

# Justification and proposed methodology for investigating CALD students studying engineering in a PBL environment

**Paul Bronson**

Victoria University, Melbourne, Australia  
Paul.Bronson@vu.edu.au

***Abstract:** This paper discusses the importance of investigating CALD (Culturally and Linguistically Diverse) students in the context of engineering courses in a PBL setting. Many Australian students have a significant number of CALD students and since this can be a vulnerable group it is worth investigating how their learning of communication and technical knowledge may be effected by their previous education. This proposed study gives some background information on a project being conducted at Victoria University, which may have wider implications for considering the needs of CALD students in Engineering courses nationally, and internationally.*

## Introduction

It is recognised that a large proportion of students in Australia and internationally are classed as CALD, that is culturally and Linguistically Diverse. For instance, at Victoria University (VU) there are approximately 50% CALD students, which was identified by a study conducted recently (VU 2008). CALD can be differentiated from ESL (English as a Second Language), as CALD fall into the category of students who speak a language other than English at home. ESL students however may, or may not, follow that particular pattern. Since CALD students do not get the same extent of English exposure as Anglophone Australia born students, it is likely to cause some differences in learning style and communication competence.

Preliminary investigation of students in engineering courses at VU, has revealed that CALD students often have difficulties with English language ability that affects their performance in a range or areas, not just with communication skills. This is likely to come down to the educational style in which they have been taught, the years of continuous study they have had, and cultural background, and a host of other factors (Ellis 1994, p. 472). One of the most significant factors affecting degree of learning is learning strategy (Altman 1980; Skeham 1989; Larsen-Freeman & Long 1991; Ellis 1994).

For purposes of the current study conducted at Victoria University, candidates for investigation are classed as those who have spent the majority of their education in a non-Anglophone country, and thus are more likely to be influenced by their home cultural education. The impact on their degree of English proficiency, values and behaviour is likely to be quite significant, which warrants further investigation.

Studies have shown that by learning another language (L2) it influences the behavioural patterns of the learner in their primary language, (L1). Investigation of Japanese learning English (Nawano 1994) and Americans learning a range of languages (Sicola 2005) have demonstrated differences in communicative style, values and behaviour after living outside their home country. These changes have been observed in periods as short as one year (Nawano 1994).

It could also be questioned as to why investigation of the communication skills and learning strategies of Engineers is relevant. Engineers are required to learn concepts, and be able to apply scientific theory, but they must also be able to express themselves in reports and also present their findings orally to the general public who have little, or no, Engineering knowledge or skills. Such demands are often difficult for native speakers of English, and would inevitably be more difficult for non-native English speakers. It is important to recognise that Engineers Australia has placed an increased

emphasis on the importance of communication skills, and this organisation is responsible for accrediting all engineering course in Australia. Moreover, the adoption of PBL by many universities demands that students hone their communication skills more than in a traditional education environment. Most students are fully dependent on the teacher when in high school where a traditional mode of teaching is taught. Thus the initial transition to a mode of student centred mode of teaching is difficult, especially since success is highly influenced by learner autonomy.

## Literature Review

### Problem Based Learning

In order to understand the Engineering education environment at Victoria University it is important to recognize the impact of Problem Based Learning (PBL) as it is embedded in approximately 50% of the curriculum. One critical aspect of PBL based curricula is that it requires that students take on increased responsibility for their own learning.

Another factor is that students largely work in teams to approach specific “problems”, which may range from a small task to a large project; these act as the trigger for learning. These problems are said to relate more to the real world as they tend to be interdisciplinary and the process of solving such problems is envisaged to more closely emulate the work-place (Boud 1985; Duch 1995; Nowak & Plucker 1998).

Students examine the situation they have been given by constructing hypotheses that promote exploration of the various aspects of the problem (Stepien & Pyke 1997, pp381). The tasks or problems should also be ill defined to maximize student thinking and creativity (Duch 1995). Thus there should be no simple, fixed solution (Nowak and Plucker, 1988; Finkle & Torp 1995).

In such an environment students should be more closely monitored so that they do not veer too far from the initial problem (Larsen *et al* 2003). Consequently the demands on staff (Mackinnon 2006) are often higher in PBL subjects as they are required to acquire unfamiliar roles, such as a coach or facilitator (Gallagher & Stephien 1996). Facilitators need to develop their questioning skills so as to guide student learning, and not simply give students solutions (Barel 1998).

