Towards Staff Awareness of Communication Education in Engineering

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***Abstract**: Traditionally engineering staff have had little to do with issues of communication. However, because PBL has been adopted as a teaching/learning approach, communication is now an integral part of the engineering course. As a result, it has become necessary to train staff to handle this new requirement. At Victoria University, Australia, it was decided that staff should undergo professional development to update their knowledge of the teaching and learning of written and oral communication skills and aspects of language education. This paper describes the workshop program specifically designed to orient staff in recognising the student learning strategies and learning style preferences to be able to assist the learners to develop lifelong learning skills, particularly concerning oral and written communication. This orientation of engineering staff to language and communication as a discipline is a shift towards holistic engineering education within the PBL paradigm.*

Background

Victoria University (VU) is a dual sector university that has two schools of engineering, Electrical Engineering (EE) and Architectural, Civil and Mechanical Engineering (ACME). Both schools introduced Problem Based learning (PBL) into their programs in 2006 (Simcock et al, 2007). The student population includes a wide range of socio-cultural, linguistic and ethnic backgrounds. Language development for engineering students is a key component. Some of the essential attributes for engineering graduates are: *good interpersonal and communication skills – both transmitting and receiving information; ability to interact with other disciplines and cultures; and well-developed capacity for self-directed, lifelong learning* (Engineers Australia Accreditation Board, 2005). Staff should be role models and, as language and communication are such integral components of the PBL approach, it is imperative that the students should see appropriate levels of expertise in all staff, thereby reinforcing the view that language is not just an adjunct to the technical component.

Initial Phase of the Program

A series of workshops, funded by a "Learning Across the Curriculum (LAC)" grant from VU, was run from February to March 2006. The purpose of these workshops was to acquaint the EE staff with

pertinent language learning theory, metalanguage and learning strategies etc. so that they would be able to analyse and evaluate student reports and reflective writings. Further, as the participants were in the process of developing PBL units for the continuing students, the workshops were intended to feed directly into the course/unit development process. The workshops were intended to strike a balance between theory and practice to incorporate changes suggested in the whole approach to evaluation. At the outset, it was recognised that staff skilled in language education would be needed to share their expertise with the engineers. Brief descriptions of the workshops and their outcomes are as follows.

Workshop 1: The cultures of learning: variation of attitudes to knowledge, teaching and learning strategies.

In this workshop the focus was on sensitising the participants to some subtle issues in cultural influences in the manner of learning/teaching as outlined in Ballard & Clanchy (1991) and Carroll & Ryan (2005). It was noted that most of the complaints about poor English language skills and inferior logical power in regards to international students are often surface manifestations of dissimilar approaches to teaching and learning. Secondly, it has been suggested that cultural and intellectual traditions shape and inform education practices in different ways. Theses include styles of teaching and learning; roles of teachers and students; and nature and functions of assessment.

Australian universities tend to work more or less within intellectual traditions of Western society. In these traditions, primary/secondary levels pupils are expected to learn the basics before they can become intellectually independent. Education is teacher-centred and pupils learn largely by imitation and memorisation to reproduce what they are taught. Late secondary years and at university, the practices progress to more analytical and critical approaches to learning. Teachers raise issues, refer to a range of sources, theories and interpretations, actively encouraging learners to question and evaluate. In the final stages of tertiary education emphasis is on the potential for extending knowledge. Students are encouraged to speculate, hypothesise and search for new evidence, interpretations or understandings while the teacher offers advice and guidance more as a mentor. This is particularly relevant for international students who come from a different educational tradition and will benefit from the lecturer's academic as well as pastoral care to adapt without much stress to the educational traditions in Australia in general, and at VU in particular.

Following from the points raised during the workshop several points were clarified for the students, namely: expectation to take up responsibility for their own learning; importance of all the work they would do as they worked on the problem towards justifying their claims to attainment of skills in the portfolios; and inclusion of an individual oral defence of their team solution in the assessment. In recognition of the point that some may be more teacher dependent, the participants were more sensitive to individual learning needs as a support to the team learning process.

