Digging Holes or Building Wholes? Reflections on Teaching Communications

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Abstract: *This paper describes difficulties of teaching a non-technical subject to engineers, in this case, the 2nd Year Communications Subject in Civil and Environmental Engineering at Monash University in Semester 2, 2002. The subject uses a project and personal development format. The authors extended the choice of project to the students, as well as reinforced the notion of professional communications for particular audiences such as clients, managers and the general public.*

The innovation of allowing students to select a project on the basis of their interests and concerns ensured that the students were engaged in the communication tasks. The personal development tasks also engaged the students – although they found this more challenging. Short term interest in marks made it difficult for some students to engage fully in all tasks.

Some thoughts are included on the challenges for the Professional Practice courses in Program Renewal at RMIT. We contend that, for engineering education to be sustainable students and their learning need to become central; we need to focus on the ideas of professional practice and how students can extract the lessons that they need to learn from the resources around them (including lectures and tutorials) and that problem-based methodologies provide a framework for this change of educational practice.

Keywords: *Teaching Innovations; Engineering Education, Communication skills, Graduate capabilities*

Some History

In 1998, the Department of Civil Engineering at Monash University introduced a new civil engineering program (see Hadgraft & Grundy, 1998, for an overview). This new program included a 4-credit point subject called Communications, CIV2203, in the second year, which was first taught in 1999. (This subject existed under other names from as early as 1986). The scope of the subject included written, oral and graphical communication skills, teamwork and problem solving.

The authors taught this subject in 2002 as external consultants to Monash. (The second author taught it during 1999-2001). This paper includes the authors' reflections on the semester's work, as well as lessons to be learned for Program Renewal at RMIT. The paper draws some general conclusions about how to teach subjects such as this in an engineering curriculum.

Focus of Communications Subject

The focus for the Communications subject in Semester 2, 2002 was on the development of non-technical, professional skills, such as oral, visual and written communications, group-work, time management and problem solving within a Civil or Environmental Engineering context. Also, our intention was for the students to consider and use this course to develop further the type of skills that they needed for their career.

The tasks that were to be completed by students were:

- Develop a career plan, which doubles as a first writing exercise
- Develop a job application for vacation work and attend a mock interview
- Form a team to work on a project of mutual interest, including defining the nature of the problem and the attendant project, a progress report and a final project report, as well as oral presentations, brochure, press release, drawings and a web-site
- Debate the project topic with another group
- Reflect on the groupwork experience
- Maintain and submit a logbook of the semester's work

These tasks are listed in Table 1 in more detail, and divided into individual (personal) and group (project) skills, some spanning both areas. Although all tasks had elements of both project and personal development, the project work tended to be more group based whereas, in the personal development, students rarely asked for direct help from others. That is, students didn't realise that they could get their group members to help them improve their writing, for instance. This is a common and essential skill in the workplace.

Personal Development (individual)	***Project (group based)***
Career Plan	Project Brief – written and oral presentation
Vacation Job Application	Press Release
Mock Interview	Brochure
Choose project – preferably engineering related	
Convince others to join your project/Be convinced by others to join their project	
Working in a group	
Reflection on Groupwork – written	Progress Report – written and oral
Personal Logbook	Research on project
Debating	Sketches – relevant to project
	Final Report – written and oral
	Technical Drawing – 2D and 3D (option of using drawing package)
Create Project Website – *choose design principles* from web site – then *defend web-site design* on basis of design principles.	

Table 1: Assessment Tasks

The subject was designed so that the communications skills were developed through a project and some personal development tasks. These two "threads" merged together through the semester. The students could learn in many dimensions, particularly around the project of interest to the group and how this relates to the profession that they are pursuing – civil or environmental engineering. They were also required to do some personal tasks that helped them focus on their own needs and abilities. Figure 1 portrays this expansion of learning in these dimensions.