The PBL learning process is student centered as opposed to traditional teacher/subject centered learning environments (Margetson 1994), thus the sharing of knowledge and discussion is valued. Self management strategies need to be honed by students to function effectively as information needs to be gathered by students, meetings held, and knowledge applied in order to solve a particular problem. It has been proposed that PBL learning shows a strong correlation to autonomous language learning (Wenden 1991; Richards & Renandya 2002); the acquisition and management of learning resources is an example (Finkle & Torp 1995; Duch 1995). This thesis supports this theory and it is likely to shown that good language learners may in fact be more successful in the PBL program than those who are more passive.

The PBL mode of learning makes an increasing demand on social, communication and co-operative skills (Larsen *et al* 2003). Furthermore, students are required to be reflective about their learning (Finkle & Torp 1995) thus students are often required to write more than they are normally accustomed. There are some fears by institutions that an increase in communication skills will lead to a decrease in subject specific understanding. Yet, international evidence has shown that the PBL approach increases the generic skills of the learners, without compromising technical skills or knowledge or theory (Krynock & Robb 1996). Another advantage of PBL is that it can offer opportunities to make finished products allowing the use of skills that will be useful in the workplace and in later life (Schmidt 1983). Thus a clear connection can be seen as to the relevance of English for Specific Purposes (ESP) to the PBL context.

There is evidence that motivation is higher in PBL subjects which is attributed to shift from traditional lecture mode. Engagement is key for the success of students, as research by Bok (1989) suggests that students’ retainment of knowledge in the traditional learning mode decreases linearly. Learning by the PBL mode however is likely to increase knowledge retention as students demonstrate higher motivation and utilize more effective approaches to study (Cole 2001). Problems are generated to

promote student interest (Margetson 1994), or more specifically to motivate student interest in learning (Boud and Feletti 1991).

Victoria University adopted the PBL mode in selected first year subjects in the schools of Electrical Engineering (EE) and Architectural, Civil and Mechanical Engineering (ACME) in 2006. Initial models of PBL were loosely based on existing practices existing at Central Queensland University (CQU), Australia and Aalborg University in Denmark. The PBL approach has been shown to be challenging and engaging for students at VU (Shi *et al* 2006) and courses have been accredited until at least 2013.

## Language Theory

Valuable research spanning much of the 20<sup>th</sup> century has uncovered understandings of language learning that are applicable to the content of this project. There are a multitude of authors who have published in the field of language learning and learning in general, and numerous theories that are held in high regard. This review will attempt to discuss some of these.

A key figure in the field of second language acquisition, Rod Ellis, admits that language learning is a complex phenomenon and much of it still remains understood (1994). Many theories are in existence that attempt to explain how it works, but these are not necessarily mutually exclusive, as commonalities are often observed, or others relate to different facets of the language learning process. This demonstrates how one theory does not answer the many questions that often arise in the field.

Socio-cultural theory is a humanistic approach to understanding how language develops. Vygotsky was a pioneer in such learning theory and proposed the Zone of Proximal Development (ZPR). This theory explains that difference in level to which someone can learn unassisted or with the assistance of someone more capable (Vygotsky 1978). It posits that children should work within their ZPR to increase engagement and later promote autonomous learning (Berk & Winsler 1995). Vygotsky also explains that the degree of learning is restricted by internal factors (1978). ZPR later led to the term scaffolding which has become very popular in the field of education and adapted to explain how teachers can assist the development of students. This is relevant in the context of problem based learning as the approach to learning is designed to scaffold students towards becoming autonomous learners.

The input hypothesis developed by Krashen (1985) is another popular theory and has strong similarities to the interaction hypothesis (Ellis 1999). The input hypothesis explains that complexity of content needs to be made understandable in order for learning to occur for any particular learner. He further states that output such as speaking does not necessarily result in language acquisition (Krashen 1985). We also see a commonality with Vygotsky's ZPR as it is proposed that teachers need to model language rather than explicitly teaching structures. Krashen is not without his critics however. Swain (1985) claims that language output is required in order to obtain mastery of grammar. Although Ellis (1994, p.282) adds that students still need to be pushed in order to gain such accuracy. Long & Pica (1996) also contest that modified output is critical in language acquisition. Pica explains that attention needs to be made to form, even if the learners are able to get their message across. A later version of the interaction hypothesis takes into account negotiation of meaning where information is clarified by an interlocutor. It also explains that comprehensible input and selective attention is required. However it can still be seen as a limited theory as it focuses on only on one method of interaction – i.e. negotiation sequences (Ellis 1999, 14). Van Lier (1996) explains that discourse needs to be seen as more holistic and his ideas are more in line with Socio-cultural theory. These theories relate to how language and communication skills are learnt and since acquisition of such skills is important in a PBL context they should be mentioned.

