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ABSTRACT: There have been a number of recent state and national reports noting the reduction in the numbers and calibre of students seeking to enter engineering education. Contributing reasons identified for this include the poor image of the profession generally, and that engineering is poorly understood in schools. The recent review of science and technology in primary schools identifies that primary school science and technology education needs to be improved, and that technology education is given significantly less time than science education in primary schools. It is clear that there are no short-term solutions to increase the number and calibre of engineering undergraduates. Improvements will only come when the community at large is better informed about the nature of engineering, and values more highly the contributions of the profession. This paper reports on a state-wide, Victorian engineering awareness competition organised by the Geelong Group of the IEAust in 1996. The results of the awareness competition are presented and its effectiveness is evaluated. Further consideration is given to factors contributing to career choice and the time at which students begin making this decision.

INTRODUCTION

There have been a number of recent state and national reports addressing various issues related to engineering education and the number of students electing to undertake engineering studies [1, 2, 3 and 4]. These reports identify concerns regarding the number and calibre of students selecting tertiary studies in engineering. This paper explores some of those concerns, identifies factors influencing students’ selection of study and career options, and reports on a state-wide engineering awareness campaign undertaken by the Geelong Group of the Institution of Engineers, Australia (IEAust) in 1996. This paper deals only with student participation in engineering generally: it does not specifically address issues related to the under-representation of women, Koories and other groups in the engineering student population.

STUDENT PARTICIPATION IN ENGINEERING


- while applications for undergraduate studies in engineering have fallen, this decrease has been in line with general demographic changes;
- mature-age participation in engineering programs has declined over the past three years;
- postgraduate numbers in engineering have declined significantly, despite overall postgraduate numbers increasing;
- demand for TAFE engineering programs has declined; and
- female participation has remained static over the last six years.

Webster [5] reporting on the ‘Engineering Education Futures Conference’, held in 1995, summarises the comments of participants relating to undergraduate engineering education in Australia as follows:

- there is a perception that entry standards are falling;
- students are entering engineering with a lack of mathematical and communication skills;
- while good students are still attracted to engineering, they are primarily interested in double degrees only; and
- while intake numbers have not fallen dramatically, progression and attrition rates are nearing crisis levels.
Many reasons for the decline in both the interest in engineering studies and the entry standards of students have been suggested, including the following:

- the relatively poor image of careers in science and engineering, and their rewards, compared to courses such as commerce and law [4];
- engineering no longer reflects community values and goals [5];
- the narrow and inaccurate picture of engineers prevalent in the community [6];
- the lack of attractiveness to senior secondary students of basic science, engineering and technology subjects, on which entry into engineering relies [4]; and
- the limited background of primary school teachers in mathematics and science, leading to difficulties for teachers in generating enthusiasm and high levels of skills in students in these areas [2].

In [2] it is reported that graduate employment surveys show significant numbers of engineering graduates still seeking employment six months after completing their studies, suggesting that there is an adequate supply of engineers for the current labour market. However, the same report goes on to identify unemployment data showing almost full employment of engineers, suggesting limited capacity for expansion of economic activity in areas that rely on engineering expertise.

The same report provides another perspective on the number of engineers required in Australia. Of all university degrees awarded in OECD countries, the country mean for engineering degrees is 13.2%, with some countries exceeding 20%. Australia ranks second last, with engineering degrees accounting for 5.1% of all university degrees awarded. While finding some comfort in the indicators suggesting an adequate supply of engineers for current labour market requirements, the report found that the patterns in the OECD data “raise serious questions about relative emphasis in comparison to other OECD countries”.

One factor of crucial importance here is that many people who qualify with an engineering degree do not remain in roles that would traditionally be described as engineering. An engineering degree is a valuable qualification that can attract people into a diverse array of careers. To assess the future need for engineering graduates solely on the basis of traditional labour market definitions of engineering is unnecessarily limiting. These points are highlighted in [7].