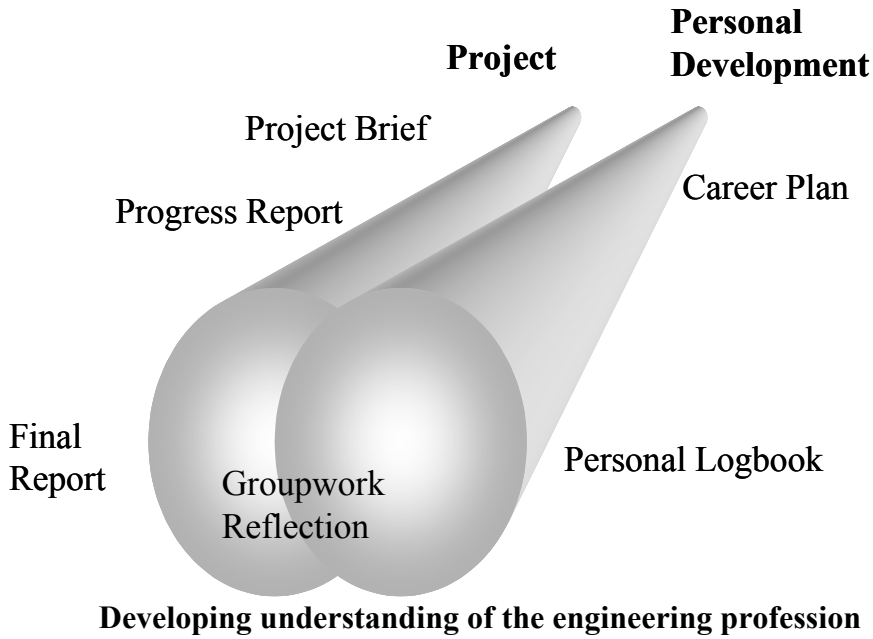

Figure 1: Relationship between tasks and learning over the Semester.

Choosing the Project Topic

In previous instances of this subject, all students attempted the same project, which was assigned to give students some experience of simple design and to allow the generation of some drawings, reports, presentations and teamwork. Previous projects had included student villages and the redesign of the civil engineering teaching spaces to make them more effective learning spaces.

In 2002, the students chose projects based on their own interests and concerns. Our rationale for having students select their own topic was to force students into thinking about and identifying what they really want in their career and in their course. The projects also picked up the objectives of previous instances of this subject - giving students some experience of design and allowing the generation of some drawings, reports, presentations and teamwork

Table 2 lists the projects that were eventually chosen by the students; groups of 2 to 6 students worked together to complete these tasks. This list shows the huge range of interests and concerns of this group of 2nd Year Civil and Environmental Engineering students and the challenge for this subject and the course to keep their interest. All project teams completed all project assessment tasks to a reasonable standard. Some teams produced tangible outcomes outside those requested (for example the Brochure produced by the Environmental Students).

Challenges for Students

Of the tasks listed in Table 1, the most challenging to the students were those in the Personal Development column, as well as, those that span both columns:

- The challenge to students to reflect on their own interests and concerns;
- The relationship between what they needed now and at the same time considering what they would need to develop for their future career was problematic.

At the same time, the Personal Development tasks provided significant breakthroughs in understanding; some students gained a greater understanding of *why* they were doing this engineering course and others understood *why* they should/could be doing another course or going to work!

Brochure – What is Environmental Engineering? For Prospective Students	**The Changing Nature of Engineering**
Survey of Energy Solutions for the Future	Documentary on Engineering
Water quality management and delivery system for a Thai village	Water reticulation for an island in Malaysia
Monorail solutions in Outer Melbourne (1)	Monorail solutions in Outer Melbourne (2)
A traffic management project – Springvale Road	Extended use of CityLink Intelligent Transport System
Noodle Bar at Monash Uni	
Making Melbourne Sustainable	A Sustainable Suburb
Student apartments	A Shopping Centre renovation
World Trade Centre reconstruction	A Hotel Redevelopment
Luna Park Development including Slide	Floating Stadium
Ice Hockey Stadium (1)	Ice Hockey Stadium (2)
Football Stadium Renovation	Building Pyramids Now

Table 2: Project List

Grading

As facilitators of learning (tutors) we discussed saying to students that we would make them all A-grade students if they could justify, in as much detail as possible, why they should be given this extraordinary grade. From Zander & Zander (2000),

