

Programmes for developing soft skills in Engineering students

C G Knobbs, E W Gerryts and W D Roodt

Department of Mining Engineering, University of Pretoria.

Clive.Knobbs@up.ac.za; Erna.Gerryts@up.ac.za; Diederick.Roodt@up.ac.za

The workplace can be an unforgiving environment when requirements for assimilation and success as seen by employers are not fully met by the knowledge and skills that young graduates bring to the company. In the mining industry young graduates enter the workplace sated with technical knowledge but often ill prepared for the hostile, foreboding and somewhat chaotic world of work where their highly-prized and hard-fought knowledge is not fully used or given the respect that graduates expect. Apart from little practical experience graduates lack soft skills acumen and the ability to deal with the people issues that crop up frequently in the workplace (often referred to as non-technical skills). The absence or poor development of these skills (gap or deficiency) on entering the workplace has been clearly identified by industry and graduates alike and has been the subject of numerous papers and publications over many years. Fortunately certain vital skills in the gap such as communications and working effectively in groups can be taught. This paper describes initiatives designed to impart useful skills to senior undergraduates in the department of mining engineering at the University of Pretoria.

The model of ‘knowing – doing – being’ was used to inform the various programmes and interventions. Psychometric assessments were administered to help with addressing the dictum of ‘know thyself’. Personal development programmes were generated from these assessments. One programme concentrates on group work embedded in a particular final year technical course while another concentrates more on communications in a mentoring situation. There are a number of leadership spin-offs from both these initiatives. The efficacy of these programmes is tested by way of questionnaires. In spite of some logistical problems the programmes show promising trends in learning particular soft/non-technical skills.

Keywords: soft skills, deficiencies, gap, communications, group-work, leadership, engineering undergraduate education, non-technical skills

1. INTRODUCTION

Many engineering graduates suffer from an inability to communicate and work effectively in groups. The lack of these two soft skills, the so-called ‘gap’ or ‘deficiency’ problem, has been recognised for many years by employer and graduate alike. These gaps have been exposed in the many surveys that have been conducted.

Male, Bush and Chapman (2010) refer to a “skills gap” when comparing what employees want from graduates with what graduates bring to the work place. They identify in their survey that the soft skills missing in undergraduate education are communications, self-management, attitude, problem solving and teamwork. Nair, Patil and Mertova (2009) confirm earlier studies and showed that communications and interpersonal skills were the two most significant deficiencies in graduates.

Baytiyeh & Naja (2012) surveyed Lebanese practicing engineers around the world asking them to identify the challenging factors in moving from student to employee. Factor analysis revealed that communications, responsibility and self-confidence were the three main challenges that graduates face when entering the workplace. Furthermore they maintain that students are oblivious to the changes that occur when moving into the real world of work and that this phenomenon is not that clearly understood and requires more research effort. Further

alumni research from Saunders-Smiths & De Graaff (2012) in the aerospace industry in the Netherlands demonstrated the importance of people management skills and oral communication skills in reaching success as an engineering manager. Technical expertise comes last on their list of 12 challenging attributes. For engineering specialists the reverse was the case, although communication skills featured prominently

In their small sample of recent graduates from the University of Cape Town, Martin, Maytham, Case and Fraser (2005) identify through a questionnaire and interviews several gaps – not the least of which is field specific practical knowledge, interpersonal skills and management & leadership.

A survey of skills required for effective project management in Malaysia singled out six skills, four of which were non-technical: interpersonal communications, people management, team management and problem solving; leadership skills followed close behind (Tong, 2003).

Because of the importance of communications for engineers technical educators are teaming up with communication educators at the University of Utah in an attempt to incorporate communications into the syllabus (Darling & Dannels, 2003). Furthermore the report cites comments from practicing engineers as to the importance of oral communication. They go so far as to assert that “communication is the lifeblood of a practicing engineer”.

