The problem designers using these concepts create the daily learning activities (problems) that are aimed at helping students achieve the specific learning objectives of the modules. The designer considers the carefully the process skills underpinning the learning of the concept in relation to the problem and indicates what learning processes could be accentuated in the problem, i.e. skilful reading, summarising, evaluating the reliability of sources etc. The tutor during the process of facilitation can

also emphasis processes or skills that are necessary for students to learn in the context of the problem at hand.

Another reason for the need of an integrated curriculum is to enable students to consolidate their learning from each day. To avoid the fragmentation of learning into many small parts demarcated by which day they learnt something, or by subject or discipline, students will be constantly called upon to use their previous learning in solving subsequent problems. This can happen more easily because the curriculum is based upon a hierarchy of objectives. While valuing and acknowledging prior experience is seen by many as the key component of PBL (Barrows and Tamblyn, 1976; Boud and Feletti 1997), in a curriculum that is not integrated it is left to the students to make the necessary connections between the immediate problem and the learning from previous problems. With a more deliberate integrated curriculum model the tutor is in a better position to ask trigger questions (questions that invoke a more focussed recall) that can help students to facilitate transfer from one problem to another.

Assessment, whether it is formative or summative, is a key tool in developing reflection, integration, and coherence (O'Grady 1996). Students at RP will not have any semester-end/annual examination rather they will be assessed everyday and also by several "understanding tests" administered intermittently during the semester. These assessments are designed to help students bring together the various aspects of their learning having worked on several course related problems. Furthermore the integrated nature of the curriculum will allow for students to use learning across subject disciplines. The daily assessment will focus on how the group has engaged with the process of learning. The tutor will make a judgement about the quality of individual students' reasoning skills and their capacity for learning. Substantive "understanding tests", conducted perhaps once every six weeks, will encourage students to articulate their understanding of the subject matter after having engaged in several subject related problems. These tests will measure the achievement of desired learning outcomes and will be characterised by novel problems that students will be required to reason out. Students will also be expected to keep an electronic learning journal. In these journal students will report what it is they have learnt and their insights into how they are learning, they will also be asked to periodically review their journal and articulate a meta-analysis about their growth in terms of the course they are studying.

The one-day one-problem approach is RPs attempt to apply PBL to meets its specific mission of training technical professionals. We believe the one-day one-problem approach as an organising principle for the curriculum is consistent with the principles of PBL. The strength of the approach is that it affords students opportunities to daily reflect about how they are learning. It also gives students the chance to develop and practice processes that underpin the quality of their learning. Finally, 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.

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