> *"grades say little about the work done…….Most would recognise at core that the main purpose of grades is to compare one student against another……..Michelangelo is often quoted as having said that inside every block of stone…dwells a beautiful statue; one need only remove the excess material to reveal the work of art within. If we applied this visionary concept to education, it would be pointless to compare one child to another. Instead, all the energy would be focussed on chipping away at the stone, getting rid of whatever is in the way of each child's developing skills, mastery and self-expression. We call this practice giving an A. It is an enlivening way of approaching people that promises to transform you as well as them……. The practice of giving an A transports your relationships from the world of measurement into the universe of possibility."*

But we decided that the current curriculum and assessment system within which this subject sits did not support this way of viewing learning, so we continued with assessment (gradings and marks) and this became an issue, which we highlight later in this paper.

Some issues with tasks

Choosing a project was problematic for many:
It seems that many students had never been given the opportunity to choose their own focus for their learning. There were concerns about "how big it might be" (either too big or too small) and how complex. There was also difficulty in defining the problem and there was a tendency to choose the solution (eg a monorail) before the problem was identified (inflexible public transport).

Some Asian students in particular found the concept of choosing the "right" project difficult to come to grips with and again Zander (2000) is some help here "In some Asian cultures, a high premium is traditionally put on being right. The teacher is always right, and the best way for students to avoid being wrong is not to say anything at all." Basically, what we were doing by opening up the choice to the students was offering the chance to choose the right (or wrong) project for them – a challenge for students who see the need to be right and expect teachers to make these decisions. But in choosing their career and goals as well as how best to get there, it is not the teacher that makes the choices, but the student. The skill of choosing is essential to living effectively in the world.

Real world practice was seen as too harsh:
Typical industry practice used to categorise job applications is to sort into three groups – those not worth looking at (the BIN category), those that will definitely be short-listed (SHORT-LIST) and those that may be worth looking at further if there are not enough candidates to short-list (RE-CONSIDER). This scheme was used for the students' vacation employment applications and caused great consternation – "you can't do that", "that's not fair" re-sounded around the room. Those applications assessed as in the BIN category were those with no resume, or no letter, or that were unreadable and yet these students could not see that the recipient of such an application would not spare the time and energy to seriously consider it, yet they expected that the tutor would put effort in where they would not.

The reflection tasks:
Both group-work and personal reflection, were difficult and were easily "put-off", particularly with the busy-ness of engineering student life. Our advice at the outset was to document experiences and reflections as the students "went along" in the class (using a logbook) but instead many left this task to the last minute. The evidence of last minute reflection could be seen in very neat notebooks all written with the same pen, in the same format, as well as a high degree of similarity across the reflections.

At the same time there were some huge insights by some students who spent quite some reflective time trying to work through the (long) list of questions – again our advice had been to focus on a few questions that resonate with the student, rather than answering all. Some examples of reflections were - "I don't really know why I'm doing engineering" "I got confidence from giving presentations" " I need to focus more on capturing the audiences attention" "I need to consider more the expectations of the client, the boss and the team when I am communicating" "Debating is more successful when you're prepared, both individually and as a team" "I need to question more" "I need to learn how to compromise and look at

things from other peoples' perspectives" "I realised that there are lots of resources available, particularly for learning drawing skills but I need to take the time to use the resources".

Authoritarian leadership models:
Some students felt that they were better at leadership (and even considered themselves to be better students) than others and this resulted in the disintegration of some groups. Rather than deal with the issues involved and to learn from the experience, it was seen to be easier to separate from the group and find more amenable group members.

Group members were not "pulling their weight":
In the final reflections, group members identified others who were not seen to be "pulling their weight"; we had advised that if this was the case at any stage this should be brought to our attention by not including their name on work handed in or by discussing with us at the time. It is very difficult for us to deal with this in retrospect as each piece of work has been marked as we went along. Our advice was to take it up within the group or with the respective individuals – that is, deal with it, as you would do in the work environment, rather than asking others to deal with the issues.

Lack of collaboration:
Even though in some cases there were similar projects (water; stadiums; "what is engineering?"; projects focussed on sustainability, monorails etc) being attempted, these groups did not see each other as possible resources to be used. Again there was an element of competition for Marks being reflected here, rather than the view that you can draw on all the resources available, as in the workplace.