In an empirical study by the first author last year (being prepared for publication) in a large mining company young graduates’ perceived the absence or poor development of soft skills as a shortcoming and something they would have wanted to learn at university. Galloway (2008), May & Strong (2011) question whether engineering schools are really delivering graduates with the attributes that industry wants.

2. GROUP WORK – PMY 410

The Plan

The integrated approach of teaching certain soft skills alongside technical knowledge was introduced in the first semester of 2010 into the technical mining course PMY 410 in the department of mining engineering at the University of Pretoria. For the three years under review the first author was the lecturer in a class of between 30 and 45 students. The course consisted of five sessions a week of 50 minutes each. The dominant teaching approach comprised assigned readings and group work. This approach was intended to promote independent learning and teamwork (Knobbs & Grayson 2012).

Teaching and learning of the course material was paramount but learning specific soft skills like oral communications and working in groups featured prominently. As a precursor to teaching and developing these soft skills a model derived from the US army officers’ course at West Point in New York and used by the Harvard Business School was introduced. The model also afforded the opportunity to introduce the importance of ‘know thyself’ as a fundamental prerequisite in fully appreciating and practicing leadership or soft skills of any nature.

This leadership/soft skills model has three components, “knowing”, “doing” and “being” (Snook, Nohria & Khurana, 2004). “Knowing”, is the technical or “hard” knowledge of the course or profession. Then there is the “Doing” component. This is the ability to execute and deliver and the ability to work effectively with people. (“Knowing” about rock mechanics and how to design a deep level mine does not prepare an individual to “do” or execute the project. Without “doing” skills, “knowing” is of limited or restricted value.). Finally, “Being” refers to an individual’s values, attitudes, beliefs, strengths and weaknesses, and the ability to reflect, introspect, and act ethically.

In order to address the “Being” component or “who am I”, three assessments were administered to the students at the beginning of the semester. Firstly, the Herrmann Brain Dominance Instrument (HBDI); this instrument measures how a person thinks about the world in relation to the four quadrants of the brain. Secondly, the Shadowmatch tool compares the individual’s profile of habits with the ‘shadow’ or benchmark profile of successful mining engineers in the industry. Shadowmatch also provides customised personal development programmes for those who want to improve specific habits in order to enhance their prospects for success in a particular environment: Thirdly, EQ-i (Bar-On 2004) measures emotional intelligence according to a number of constructs.

Interpretation of results from these assessments and their significance is discussed with the class as a whole and individually in most cases. Students are eager to understand the significance of the results and how critical or otherwise these might be in their careers. The ability to operate outside the profiles is carefully explained and discussed in class. Feedback is given in class and privately where requested.

Results of the psychometric tests together with race and gender were considered when assigning students to heterogeneous groups and explaining why conflicts arose in some groups but not others. The groups changed frequently to mimic reality in the workplace.