Behind the underlying theories of language acquisition, there needs to be a readily useable system in which to test the progress of students in regard to their written communication skills. One such method is error analysis which identifies and quantifies mistakes of various types (Selinker 1972; Richards 1974). A study performed at the university of Natal in South Africa (Greenbaum and Mabi 2002) demonstrated the appropriateness of using this method on CALD law students. Law is said to

be an extremely conventionalised genre (Greenbaum and Mabi 2002), as is Engineering, which indicates the need for a more valid and systematic approach to determine accuracy of this discourse.

## Research Questions

The following research questions will be the main focus of this study:

- 1) What degree of English communication is used by CALD students of various linguistic denominations at University and outside of University?
- 2) How do various CALD groups measure success (in language and communication skills and technical skills etc)? Why are they doing the course, and what are their long term objectives?
- 3) Which CALD groups seem to achieve higher academically (by results) in various Engineering subjects?
- 4) Which CALD groups seem more likely to be identified as “at risk” in terms of their English language ability?
- 5) Which CALD groups seem to use more strategic planning in their approach to study various units at VU? Students may be unaware of their own learning strategies and thus need to be interviewed to determine this.
- 6) How do the results regarding the factors listed above change over the students first 2 years of study?

## Methodology

In considering the overall epistemological and methodological approach to this study, I thought it best to use one main approach, but triangulate by applying others in order to gather and interpret the data more effectively.

There will be two levels guiding the overall framework – the first being a phenomenographic methodology, which will guide my position as a researcher. The second level will relate to a lens guided by theories of learning in general, and theories of language learning, which will examine student learning processes. As the study’s object of gaze is the learning process of various students there is need also to draw on learning theory that will shed light on the learning behaviour. Thus, this study proposes to draw on cognitivist theory (Skinner 1989), sociocultural theory (Vygotsky 1978). It is also worth considering the general learning style preferences of students, as proposed by Gardener’s theory (1983) of multiple intelligences.

As a lecturer and tutor in units involving PBL I believe it is important that I maintain my identity as an educator in the eyes of my students, and thus cannot use an ethnographic approach by living with the so called “student tribe” which was taken by Siva Krishnan (2009) in his thesis concerning group learning cultures in PBL. In contrast I see my role as that of an observant practitioner. I have ample experience in teaching and assessing students in the PBL paradigm, and as a result this will reinforce my ability to interpret student learning and communicative competence of CALD students in Engineering. Furthermore, my research focuses more on individual learning of students, rather than group learning and relationships that are of greater importance to ethnographic studies.

My main approach would be that of phenomenography, as this paradigm values how people relate to and experience a particular subject matter (Marton 1986). Moreover most of the data collected will be qualitative in nature, as I will be using interviews to acquire knowledge on student learning and also reviewing students’ written reflections. The language learning and general learning theories will help in the interpretation of data within the framework of the phenomenographic approach. Validity in the research will be based on the rigour of the methodologies used, which justified in qualitative research.

Much of the ideas on student learning of communication in PBL will draw upon knowledge of language learning in order to make sense of how students learn communication and other skills within

an Engineering education environment. The reasons for this are that parallels between language learning and learning of other knowledge has been documented (Mphande *et al* 2007), and another is that there is much more literature on the study of language learning as opposed to learning of Engineering, especially in regard to how non-native speakers of English learn in such an environment.

It is anticipated that approximately 10-15 students will be studied in detail in a longitudinal study covering a two year period. Over the first six months of the project information from the entire first year Engineering cohort will be collected in order to assist in identifying 'suitable' CALD students in which to analyse further. This wider study will be restricted to gathering information on student education and cultural background, language use and motivations for study. Based on the number of students who volunteer for the study, and anticipated attrition, I hope to obtain the aforementioned number. This cohort would include students from the main representative cultural backgrounds at VU. The two year duration was chosen because the communication requirements are more demanding in the first and second years of PBL units in Engineering. It is further expected that students will develop in both English communication ability and their ability to learn autonomously over the period of the study. There is likely to be mostly male participants involved in this study, due to the low enrolment rates of female students.