Impractical designs:
Drawings were presented of a floating stadium that had no means of floatation or propulsion, it had no access on and off, no clear idea of where it would be sited and no emergency procedures etc. When the drawings were returned to the students with a low mark, the reflection of the group centred on the quality of the drawing (it was quite well drawn) not it's relevance as a communication tool. This lack of connection with the reality and intent of the project was apparent in other projects also.

Limited use of resources:
The World Trade Centre group focussed on the material they could find on the web. Like the old joke about "the engineer who looks for his keys under the light because that's where he can see", there was little attempt to go beyond this material that was easily available, to seek alternative sources and after significant discussion the group changed tack and reduced the potential of their project.

Some students and particularly many International students would not use the resources available to them, for example spell-checkers and grammar checkers, or get others to proofread the work before handing it in.

Feedback to Students

As well as the reflection directly between tutors and students, either individually or as groups, a detailed (2 page) feedback sheet was provided to all students at the end of the subject. The key recommendations were:

- **Focus on the long-term goal** (your career) and less on the short-term (marks).

- In future project work, **concentrate on learning new skills** and less on getting a good mark. If you concentrate on learning, the marks look after themselves.
- In future subjects, **form groups with a diversity of perspectives** (gender, nationality, age, personality preferences, etc). Learn to listen to other points of view and to respect conflicting opinions and expectations.
- **Use action plans** to guide the completion of the task. These will need to include both short term (this week) and longer term tasks (the whole project), as well as the requirements of the overall course and your life.
- **Use a problem solving methodology** to guide your thinking that is appropriate for the problem. See "The Learning Centre" for one approach and further reading.
- Learn to use several **decision-making tools** to support your decision-making needs.
- **Become an autonomous learner**! Make good use of all the resources around you, including the textbook - Anderson (1999). An effective Internet connection at home will be invaluable during your studies.

Challenges for Staff

Assessment:
The amount of material from around 110 students doing around 20 tasks was large and highly varied in quality. The skill level of the students across the range of tasks was also varied.

There was a commitment to do a good job – to enhance the students' learning in this subject by providing constructive feedback – but at the same time, there was recognition of a limited budget of hours and money and also that for the students this subject was only one among many.

Tutors took the role of the client:
In order to make the tasks as contextually relevant as possible, we attempted to act as per the particular audiences - clients, managers or the general public. We therefore asked questions from the particular audience' perspective and expected to see the material developed with the particular audience clearly in mind.

Large class sizes:
The total number of students was around 110; this meant 4 class sizes of around 26-28. As a result, there was not always time to deal with all the issues that came up and, as a result, we tried to focus on the most important issues (for learning) not necessarily those that were considered by the students as the most pressing/urgent (usually around marks).

Designing the course as we went along:
As we got to know the student groups and where they were up to, we modified the design of the face-to-face sessions and the nature of the tasks to be undertaken. Sometimes this meant that there was different communication to the different groups, which caused great consternation and a flow of e-mails to occur. There was a tendency by students to expect us to be always "on-top" of these issues; our philosophy was that this is often the situation in a work environment where there are different expectations and people (especially the boss or the client) change their minds, and that there is a responsibility on all sides to work through the issues. Learning can occur by dialogue, articulating both intent and expectations, it then becomes easier to understand the many aspects of "why" including both those of the

facilitator and learner – though sometimes it can be difficult to distinguish who is performing which function.

Program Renewal at RMIT

In 2002, the Faculty of Engineering launched its Program Renewal project, to create new programs based around graduate capabilities (eg the IEAust accreditation requirements: IEAust, 1999; also ASCE, 2002). In the current plans, each degree program will include a spine of *professional practice* courses, one per semester. The communications course described above would be typical of what might be taught in either first or second year. What are the lessons to be learned?