Workshop 2: Knowledge about (language) learning: characteristics of meta-cognitive knowledge; kinds of meta-cognitive knowledge; learning styles – a glossary.

This workshop was intended to introduce the participants to the language to describe the learning process, and what language educators perceive it to comprise. Drawing largely on Flavell (1979), Wenden (1999) and Rubin (1989), key features of the learning process were mapped out. According to Flavell (1979, p906) "*metacognitive knowledge includes all facts learners acquire about their own cognitive processes as they are applied and used to gain knowledge and acquire skills in varied situations*." Metacognitive knowledge has to do with beliefs people hold about learning, as follows:-

1. Person knowledge - not only cognitive factors that facilitate learning but also affective factors that facilitate learning. For language, learning the following cognitive and affective factors are valid:-

- Age/maturity
- Language aptitude, ie. the ability to discriminate meaningful sounds, to associate sounds with written symbols and identify grammatical regularities
- Intelligence, a general academic/reasoning ability, in short the ability to learn
- Motivation – learner's purpose for learning the language
- Personality – personal traits such as extroversion or introversion; social skills or factors that influence behaviour, such as risk taking, self-esteem, empathy, anxiety, etc.

- Socio-cultural factors, such as attitude to the subject, or discipline
- Cognitive style - the way in which people perceive, conceptualise, organise and recall information
- Learning style – learner's characteristic or consistent way of perceiving, interacting with and responding to the learning environment.

2. Strategic knowledge - effective strategies for particular tasks, and general principles that determine the choice of strategy.

3. Task knowledge, including the following:-

- Knowledge of the purpose of the task. Learners need to know why they are asked to perform a task so that they can appreciate its significance. Two factors that determine a task's significance are achievement (e.g. mastering a particular skill) and survival (e.g. finding a job in the field).
- Knowledge of the nature of the task, involving task classification, requires determining what kind of learning is science/engineering or language learning.
- Knowledge of when deliberate learning is required. In other words, learners need to know when tasks will require conscious effort, i.e. situations when metacognitive knowledge is more likely to come to consciousness rather than remain tacit.
- Knowledge of task demands includes determining what resources may be necessary to complete the task; knowing how to go about the task – steps and strategies.

For this and the subsequent workshop, the participants familiarised themselves with the principles of language acquisition so that they would be in a position to assist learners to understand what is going on in them as they learn autonomously in the PBL approach.

As a result of this workshop, the participants built into the PBL unit for continuing students, early identification of students that showed problems in the lifelong learning skills that include oral and written communication. This was worked out from their reflective journals that the participants had access to during team meetings or the teams' tutorial sessions.

Workshop 3: Learning strategies: characteristics of learning strategies; kinds of learning strategies.

This workshop was designed to equip the participants with the knowledge and language of cognitive learning processes, so that they may assist the students to understand their own learning processes, which the lecturers accessed through the students' reflective journals. Wenden (1991) views strategic knowledge as stored knowledge that learners have about strategies. Strategic knowledge has two main aspects:- knowledge regarding strategies that work best and knowledge about how best to approach learning. The workshop focussed on strategies for cognitive learning that include the following:-

1. The Getting process, which includes:- clarification/verification strategies or attention focus, guessing/inductive inferencing strategies, deductive reasoning strategies and resourcing strategies which are crucial elements in developing lifelong learning skills.

2. The Storing process, which is basically memorisation strategies. According to Rubin (1989), there are seven such strategies ranging from association or grouping of words and phrases according to some principle (phonetic, semantic, visual, auditory, kinesic, kinesthetic, olfactory or sensory) to silent rehearsal with delayed production.