If the current perception of the role of the engineer can be expanded, there is no reason why the numbers of students studying engineering cannot be increased, perhaps substantially. For this to be achieved, however, the number of students desiring to undertake engineering studies also needs to be increased, as does the match between student capabilities and engineering entrance requirements. There is no point in tertiary institutions competing even more fiercely for the same student pool in a zero-sum game. The attractiveness and attainability of an engineering degree needs to be enhanced.

Knowledge about career options translates into desire to explore these options and informed decision-making. [8]

Even when young, children exhibit consistency in occupational aspirations (that is, their first and second choice of desired occupation will be related). Children often aspire to jobs held by someone they know intimately, rather than simply jobs with which they are acquainted. Personal interests play a major role in both the selection and rejection of occupations. [9]

There is a strong correlation between the existence of extra-curricular activities (science clubs, competitions, support of local parents and engineers, etc) and the success of schools in sending students to study engineering or physical sciences. Science teachers’ perceptions of the most important factors encouraging students into engineering and science include good science teaching, involvement in extra-curricular activities, nature of the science subject (practical, problem-solving), and good careers advice. Their perceptions of the factors discouraging students from engineering and science include; low salaries, the academic difficulty of the subject and low professional status. [10]

School is just as important a factor as family and social background in career choice. Students are required at an early age to make decisions about selecting subjects that they will study leading up to school-leaving certificates. These decisions have a direct and important influence on later occupational choices. Students who have pursued their favourite school subjects may later find that these are now inappropriate for the course they wish to follow. [11]

The governing factors appear to be negative; that is, students pursue science subjects because they dislike social studies and the arts, rather than because of a passion for chemistry. Forced to make important decisions about subject streams at an early age, students are pushed along a shrinking pipe of narrowing career options. [12]
The sources of information listed by senior high school students as ‘very helpful’ in making career plans included; work experience, family and career counsellors. [13]

It is obvious that career choice is a complex process, dependent on many factors. Some students well qualified to undertake engineering will consciously elect not to, and other students well suited and motivated to undertake engineering will find they are unable to do so, because of the path of their studies through secondary school. This second point is perhaps a strong argument for opening up study entry requirements to students who are, on paper, less qualified for engineering, but highly motivated to succeed.

The narrow and inaccurate picture of engineers prevalent in the community can and must be addressed. The relative invisibility of the profession needs to be countered by the dissemination of information. There is no doubt that this will require a long-term and ongoing effort.

Relevant careers guidance, outstanding science teaching and opportunities for work experience are important, but if secondary students have not made informed decisions about subject choices prior to their final years of study, then the option of engineering studies may be closed to them. There will be some upper secondary students who have the appropriate academic background and who have not made up their mind on the type of further studies they wish to pursue, so information targeted at this group will be helpful. To reach the other students who might make successful engineers, information about the profession and the appropriate study paths should be provided in the lower secondary years, and general information about the profession is required in the primary school years.

Family, personal interest and general societal influences come into play on students long before they reach high school. A poor general understanding of the profession and primary teachers ill-equipped to present science and technology mean that many students will develop no understanding of engineering at all in these formative school years, or if they do, it may be an inaccurate picture. Primary school students who are ‘turned off’, or worse, never given an opportunity to be ‘turned on’ to engineering and technology are unlikely to pursue the most appropriate path of secondary studies, or be swayed by later promotional activity.

The 1997 report by the Australian Science, Technology and Engineering Council (ASTEC), ‘Science and Technology in Primary Schools’ [3], notes that while the prominence of both science and technology curricula in primary schools is low, the problem for technology education is compounded because the status of technology education is then low compared to that of science. The report notes that, until recently, there has been no inclusion of technology education in the national curriculum, and, as a result of this, many school principals and teachers do not understand what technology education encompasses and how it relates to and differs from science education.

