Integrating Communication Skills in a Telecommunication Engineering Course

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ABSTRACT
This paper describes how written and oral communication skills have been integrated into a unit of a Telecommunication Engineering course. The principle aim of the unit is to develop the students lifelong learning skills in Telecommunication Engineering. To make the unit interesting and relevant, it is based around the topical theme of digital mobile telephone systems. Students, working in pairs, research one aspect of the mobile phone system. Classes on the use of the Internet and the library are also based around this theme. Students present talks and prepare posters on their topics. These written and oral communication tasks are included, not as an end in themselves, but as an effective way of encouraging the students to develop lifelong learning skills including the ability to extract the key points from the mass of technical information which they have gathered.

INTRODUCTION

A Communication Engineering Stream has recently been introduced to the undergraduate Electronic Engineering degree at La Trobe University. Communication Engineering is a vast and rapidly changing subject. It is therefore possible for students to learn, during their undergraduate course, only a small part of the information which may be important to them in their careers as Communication engineers.

In designing the course we tried to avoid overloading the students. Course overload in engineering courses in Australia has been identified in a number of important publications as a major issue. For example the results of the Course Experience Questionnaire [1] published by the Graduate Careers Council of Australia indicate that engineering graduates believe their courses were overloaded. A similar message comes from the Review of Engineering Education status report [2]:

> A number of strong messages about educational programs have come from the engineering students. Courses are overloaded, there is a widespread lack of interest by academics in teaching and learning and the "big picture" is missing. Increased flexibility is sought in terms of entry and progression paths. Much of the content of courses lacks relevance to workplace engineering.

To avoid overloading the new stream with content, it was decided that no attempt would be made to 'cover' the whole field of telecommunications. Instead the course would be designed with two main aims: to give students technical expertise in the areas which are most likely to be useful to them on graduation, and to develop their lifelong learning skills so that they had the skills required to learn, when necessary, about topics not covered in the course and to keep abreast of new developments.

The authors were also keen to include some of the skills and knowledge which would have helped them in their work as new graduates in industry but which are not

normally formally taught in engineering courses. These include awareness of informal sources of information, knowledge of the range of engineering literature and of the range of journals from overview to research, ability and persistence in asking questions.

As part of the new Communication Engineering Stream a new unit called "Technical Research for Communication Engineers" has been developed which has been specifically designed to develop the students lifelong learning skills. The rest of the paper describes how this unit was designed and our experience in running it in 1995 and 1996.

LIFELONG LEARNING SKILLS

Keeping up-to-date in a fast changing discipline such as Communications Engineering is difficult and has at least two aspects: the ability to locate and understand information on a specific subject as required for a particular project, and the ability to skim a vast volume of information and extract and remember the key points for later use. During the development of the course, we informally surveyed a number of academics and engineers about the ways in which they kept up-to-date and the sources of information they found most useful in their speciality. A wide range of responses were obtained. For those involved with computers, networks and software, computer newsgroups were an important source of information. A researcher in the bioengineering field gained most information from attending conferences. A management lecturer kept up-to-date in aspects of management by attending some workshops and reading books. Technical information supplied by manufacturers was a major source of information to some.

Some of the skills required for lifelong learning in telecommunication engineering which we have identified are:

- <u>knowledge of sources of technical information</u>
  - technical journals (overview and research)
  - books
  - information supplied by manufacturers including data sheets
  - world wide web
  - conferences, talks
  - conversations with colleagues
  - company training documents
- <u>ability to extract and understand relevant facts from a large volume of information</u>
  - identify most relevant, easy to understand sources
  - understand relevant information to the depth required for the task in hand
  - extract key points
  - fit new information into a 'big picture'

The ability to extract and understand relevant information is an iterative process in which literature is repeatedly reviewed with increasing understanding. Often students get bogged down in a mass of theoretical papers where the more experienced engineer starts by trying to find a review article in a more general publication and consults research papers only when it is necessary to clarify a technical detail.

INTEGRATION OF TALK AND POSTER IN COURSE

The principle aim of the new unit is to develop the students lifelong learning skills in telecommunication engineering. It is well known that students are to a large extent assessment driven. For example, in a keynote address on a conference on student assessment John Fyfield [3] said:

> But one of the most powerful of all factors relates to the assessment regime in the subject. Students perception of what is expected of them when they are being assessed has a strong - in many cases determining - influence on their approach to learning in the subject.

To ensure that the course met our aims, we had to design an assessment regime which measured the students achievement in skills associated with life-long learning.