3. The Retrieval and Using process, which includes the following:

- Practice strategies - according to Rubin (1989) there are nine - from repetition to self drills
- Monitoring strategies to identify the problem, determine the solution, and finally make corrections
- Social strategies that may involve joining a group and acting as if one understands; counting on one's friends for help; creating opportunities for practice, such as initiating conversation with native speakers, or attending social events
- Working with peers to obtain feedback, pool information or model a language activity.

Further to action mentioned as a result of Workshop 3, the participants were keen to advise the students that were in some way challenged in the oral and written communication, to seek assistance from the Teaching and Learning Services (TLS) Unit of the university. The lecturers did not leave this

to the students alone; they passed on details of the learners to the TLS Unit. What was left for the students to do was to book for the special sessions with TLS for times that were convenient to them.

Workshop 4: Learning culture influence on attitudes towards self-directed learning/learner autonomy.

This workshop was designed to extend knowledge in relation to cognitive awareness towards self or participant directed learning. In the PBL approach there is provision for the learners to take responsibility for their own learning. This workshop highlighted awareness of factors that may impinge on the process of becoming a self-directed learner. Drawing largely on Wenden (1999), a few characteristic points were identified:-

- Attitudes have an object, i.e. they have a cognitive component – beliefs, perceptions, information – about their object. In (language) learning, this could be what learners believe about the role in the learning process or about their capability as language learners
- Attitudes are evaluative, that is, the object of the attitude may evoke like or dislike, agreement or disagreement, approval or disapproval. Some students may agree with the view that they should take more responsibility for their learning while other may wish to avoid an independent role
- Attitudes predispose one to certain actions. In other words, attitudes have a behavioural component; they predispose people to act in certain ways. Learners who evaluate learner autonomy positively will try to become more responsible for their learning as opposed to those whose evaluation of learner autonomy is negative.

There are two main factors that influence attitudes towards learner autonomy. Socialisation processes lead to acquisition of beliefs that encourage dependence rather than independence. Some knowledge of background educational cultures of learners may help if the lecturer is to understand the learners' behaviour towards self-directed learning in the PBL approach. If the learner perceives that many different things compete for time and effort, in the face of carrying out a technical engineering task, it is likely that further learning of language may not be given priority. This means that transferable skills must be seamlessly integrated into the engineering problem requirements.

Learner beliefs central to their attitudes, role and capability as learners are a form of metacognitive knowledge. These, however, differ from the person, strategic and task knowledge in some basic ways. Beliefs about the learner's role and capability are shaped by other beliefs they hold about themselves, for example that certain personality types cannot learn languages easily and that they are in that category. Thus, some valued belief is central to attitudes towards autonomy. This is not always the case with other forms of metacognitive knowledge, namely, strategic and task knowledge.

As a result of this and the subsequent workshops, extreme facilitator stances were advised against; such a stance would not be beneficial to the largely international student cohort. However, the lecturers were clear about their roles; they would attend to all learners as individuals at whatever stage they were and assist them to develop into more autonomous learners.

Workshop 5*:* Identifying the issues in stages of teacher/learner in learning to learn.

This workshop drew mostly from Grow (1996) and was intended to bring to the awareness of participants that learners go through stages of increasing self-direction, which teachers can help or hinder. Learners go through four stages to participant/self-directed learning. The teachers' sensitivity to the changes and their corresponding change of style at appropriate points in the learners' progress is crucial towards making (or, if mishandled, breaking) the lifelong learner in the student. At stage one, the learners are highly dependent on the teacher as an authority or coach. The pedagogic style may involve coaching with immediate feedback; giving informational lecture; drilling; and overcoming learner deficiencies and resistance. Most of the learning is teacher driven. Then the teacher lifts learners' self-esteem with the realisation that the fact that if they have managed to do it once, they can do it again. Thus the teacher prepares the learners for higher levels of achievement and self-direction. The stage one teacher's pedagogic style is captured in the following verbs:- **tell, impart, transmit, give, propound, convey, expound, transfer, direct, fill, inform, coach, input, drill, condition**.