The development by the Victoria Division of the IEAust of the ‘Teachers Resource Handbook’ is an outstanding contribution to technology education in primary schools. This publication targets the upper years of the Victorian Curriculum and Standards Framework (CSF) and provides teachers with a structure and the background information to confidently introduce engineering and technology into the classroom. While designed for Victoria, the content has general applicability. The entire package may be downloaded from the IEAust national Web site at: http://www.ieaust.org.au/educn/trh/teach0-Home.htm

THE ENGINEERING AWARENESS COMPETITION

In 1995, the Geelong Group of the IEAust hosted the Victoria Division Country Convention, which made an operating surplus. In 1996 it was decided to use these funds to support a state-wide engineering awareness competition targeting school students. The competition involved students preparing either a poster documenting their understanding of engineering (primary school students), or a model embodying an engineering principle (secondary school students). Prizes on offer consisted of book vouchers for both the winning students and their schools.
Information about the competition and entry details were sent to all of the approximately 2200 schools listed by the Victorian Directorate of School Education. Close to 700 entries were received, of which 664 came from primary schools. Figure 4 below shows the breakup of primary school entries by year level of the entrant.

Apart from the funding supplied by the IAE Aust Geelong Group, additional funding for prizes was provided by the IAE Aust Victoria Division, Deakin University School of Engineering and Technology, Melbourne Co-operative Bookshop, Geelong & Bellarine Books, and Deakin University Equity & Equal Opportunity Office. To encourage female student participation, funding was sought from the last listed sponsor to permit the inclusion of an additional line of prizes available only to female students. It is unknown if this initiative contributed to participation of female entrants, but, as shown in figure 5 below, the level of female student participation was almost 50%.

Given that the competition was organised by volunteers, the limited finds available and that only one promotional mailing was possible, the competition was considered very successful in engaging a large number of primary school students with the idea of engineering. It is unknown at this point whether this activity will translate directly into a better understanding of engineering by school students and by the wider community in general, but such activities must contribute in some manner to raising the general level of awareness of the profession.

A wide variety of entries was received (some reproduced here in this paper). This variety extended to physical construction, images portrayed, demonstrated understanding of engineering, the technology disciplines presented, the representation of engineers as people, etc. It is felt that the collection of 664 entries represents a valuable insight into the perceptions of engineering held by primary school students. Colleagues from Deakin’s School of Psychology were keen to undertake an in-depth analysis of the collection, but to date, no source of funding for this project has been secured.

Only five entries where received state-wide in the secondary school division of the competition, and these were all projects that students were already working on as part of their VCE common assessment tasks (CATs) in technology. It was clear from speaking to students and teachers that the general secondary curriculum is far more defined and rigid than the primary curriculum, making it significantly more difficult to introduce extra content and activities.

In 1997 a second state-wide engineering awareness competition was held, but due to the need for commercial sponsorship, the prizes on offer and the structure of the competition varied significantly from the original competition. It is interesting to note that, even with these differences, approximately the same numbers of entries were received from primary and secondary schools respectively. It seems that primary schools have a clear interest and ability to participate in engineering activities. This represents an opportunity for the profession to contribute to the development of an accurate and positive understanding of engineering that will accrue benefits in the longer term.

The ability to achieve the same level of engagement at the secondary school level appears more problematic. The more prescriptive and fully-laden general secondary curriculum leaves less opportunity for extra-curricula activities. Further consultation with secondary science and technology teachers is required to explore ways of integrating the exploration of engineering into the standard curriculum.

CONCLUSION

While engineering undergraduate numbers have declined in proportion to general demographic changes, mature-age, postgraduate and TAFE participation have declined significantly, and female participation has not improved in
There is a perception that entry standards into conventional undergraduate programs are falling. Reasons for these occurrences include: the poor image of careers in engineering; the narrow and inaccurate picture of engineers prevalent in the community; the unattractiveness of basic science and technology subjects in secondary school; and the limited background in science and technology held by a majority of primary school teachers.

The choice of career and tertiary studies is a complex issue dependent on many factors, but it is clear that the desire and ability to pursue a particular career path is determined at an early age. Lack of exposure to information, or inaccurate information, about engineering can lead to students pursuing a subject stream that precludes them from entering engineering studies. The importance of education about engineering and technology at primary school has been identified in several recent reports.

The Geelong Group of the IEAust organised a state-wide engineering awareness competition that was successful in engaging a large number of Victorian primary school students with the idea of engineering as a profession. Effectively reaching large numbers of secondary school students has continued to be problematic due to the more rigid and full curriculum.

REFERENCES