The overwhelming impression from teaching CIV2203 and also ENG1601, Engineering Context, in semester 1, 2002, is that, for many students, everything comes down to marks (the short term). "How much is this worth?" is the typical students' response. The semester becomes a sequence of assignments ticked off, but not much real learning happening in many cases. Students failed to grasp the opportunity for:

- New learning (often just sticking to things they're already good at). There was little use made of the wealth of resources at their fingertips (textbook and websites for example).
- Forming groups with non-friends (although random assignment of pairs was used to create some diversity).
- Organisation of group and individual effort (little formal use of action plans or logbooks).
- Formalised problem solving and decision making (these were usually ad hoc).
- Autonomous learning!

The authors believe that fixed agendas with carefully segmented assessment plans lead students to drop into automatic mode, rather than really engaging in the task. Someone else has already decided what is important for each student to learn! The second author has had some success in a fourth year elective in which students worked independently on projects, within a collaborative environment to learn AutoCAD (Hadgraft, 1997). Can this be translated into first and second years with larger, more diverse classes?

Conclusion

Teaching non-technical subjects in an engineering degree is always challenging. Students often see them as a "bludge" or "Mickey Mouse", yet the skills being taught are neither easy to master, nor widespread within the student community. These same skills will be the underpinning of their professional practice throughout their working lives.

It is clear that there is a wide range of capabilities for each skill within the class, together with large numbers in each class. This makes each topic difficult to teach, because many students fail to recognise that they lack the skill (unconsciously incompetent) or they are restless while we cover what they see as secondary school material. It is also clear that marks are a major blocker to *student learning* in non-technical subjects; by focussing on "what is this task worth?" and "what marks do I need to pass?" students are failing to realise their learning potential.

We believe that in technical subjects also, the student' and lecturer' focus on marks-based assessment schemes drives many students' engagement in the course to be "in automatic mode" rather than truly engaging. There is this sense in traditional lecturing that by the student being technically correct, in a fairly narrow way, (e.g. by being able to do the problem set and to get good marks in the exam) that *something will happen* that will allow them to successfully practice in the workplace. In the workplace people expect engineers to practice a whole range of non-technical skills as well as being proficient technically, as well as being able to handle novel situations and problems professionally. Is this not what an engineering degree is or should be preparing students for?

Further some non-technical skills are applied across the technical subjects such as report writing and presentations; these are core also in engineering practice. There is a need for consistent *professional* practices, standards and formats across an academic department for:

- Teams
- Reports
- Presentations
- Use of logbooks or journals
- Explicit problem solving and decision making processes
- Assessment of learning

Students need to see themselves moving from satisfying the teacher (marks) to building their own engineering skills. The development of autonomous learning skills is a key ingredient in this process. To achieve this, a mindset change is necessary. This is difficult in the current situation where a focus on content delivered through lectures turns even active students into passive followers. Substantial changes to teaching practice are necessary if students are to develop themselves to their full potential. Examples of active learning, such as Olin College in the USA, give us hope (Sanoff, 2003).

Returning to the title of the paper, our aim as educators should be to develop whole engineers, not just to dig a number of discipline holes that students fail to connect in their minds. We may be able to make this shift through the subjects of the type described here (Communications for Civil and Environmental Engineers) but then students will need to shift into a different mode for the discipline-based/technical subjects. Some students may be capable of shifting mode but our aim should be to shift all students as quickly as possible to autonomous learners.

On the other hand there may be a case to make a complete shift to problem-based learning methods. A paper (Emery, 1993, pp172 – 175) reflecting on organisational design argues that there is no half-way house in moving from autocracy (where someone outside the work-group – the supervisor, decides what is important) to democratic work groups. Emery shows that the critical thing for democratisation of the workplace is that those that contribute to group performance make the decisions about how they co-ordinate their work; not some supervisor. From our experience, this appears to be relevant to education also - that there is no half-way house between lecturer delivered and autonomous learning. This assertion needs to be validated.

Students and their learning need to become central to engineering education and when we do this we need to focus on the ideas of professional practice and how students can extract the lessons that they need to learn from the resources around them (including lectures and tutorials).

We believe a *more sustainable solution to developing whole engineers* is to shift to using problem-based learning methodology as the core concept. Problem-based learning shifts the *focus of learning* from revealing the types of lessons learned by previous engineers to the students *extracting the lessons they need to learn* for their current and future professional practice.

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