At stage two learners are described as **Interested**. Learners may respond to motivational techniques and are confident but may be seriously deficient in the subject matter. In the traditional teaching

setting these would be the proverbial 'good students.' Grow (1996) asserts that learners at this stage show readiness to learn when they understand why. Correspondingly, teachers at stage two are considered to be motivators or guides and should give clear explanations of why the skills are important and how the problem helps the learners to attain the skills. Showing concrete results in what the teacher teaches, motivates and encourages stage two learners to continue to learn on their own. For this reason, the teacher may well begin training students in basic skills such as goal setting. The teacher may also begin to bring to learners an awareness of learning strategies. It is at this stage that use of praise (as an extrinsic motivation) is being phased out significantly while phasing in encouragement which builds intrinsic motivation. Some verbs that are used to describe this teaching style include:- **develop, mould, produce, instruct, reinforce, prepare, direct, demonstrate, push, motivate, inspire, shape, drive, persuade, sell and train.**

At stage three learners are described as **Involved**, and are well on their way to being autonomous learners. They have skill and knowledge and regard themselves as participants in their education. They are also ready to explore a subject, and may well explore some of it on their own. What they need is to build more confidence, sense of direction and a greater ability to work with, and learn from, others. Grow (1996) asserts that they will benefit from learning more about how they learn, so as to make conscious use of learning strategies. Teachers are regarded as facilitators and their style may involve such activities as:- discussion facilitated by the teacher who participates as an equal; seminars; and group projects. The teacher may begin by negotiating interim goals and evaluations and allowing learners to go as far as they can on their own. Standards at this level are negotiated with learners and are often related to some external standard, such as professional accreditation requirements. Some verbs that capture their pedagogic style include:- **lead, guide, initiate, help, show, point the way, explore, facilitate, discuss, share, participate, offer, suggest, negotiate, collaborate, and validate.**

At stage four, the learners are described as **Self-directed**, and the teachers are taken to be consultants or delegators. These self-directed learners exercise skills in time management, goal-setting, self or peer evaluation, information location and evaluation and the use of educational resources. These learners are highly social and belong to other clubs or other informal learning groups. Pedagogic activities include internship, dissertation, individual work or participant/self-directed study-group. The teacher's role is not to teach subject matter but to cultivate the student's ability to learn. As Grow (1996, p11) puts it, the "*ultimate subject of Stage 4 is the learner's own personal empowerment as a mature creator and evaluator of knowledge, or as a high-level practitioner of a skill.*" Some verbs that capture the teaching style at this stage include:- **cultivate, encourage, nurture, develop, foster, enable, bring out, mentor, plant, challenge, and advise**.

Workshop 6: Writing across the curriculum: Writing as a tool for developing professional skills.

The workshop looked at some key points about writing as a tool for developing professional communication skills. This workshop drew mainly on Chanock (2003) and Taffe (1989) as follows:-

1. Why writing is necessary for career-oriented learners: Learners have two thrusts: professional studies and general education. Writing plays an important role in both cases.

2. Modes of writing for career-oriented learners: These seem to fall in three categories:-

- Developing ability with the specialised language of the discipline. Learners need to join a professional community by practicing professional writing on a regular basis. This may be possible by engaging learners in activities that involve learning the professional language and its proper use and learning to organise professional material. This may be difficult to handle for most learners. However, the suggested approach advances the idea that learners should be introduced to technical journals or other sources, with set exercises (e.g. summarising technical texts of interest).
- Writing to explain results of a particular study:- Reports that answer somewhat open-ended tasks help to give opportunity to use specialised language, and practice organising texts in line with the professional conventions. The literature makes other pedagogical suggestions, especially for the traditional teacher-centred and content-focus educational settings and tasks including:- user questionnaires and diaries, formal specifications, project correspondence, system documentation, requests for proposals or quotations, final reports and standards for the analysis process itself. Oral communication may be practiced in formal project presentations or colloquia at appointed times.