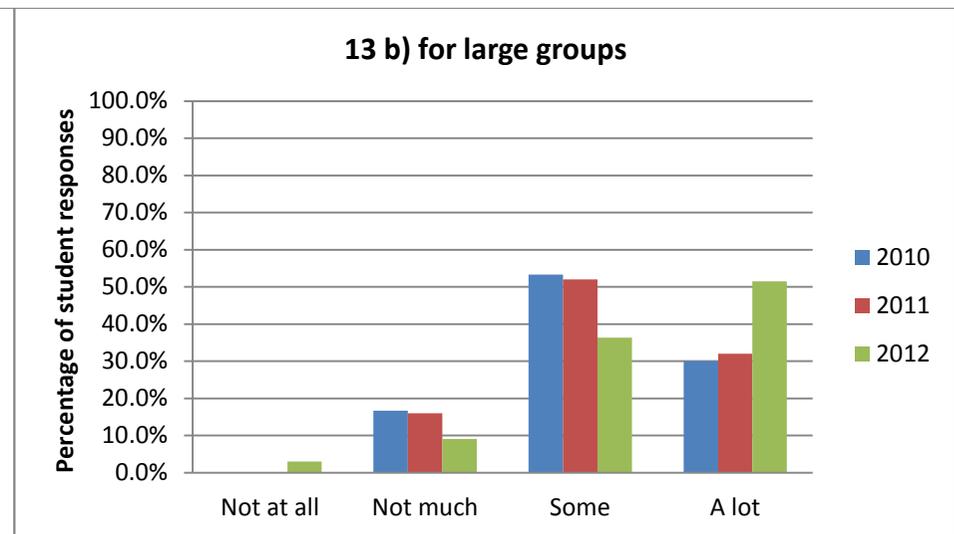
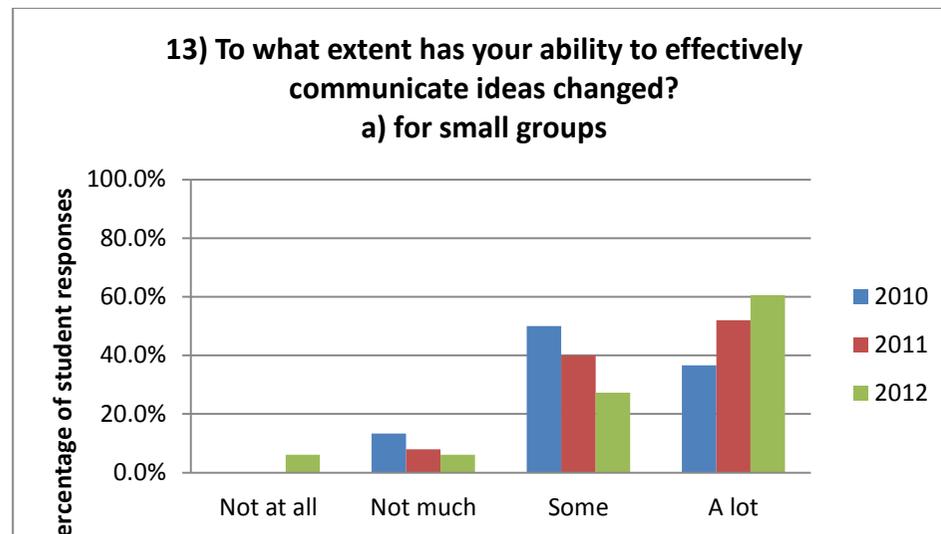