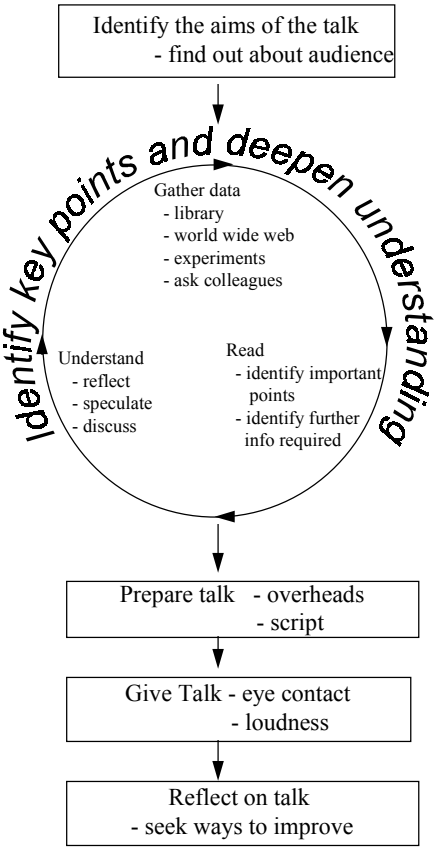

Figure 1. A model of the steps in preparing and presenting a talk

A simple model of the steps in preparing and presenting a talk on a technical topic is given in Figure 1. A large part of the preparation for a talk is an iterative process involving gathering, reading and understanding relevant technical information. These are the skills which we identified as being central to lifelong learning. Thus by using a talk as part of the assessment process, we are assessing the students on the skills which we wish them to develop. We also think that the students in general tried much harder to develop a deep understanding of their subject than they would have done if

the assessment had been as an examination or as a report. This was because they wanted to be able to give good talks and to be able to answer questions with confidence.

The steps in preparing for a talk are very similar to the steps in many other tasks required of an engineer. For example the engineering design process is very similar, with the first step 'identifying the aims of the talk' being replaced by 'identifying a need' and 'building prototypes' being added to the iterative cycle. The final steps would then become 'manufacture product' and 'sell product' rather than 'prepare talk'.

The new unit gives the students experience in many of the skills required of practising engineers. In contrast, many conventional engineering courses only require students to understand a fixed body of information (the lecture notes) in a fairly superficial way.

DESIGN OF THE TECHNICAL RESEARCH UNIT

Background

The Bachelor of Electronic Engineering course at La Trobe is structured with the first two years fixed and taken by all students. In third and fourth year, students choose a speciality. Currently four specialities are offered: Communication Engineering, Biomedical Engineering, Electronic Systems Engineering and Optical Engineering. There are three specialist units in third year, and two in final year for each stream. As well, there are as a number of subjects shared by the streams in third and fourth year. The specialist units have nominally 24 lectures. Third year units also have a component of laboratory work. Students also complete a major final year project on a topic associated with their speciality.

The unit Technical Research for Communications Engineers runs in the first semester of third year. There are no Communication Engineering subjects in first and second year. 'Introduction to Communications', which is taken by students in all four specialities, and covers subjects such as modulation, also runs in first semester.

The students taking the Technical Research unit, therefore have very little prior knowledge of Telecommunications. In many ways this has been an advantage. The students are forced to extract the information they require for their assignments from technical papers which they do not completely understand. They develop the skill of understanding information only to the level required, of extracting what is necessary and ignoring what is not: an essential skill in a field which is large and rapidly changing. They also develop confidence in their ability to take on a project in a technical area in which they have little formal training, to gain the necessary information through their own researches, and to complete a task using this information.

In the second semester of third year, students begin a literature search and develop a project plan for their final year project. With the Technical Research unit running in first semester, the students are able to apply the skills, which they have acquired, to

these later tasks. Students who have taken the unit produce very markedly better literature surveys than those who have not.

The unit has now been run twice, once in 1995 and once in 1996. Some minor adjustments were made to the course in 1996 in response to student feedback.

Introductory Lectures

The unit begins with a number of introductory lectures. The first explains the rationale and structure of the unit. A typical engineering undergraduate course requires students to master a very well defined amount of information. In contrast, a typical task for an engineer is much more open-ended. It requires him, or her, to identify what information is required to solve a task, find the information, work out what is, and what is not relevant, understand in the most efficient way, to a level required to solve the current problem, the material which is relevant. It is explained that the unit more closely resembled the task of an engineer, than a typical lecture course.