- Writing as a means to clarify ideas Writing forces the writer to clarify thinking by exposing the gaps in a progression of ideas and frequently raising new questions. Tasks that require students to express their thinking about problems may help to sharpen their understanding of the concepts. Students may end up clarifying the confusion or coming up with a focus for discussion. Various writing tasks, such as keeping a reflective journal, writing reports etc., offer such opportunities.

The workshop also highlighted issues about diagnosing student problems in written communication. According to Taffe (1989) lack of facility with technical language may be mistaken for inability to organise thought, and disorganised thinking may be passed off as mere lack of writing skill. Teachers need to be aware that superficial and hasty conclusions about students' written communication could lead to inappropriate action. A careful examination of the learner's educational background may be helpful. In the EE PBL program, a written communication diagnostic exercise is given at the beginning of the academic year so that learners who show that they are at risk may be referred to appropriate learning services units to bring them up to expected levels.

A review session was conducted after the above set of workshops. Reflective writings submitted by the students for first year EE PBL Unit were analysed by he EE staff to identify students' learning styles and strategies. Students' concerns and problems were identified and strategies to address their concerns and to assist the students to overcome their problems were developed.

The Second Phase of the Program

Three workshops were conducted in April and May 2006 and are briefly described here:-

Workshop 7: PBL and LAC: Writing across the curriculum/writing in disciplines.

Assessment is a complex task. The literature shows that in some English for Academic Purposes (EAP) programs, subject specialists assess learner success more in terms of communicative achievement (Elder 1993), or they use other criteria set by themselves – 'indigenous criteria' (Douglas, 2002). However, among EAP/ESP (English for Specific Purposes) practitioners, there is a growing recognition of the need to understand learners' perspectives of their own learning experiences (Barkhuizen, 1998; Kumaravadivelu, 1991). It is also recognised that learner perceptions and those of teachers may vary (Basturkmen & Lewis, 2002; Peacock, 2001), especially in regards to:- describing and assigning purposes to classroom tasks, the most useful learning strategies and measures of success.

The workshop highlighted recent research on teachers' personal theories or subjective theories, ie. subjective understanding that motivates their thoughts and practices. Thus, teachers interpret a situation in the light of their beliefs about learning and teaching. An important consideration was that if personal theories motivate teacher practices, how do learner's beliefs affect their decision-making and practices on or off campus, in or out of class (Basturkmen & Lewis, 2002)? The workshop looked at insights drawn from the Activity theory/concept that falls within Vygotsky's socio-cultural theory (Lantolf, 2000). Activity theory proposes that individual learners construct learning activities in unique ways and activities are differentiated not by their concrete realisations as action but by their objects and motives. Basturkmen & Lewis (2002) draw some insights from Activity theory - "*If motives and goals of individuals for doing the task and carrying out the action differ, then the activity means different things to them and different things will be learnt*.". van Lier (2000, p246) went further to argue "*these activities do not just facilitate learning, they are learning in some fundamental way*." Thus within a single course, individual learner perceptions of success will lead them to pursue different objectives and learn different things.

This constructivist outlook is pertinent to the PBL approach in many ways. Firstly, it recognises the learner as the focus. Secondly, it points to the importance of collaborative goal setting, as may be done through joint teacher-learner rubric formulation for various learning outcomes or tasks towards learning outcomes of a set problem. This goes a long way to make learning meaningful and enjoyable, and assessment more reliable. Two major points were underlined in the workshop: -

- To understand learning behaviour and learners' perceptions of their behaviour (e.g. written communication) as successful or not, lecturers may need to access the student's own understandings. If they are misguided, the lecturer will have opportunity to offer expert advice at the collaborative planning stages

- To get a fuller picture of learning, we need to understand the learners' own perspectives, especially their criteria for success, as these represent their goals in the programs.