At the end of the two year study a comparison of the primary subjects in relation to the entire beginning engineering cohort will be made in order to identify how they may differ in relation to academic achievement and progress.

## **Methods**

The following research tools will be used in this study: reflective journals, portfolio responses to learning outcomes, surveys, interviews, language proficiency testing data and observation of group interaction.

### Self-profiles and surveys

As part of a phenomenographic approach, student self-profiles (essays which the students write in both Electrical and ACME) can help initially select student who may be promising candidates for this study. Surveys will also be used to collect data relating to factors such as the students education background and aid in more definitive selection of participants for further study. Included in the initial survey would be VCE results or International English Language Testing System (IELTS) scores which give a general guide to the student's base level of English language proficiency. Information gathered will provide a basis for comparison of the selected students against the background of the initial engineering cohort.

### Interviews

Semi-structured interviews will be conducted to acquire further information on participants communication ability and learning strategies used in their Engineering course. This would allow flexibility in how the participants respond, but also guide them to address the research questions and allow collection of phenomenographic data. These will take place four times for each participant to determine how their learning strategies, and language and communication and competence in Engineering knowledge and skills may have changed over a two year period. By using such an approach it will be possible to determine learning style and preference to learning communication skills.

### Written and Oral Communication

The approach to learning in general will be investigated using a phenomenographic approach. In order to monitor progression in language proficiency of the participants in the study both written and oral communication will be investigated using the lens of sociocultural theory. Communication of technical knowledge will also be analysed within this context. This is distinct from student claims on their own technical knowledge, but it would be useful to see how well students judge their ability to communicate technical information. Their claims can be compared against the comments made by other PBL team members, facilitators, and other records.

Written communication

Report writing and reflective submissions (journals, portfolio responses to learning outcomes) will be used to analyse students written communication skills, and ability to conceptualise understandings of their learning and issues relevant to the research questions. Error analysis (Selinker 1972; Richards 1974) will be used to assess the amount of errors quantitatively which would be more meaningful than using IELTS, which gives only a rough understanding of individuals English language ability.

Oral communication

Oral communication feedback would be used to gauge how their public speaking skills had progressed over the period of this study based on their approach to learning.

Group Interaction

Observation of group interaction could be used to add validity to student claims on communication with the team. It would be useful to use video to investigate interaction of the CALD students within a team environment and how their interpersonal skills develop over the 2 year period. Filming would be preformed up to 3 times per semester. Data would be analysed by considering the theoretical lens of symbolic interaction (Blumer 1963).

**Bibliography**

- Altman, H. (1980). 'Foreign language teaching: focus on the learner', in *Foreign language teaching: Meeting individual Needs*, Oxford, Pergamon.
- Barel, J. (1998). *PBL an Inquiry approach*, Hawker Brownlow Education, Australia
- Berk, L. & Winsler, A. (1995). 'Vygotsky: His life and works' and 'Vygotsky's approach to development'. In *Scaffolding children's learning: Vygotsky and early childhood learning*, Natl. Assoc for Educ. Of Young Children.
- Blumer, H. (1962). 'Society as Symbolic Interaction' in Arnold M. Rose. *Human Behavior and Social Process: An Interactionist Approach*. Houghton-Mifflin.
- Boud, D., and Feletti, G. (1991), *The Challenge of Problem-Based Learning*, St Martin's Press, New York
- Cole, G. (2001), 'Problem Based Learning (PBL)'. In B. Hoffman (Ed.), *Encyclopedia of Educational Technology*, Viewed January 22, 2007.
- <<http://coe.ddsu.edu/eet/Articles/pbl/start.htm>>.
- Duch, B. (1995). "Problem Based Learning in Physics: The Power of Students Teaching Students." *About Teaching*, vol. 47, pp. 6-7.
- Ellis, R. (1994). *The Study of Second Language Acquisition*, Oxford University Press, Great Briton
- Finkle, S.L. and Torp, L.L. (1995). Introductory Documents 1995:1 (Available from the Center for Problem-Based Learning, Illinois Math and Science Academy, 1500 West Sullivan Road, Aurora, IL 60506-1000).
- Gardener, H. (1983). *Frames of Mind: Theory of Multiple Intelligences*. Basic Books, New York.
- Gallagher, S.A., & Stepien, W.J. (1996). 'Content acquisition in problem-based learning: Depth versus breadth in American studies', *Journal for the Education of the Gifted*, vol. 19, pp. 257-275.
- Gordon, R. (1998). *Balancing real-world problems with real-world results*, viewed January 11  
<<http://www2.imsa.edu/programs/pbln/articles/>>
- Greenbaum, L. & Mbali, C. (2002), 'An analysis of language problems identified in writing by low achieving first-year students, with some suggestions for remediation', *Southern African Linguistics and Applied Language Studies*, vol. 20, 233-244.
- Grellier, J. & Goerke, V. (2006), *Communication Skills Toolkit: Unlocking the Secrets of Tertiary Success*, Thomson Social Science Press.