The next few lectures outline the fixed and mobile telephone networks. These are intended to give the students a framework which will enable them to research their particular topic. It also forms a common background so that students did not have to repeat basic information in their talks. Topics include the basic concept of cellular phones, signalling, switching, traffic, time-division-multiplexing, numbering systems. An overview, rather than a deeply theoretical approach is taken. Some students are uncomfortable with this approach as they are more used to lectures as a basis for later written examinations and are concerned about not noting down every detail.

A later lecture is devoted to telling the students about some of the information sources that are useful in Telecommunications. The range of literature in Telecommunications from overview to deeply technical is outlined. Examples of each type are given. A list of relevant international and Australian journals is provided. Some of the lecture is devoted to things which the authors would have found useful but had not been taught: the importance of making and maintaining contacts in many forms, speaking to people, attending product launches, putting your name on mailing lists. A range of technical literature is made available for students to browse through.

Internet Exercises

Students are introduced to the Internet. They use Netscape software to access World Wide Web information. The first Internet exercise involves a number of simple tasks intended to familiarise the students with the Net and Netscape. While most of the students were very enthusiastic about this introduction, students who had previous experience of the Web found it ‘boring’ or a ‘waste of time’. In future years this class may be made optional.

A second exercise is more closely related to the research topics. Each student is allocated a World Wide Web site and newsgroup related to communications. As many as possible are chosen to have information on mobile phones, but in order to find enough to give each student a different site and newsgroup, some had to be included which were related to communications but not to mobile phones. The directory of telecom information resources available on the Internet, produced by the University of Michigan has been used to find sites suitable for this exercise.

Students have to produce short, one page summaries of the information on their site and in the newsgroup. This, like all the other written work which the students do, is required to be quite brief. This forces the students to identify what is important, rather than just copy large slabs of information. It is also intended to limit the workload to a reasonable level. However a few students did not understand the concept of a summary and instead simply gathered a number of excerpts. In future years more precise instructions and an example will be given. It is interesting to note how dramatically the volume of useful information has increased between 1995 and 1996. In 1995 the use of the World Wide Web was an interesting sideline, whereas by 1996 it has become the most useful source of information on some of the research topics.

Research Topics

Students were asked to arrange to work with a partner of their choice, and choose a research topic from the list shown in Table 1. Most of the rest of the unit was based around their research topic. In 1995 a few students for various reasons, chose to work alone, but in general this was a less successful arrangement and in 1996 all the students worked in pairs.

Speech coding for GSM mobile phones
Error correcting codes for GSM mobile phones and interleaving
Encryption
Frame format
GSM modulation format
Channel allocation
Antenna design for cars
Electromagnetic interference and biological effects
Propagation in the mobile phone system
Cell size and shape
User-network signalling in the mobile phone system - outgoing calls
User-network signalling in the mobile phone system - incoming calls
Handover (handoff)
Traffic
Data transmission over the mobile phone system - fax transmission
Data transmission over the mobile phone system - short messaging system
Data transmission over the mobile phone system - connection to the Internet
Authentication of mobile phones
SIM cards for GSM mobile phones
Comparison of spectral efficiency of the AMPS and GSM mobile phone systems
Comparison of spectral efficiency of the GSM and CDMA mobile phone systems
GSM network components and integration with the PSTN

Table 1. Research Topics Offered

Library Class and Exercise

The students attend a library class which lasts for two hours and is given by a member of the library staff. The class covers fairly conventional topics such as how books are catalogued, the use of Library of Congress headings, how to find a book in the library,

the use of CDROM indexes and the use of Current Contents. The class is made particularly interesting and relevant to the students, as all the examples given are related to mobile phones. For example the Library of Congress headings related to mobile phones are found. The library catalogue is searched for books related to the mobile phone system.

The students are later given an exercise to do in their own time, which required them to apply the knowledge they have gained in the library class to their own research topic. This both reinforces the information given in the class and forms a significant first stage to the research required for the rest of the course.

Minor improvements will be made to the library exercise for 1997. Some students did not give references in a standard form and this will be required in future. Some students managed to complete the library exercise without finding any useful information for their project because they did not look for any review type articles and only searched over a single year.

Talks

Each student is required to give a talk on their research topic. In 1995 the talks lasted for eight minutes, but many students felt this was too short and in 1996 the time was extended to ten minutes. In 1996 only one student commented that the time allocated was too short. The class is divided into two with one member of each pair in each group. Students are only required to attend the talks for their group. Members of a pair are given the choice of using the same or different overhead transparencies. Students are taught how to use Powerpoint software to produce high quality overheads.