Workshop 8: Genre analysis - ideas for teaching varieties of writing.

This workshop drew on work in genre analysis, particularly Swales (1990), Bhatia (1993) and Chanock (2003) to sensitise participants to the different kinds of writing that students may be called upon to write in their professions. As the PBL approach simulates professional/workplace demands, it is important to familiarise learners with the variety of written communication. Often schools and universities focus on essay or report writing, with little consideration of audiences extra to the teacher. This hypothetical situation takes away the demand for the creativity and is, therefore, hardly authentic.

Chanock (2003) suggested a framework of analysis and demonstrated it for university instruction, albeit in the traditional lecture setting. Taking a variety of related texts, for example journals and project plans, the aim is to show features of writing across these genres. Such features may include: author(s), venue/audience, purpose, structure, accommodation to/interaction with audience (in prose and visual aids), language covering elements such as technical terms, sentence length, lexical density, grammatical metaphor, passive verbs/constructions, use of first person and emphatic expressions. Similarly, other properties of text may be explored, namely those in relation to audience and language, assumption about readers' knowledge, language level, transitivity and degree of abstraction, ie. grammatical metaphor. In a PBL context, teaching/learning written communication could be incorporated creatively, by building into the problem a variety of genres of written deliverables.

A direct result of workshops 6, 7 and 8 were several features the participants included in the PBL unit for the continuing students. One component was practicing writing a paper for a journal, following the process approach to learning/teaching writing. Researching for various sections of their topic, the learners contributed to this paper as a team. Thereafter, the various teams swapped their papers for peer reviewing. The learners derived a lot of fun out of this exercise, and they developed professional communicative skills. Another component that was built into the unit was writing an instructional manual, with the assistance of the Language and Communication Co-supervisor, for the robots they built. Instructional manuals were also needed for a task related to programming for the robots which tested the students' understanding of the principles they had used to build and program the robots. At the conclusion of the problem, the participants were judged their unit as being more holistic than it would have been without the components that were inspired from the workshops.

Workshop 9: Developing assessment criteria for evaluating student portfolios.

This workshop was designed to highlight the relevance of rubrics (Mphande, et al 2007). The workshop explored the possibility of incorporating elements of the SOLO (Structure of Observed Learning Outcomes) taxonomy in the development of rubrics that would facilitate student learning and help in the matter of interrater reliability and validity. Making the rubrics available to the learner at the beginning of the program would make the learning more guided and meaningful and, hopefully, more interesting. Furthermore, clear guidance would be motivating to the learner, and so help the learner towards building lifelong learning skills. As a result, assessment would be more reliable and valid as both learners and assessors would be clear about the benchmarks of the quality of the skills that are set as learning outcomes. Obviously, the participants have adopted criterion-based learning in all the units that are now offered in the PBL units continuing students, both as a learning and assessment tool.

Conclusions

The collaborative effort has empowered the designers of the EE PBL programs in matters pertaining to: the nature of language and language learning; oral and written communication in disciplines/across disciplines; student learning styles and strategies and assessment. This was achieved through workshops, guided tutorials and group discussions. The program successfully led to an understanding and appreciation of the difficulties learners who come from different educational background face in adapting to not only the Australian educational system, but also to the PBL approach. Furthermore, given the tight timeframes the PBL program was developed in, the workshops have provided an opportunity to address a few teething problems that would otherwise have been less apparent and could have eventually become compounded. Judging from the practical expertise that the team

demonstrates in handling the PBL unit, the collaborative effort has been worthwhile. The program, supported by the LAC grant from VU, has opened up numerous avenues for future interdisciplinary collaboration. To conclude, as engineering education is undergoing significant changes, incorporating skills that are traditionally not the province of engineering studies, interdisciplinary collaboration appears to be the way forward towards the provision of robust and holistic engineering programs.

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