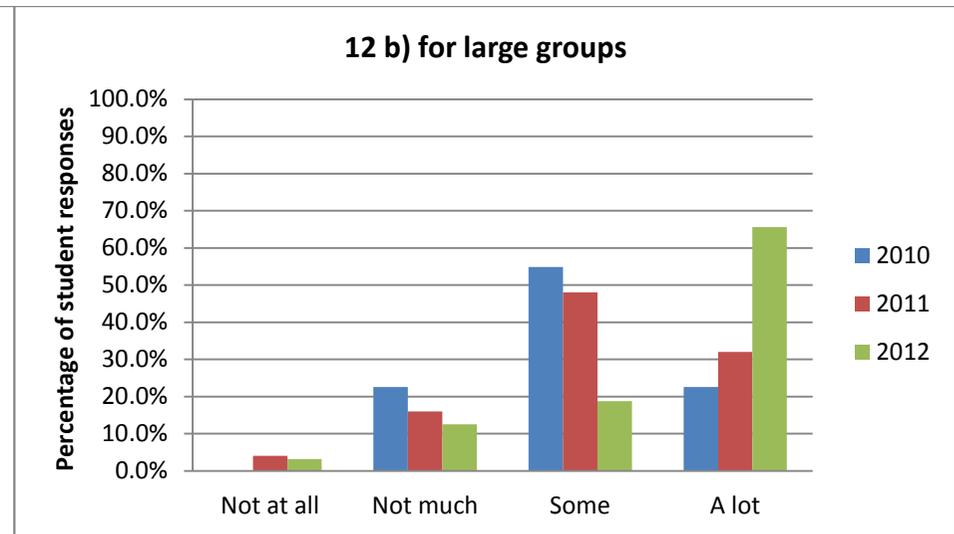
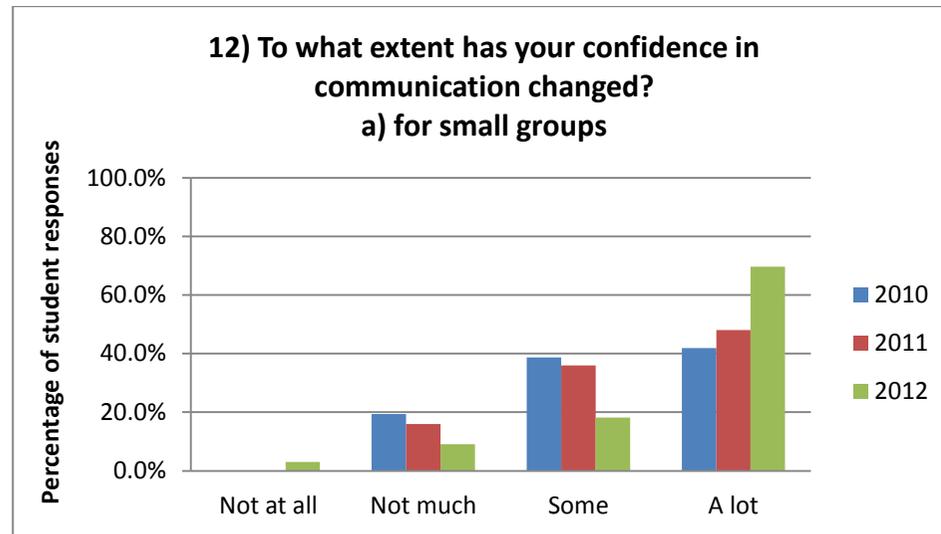
Execution