Staff members are available for consultation at a number of fixed times. Two weeks after the students begin their projects, a number of very useful information sources are made available to the class which are not available through normal library sources, such as communication companies internal training documents. A number of students, through their own contacts have added to this resource.

Because the topics are closely related, students are keenly interested in each others presentations. Students are required to fill in assessment sheets for at least two other students. This both provides the student giving the talk with some feedback on performance and forces the students in the audience to analyse what is good and bad about the presentations of other students.

At a later session devoted to a ‘post mortem’ on the talks, students are asked to fill in an assessment sheet. This time instead of evaluating the performance of others, they are required to assess themselves. They are not required to show their self assessment to anyone. They are then given the assessments made by others of their talks and are given time to consider to what extent this agrees with their self assessment. This is followed by a discussion about what were the best aspects of talks and which were the best overheads and why.

The students are very positive about having to give talks. Typical comments on the evaluation sheets are that they would like more practice in giving talks, that they have

gained confidence and that they have learned more than they would have in a conventional lecture course.

We however found assessing the talks one of the more difficult aspects of the course. It is impossible to give anything other than a subjective assessment. It is difficult in commenting on the talks to correct faults without sounding too negative and so risk reducing the students' self confidence. The students seemed to want to gain high marks in this topic much more than in a conventional examination and feel more personally hurt by anything less than totally positive comments.

Some students who are very good at conventional examinations did relatively poorly on this exercise - they failed to realise the importance of extracting key points and felt that presenting a mass of technically correct information should have earned a high score.

Poster Session

Rather than require the students to produce a written report on their researches, each pair is required to produce an A3 sized poster. A poster session is held, to which staff of the school and students from the second year of the course are invited. Because of the very limited amount of information that can be included, the students are forced to identify the key aspects and present them in a concise way. As they work in pairs, this requires considerable negotiation between partners. The poster sessions have been very lively with genuine interest being shown by staff and by students. Most students enjoyed doing the poster, and there were many comments like 'fun' and 'interesting' on their feedback forms.

A3 size was chosen for the poster as it allows the posters to be photocopied readily. However larger posters would have more visual impact and would allow students more flexibility in presentation.

The poster session is held one or two weeks after the student talks. Many of the students learn by the mistakes made in their talks. They correct technical errors and are more careful in selecting the key points.

Assessment

The weighting of the various components of assessment in 1996 is listed in Table 2. In 1995 students were required to keep logbooks and these were assessed. The use of logbooks was the least successful aspect of the course in 1995 and this was dropped in 1996. Students are also required to go on excursion related to the course in second semester but this is assessed separately.

Computer exercise and laboratories	15%
Library Class and exercises	25%
Contribution to class discussion	5%
Oral presentation on research topic	30%
Poster presentation on research topic	25%

Table 2 Weighting of Components of assessment

A small weighting was given to contribution to class discussions, to encourage students to attend the problem solving sessions and show interest in other students' talks.

Excursion

In second semester of 1995 the class was taken on an excursion to the communications centre of the Melbourne based, Silver Top taxi company. This showed an interesting and practical application of mobile communications. Silver Top sponsored the excursion by providing taxis to take the students to and from the centre. The students were able to see how voice and data radio communications were used in each taxi and how a Global Positioning System (GPS) in each taxi located the taxi's position and relayed this through the radio to the communication centre. At the communications centre they could see how telephone, radio, networked personal computers and the GPS were all integrated to give a state-of-the-art system. A representative of the Melbourne based electronic company, Raywood was available to answer technical questions while Silver Top staff explain more commercial aspects. The students found both the technical and commercial aspects very interesting, in particular they found the commercial information reinforced the management subjects within the engineering course.

CONCLUSIONS

Overall the unit has run very successfully for two years. The students are enthusiastic about the written and oral communication tasks which are required in the unit. This is probably because these tasks are integrated into the unit and the students can see the relevance of the skills they gain to a career as a Telecommunications Engineer. Digital mobile telephony is a particularly good theme as it is clearly an important and topical area in Telecommunications and it is easy to use as the basis of a number of different but closely related research topics. Another possible theme which is also topical and which has a number of possible facets is ‘video to the home’. This may be used in future years.

In future the course could be improved by involving experts in written and oral communication. Some of the students are more skilled than us in the art of producing posters. We are not able to give guidance on layout and the use of colour. We also believe that the instruction on giving oral presentations could be improved and we welcome suggestions on how to give useful feedback on student talks which does not unduly discourage the students.

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