- Krashen, S. (1985), *The input hypothesis*. Longman, London
- Krishnan, S. (2009). Student Experiences of Problem-Based Learning in Engineering: Learning Cultures of PBL Teams, PhD thesis, Victoria University.
- Krynock, K & Robb, L 1996 'Is problem based learning a problem for your curriculum?' viewed January 14, 2007.  
<<http://www2.imsa.edu/programs/pbln/articles/>>
- Larsen-Freeman, D. & Long, M., (1991). *An introduction to second language acquisition research*, Longman, London
- Long, M., (1996), 'The role of the linguistic environment in second language acquisition, in K de Bot, R Ginsberg and C Kramsch (eds), *Foreign Language Research in Cross-cultural perspective* pp. 39-52, John Benjamins, Amsterdam
- Mackinnon, J. (2006), 'Problem Based Learning and New Zealand Legal Education', *Web Journal of Current Legal Issues* 3, viewed January 17  
<http://webjcli.ncl.ac.uk/2006/issue3/mackinnon3.html>
- Margetson, D (1994). 'Current educational reform and the significance of problem based learning', *Studies in Higher Education*, vol. 19, pp. 5-19.
- Marton, F. (1986). Phenomenography - A research approach investigating different understandings of reality. *Journal of Thought*, vol. 21, pp. 28-49
- Mphande, C., Bronson, P., Ives, R., Shi, J. & Simcock, A. (2007). 'Building staff Awareness of Communication Education in the PBL Approach', paper presented at the *International PBL Symposium 2007 – Reinventing PBL held at The Republic Polytechnic*, Singapore, 7-9 March, 2007.
- Nowak, J. & Plucker, J. (1998), *Do as I say, not as I do. Student Assessment In Problem Based Learning*, viewed January 20  
<http://www.indiana.edu/~legobots/q515/pbl.html>
- Pica, T. (1996). 'The essential role of negotiation in the communicative classroom', *JALT Journal*, vol. 78, pp. 241-268
- Richards, J. (1974), *Error Analysis: Perspective on Second Language*, Longman, London.
- Richards, J. & Renandya, W.A. (2002), *Methodology in Language Teaching: An Anthology of Teaching Practice*, Cambridge University Press.
- Schmidt, HG 1983, 'Problem-based learning: rationale and Description', *Medical Education*, vol. 17, pp. 11-16.
- Selinker, L, 1972, 'Interlanguage', *IRAL*, vol. 10, No. 3, 209-231.
- Shi, J, Mphande, C, Simcock, A, Ives, RC & Bronson, P 2006,. 'Communication in a problem based learning environment: supporting the teaching team in the School of Electrical Engineering.' Proceedings of the 17<sup>th</sup> Annual Conference of the Australasian Association for Engineering Education, 10-13 December, 2006.
- VU, (2008). *The diversity and performance of the student population at Victoria University*, Faculty of Business and Law, Victoria University

Copyright © 2009 Remains the property of the author(s). The author(s) assign to AaeE and educational non-profit institutions a non-exclusive licence to use this document for personal use and in courses of instruction provided that the article is used in full and this copyright statement is reproduced. The author(s) also grant a non-exclusive licence to AaeE to publish this document in full on the World Wide Web (prime sites and mirrors) on electronic storage and in printed form within the AaeE 2009 conference proceedings. Any other usage is prohibited without the express permission of the author(s).