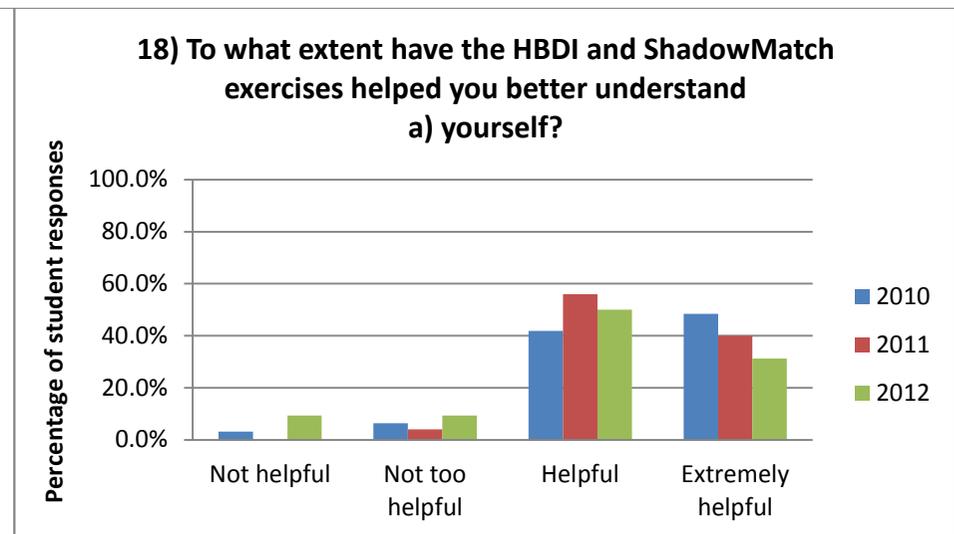
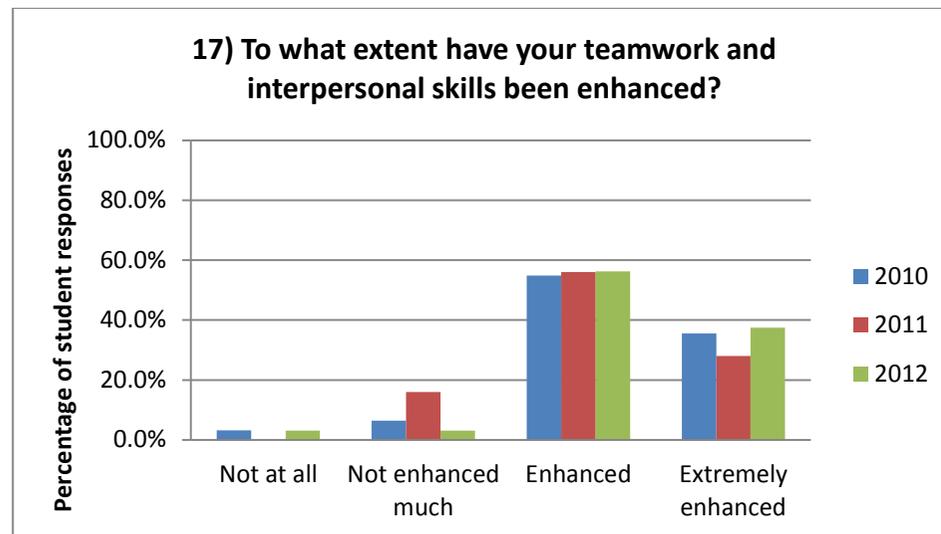
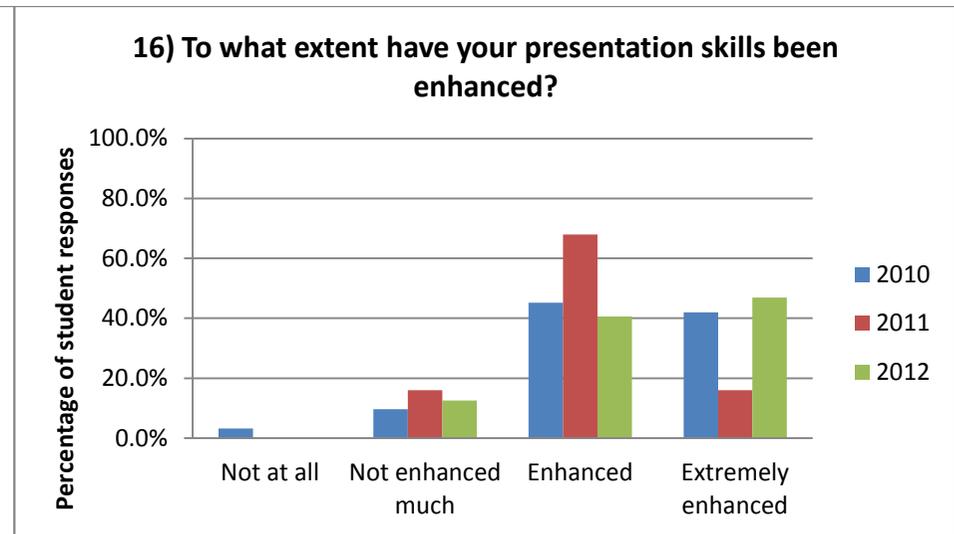
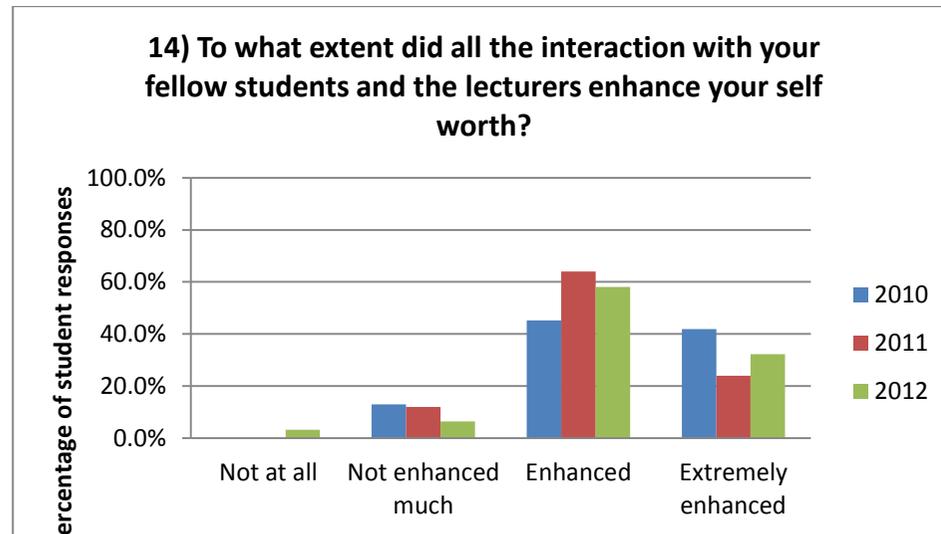
In the mining PMY 410 course technical reading material relating to the subject for the week ahead was posted on the university’s web-based course management system, Click UP, for students to download and read in their own time. This material, sent on a Thursday or Friday of the preceding week, consisted of published papers, presentations from experts, lecture notes, references to chapters in a prescribed textbook and material from the Internet. Students were expected to familiarise themselves with the material and be prepared for discussions the following week. The week started with a full class discussion and a mini-lecture of about 20 minutes. The class then broke up into their assigned groups and moved to the discussion rooms where different issues and questions, as identified in the full class, were debated for 30 minutes. Thereafter each group made a short presentation of 20 minutes on the group’s findings. Unresolved or unsatisfactorily resolved issues from the small groups involving understanding or interpretation were discussed and debated in the full class after each presentation. In both the small groups and the full class students were “coached” through the discussion and helped to think through the issues rather than given pat answers.

The small group presentations mentioned above were conducted using old-fashioned flip-chart and blackboard facilities rather than the mechanistic and impersonal PowerPoint approach. Three assignments covering two mini-designs and a critique of an existing design were completed in the semester. These assignments required the submission of reports which, in turn, formed the basis of presentations with marks allocated for content and quality of presentations. Peer marking was introduced for these assignments. Marks were allocated for group performance and individual contribution based on the peer reviews.

Results

At the end of the semester (May 2010;2011;2012) the thoughts, perceptions and opinions of students with regard to the group process as a teaching strategy for technical and soft skills were measured by an anonymous questionnaire. The questionnaire consisted of 23 questions, 17 requiring structured responses and 6 open-ended responses. Each structured question used a 4-point Likert scale, ranging from very favourable to very unfavourable. The results of questions relating to the structured questions are recorded in Figure 1.





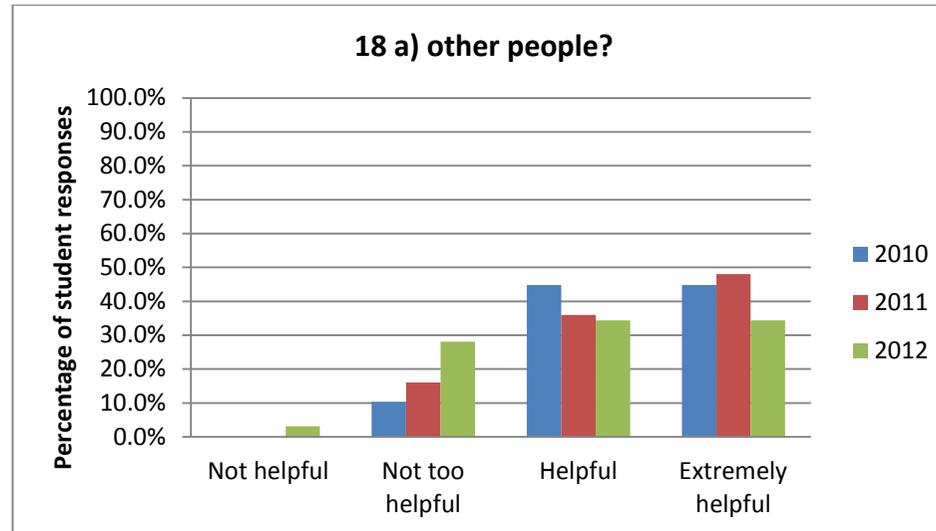


Figure 1: Graphs depicting the responses to questions from the PMY 410 students between 2010 and 2012.

Here are some quotes to the unstructured questions from the three years. Regarding the question of ‘what they enjoyed during the course’, the answers were:

- “Working in small groups, this gave me a chance to communicate with fellow students and to exchange ideas”.
- “I enjoyed the class interactions aspect. It always kept me awake and aided me in learning many industry standards from other students.”
- “Being able to share my knowledge with the class without being made to feel ‘dumb’. Learning from others in a free (didn’t doubt others or ourselves) environment.”

In response to the question, ‘What aspects of the course did you not enjoy?’ some students thought that there was too much group work or that some group members did not contribute enough, as illustrated below:

- “Being in groups and not actually getting any work done by group members.”
- “Having to work in groups and not everyone bringing their part to the work.”
- “Evaluating group members.”

Both student comments and our own observations suggest that the groups did not always function well in promoting peer learning which was another objective of the exercise. In addition, some students encountered challenges in working in a diverse group.

3. COMMUNICATIONS - PEER MENTORSHIP PROGRAMME

The plan

Knowing about leadership and its attendant soft skills is one thing but executing these skills is another. Hands-on experience is essential to augment and consolidate the theory. To this end a peer mentorship programme (PMP) was introduced into the Department of mining engineering. It required final year undergraduates taking the Mining 410 course to act as mentors for two to three first year students (mentees). The PMP was intended to not only assist first year students to adapt to university life and reduce the high drop-out and failure rate, but also to give the mentors the opportunity to improve their soft skills experientially. Not only could mentors gain leadership skills but the five full-time honours students in the department who were classified as supervisors and managed the PMP also benefitted. Each supervisor was responsible for five to seven mentors. Again psychometric assessments were used to kick-start the process.

Execution

The first year students (mentees) were put through two assessments, Shadowmatch and the EQ-i as an aid to getting them to appreciate ‘who am I?’ and to assist the mentors in better understanding who their charges were. (These are the same assessments that the mentors had completed as preparation for Mining 410 described earlier.)

Mentors were expected to meet once a week with their group of mentees. Communication by means of SMS, e-mail and cell phone was permitted but face-to face contact was strongly encouraged. Difficult or unresolved issues experienced by mentors in dealing with mentees were relayed to supervisors for their attention. The supervisors have recourse to the ‘management’ (the first two authors) for advice and guidance. Supervisors meet with management for a short meeting every Monday immediately after the weekly Staff meeting.

For mentors the PMP formed part of the curriculum for Mining 410. Ten per cent of the course marks were allocated to the PMP and awarded on the basis of the success or otherwise of the

mentor communicating regularly and effectively with his mentees, and resolving mentee problems where possible.

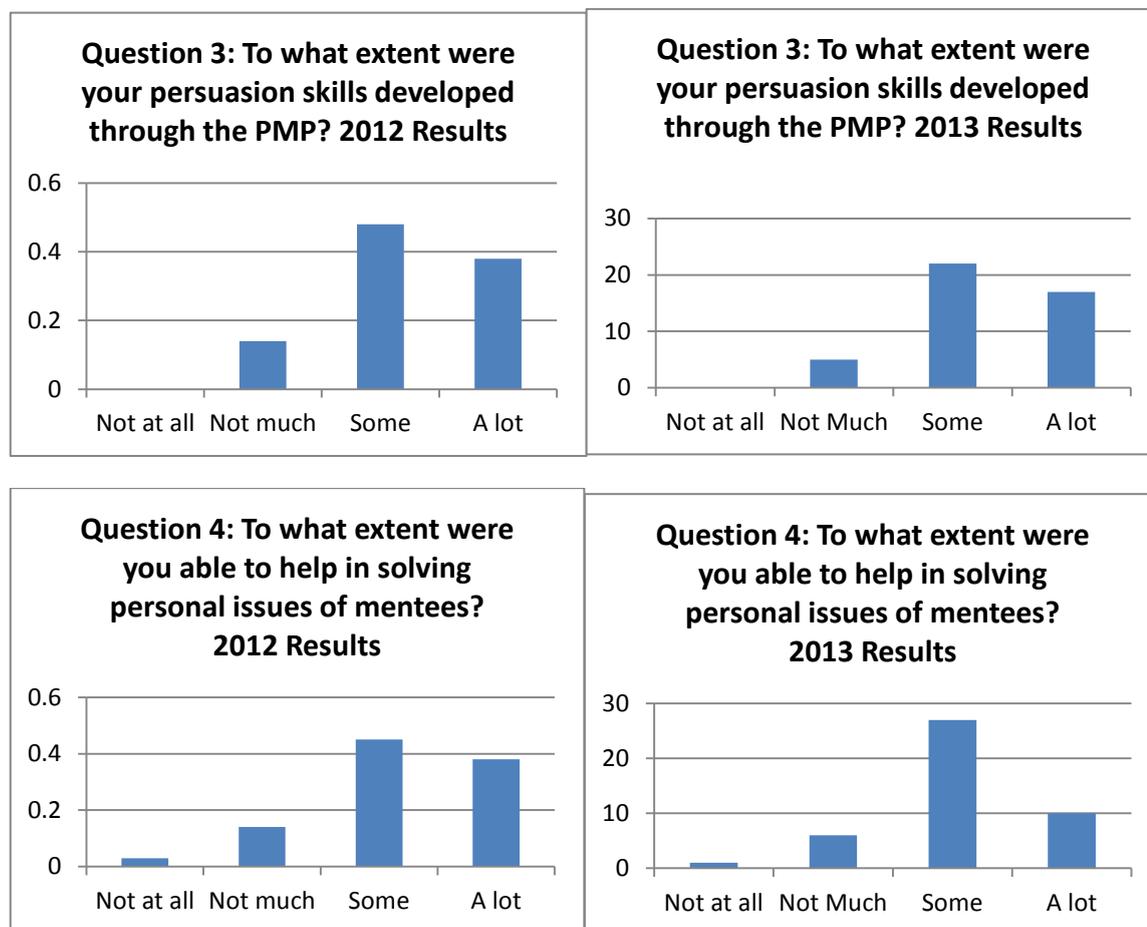
To help supervisors award marks to mentors a simple Mentorship Control form was used which incorporated relevant measures for completion by all participants every two weeks. This feedback attested to the efficacy of the process in meeting the stated objectives of the programme.

Results

The mentors completed a questionnaire at the end of the first semester 2012. It consisted of nine questions, some structured and some unstructured. The structured questions (1 to 6) yielded the results in the pie charts shown in figure 2 below.

It can be seen in these charts that the majority of students felt that the PMP indeed had a positive effect on them. In all cases more than 50 % of students believed the programme had assisted them either to ‘a lot’ or to ‘some’ extent.

Question 6 asked whether they would ‘volunteer to be a mentor again’? It was answered with a resounding 75% ‘yes’ response. This also improved to 91 % in 2013. Thus it can be stated that even though it took time for mentors to adjust to an extra facet of their studies with a paltry contribution to their marks for Mining 410 most agreed that it had been beneficial for them. Many students offered to take on more mentors in the second semester.



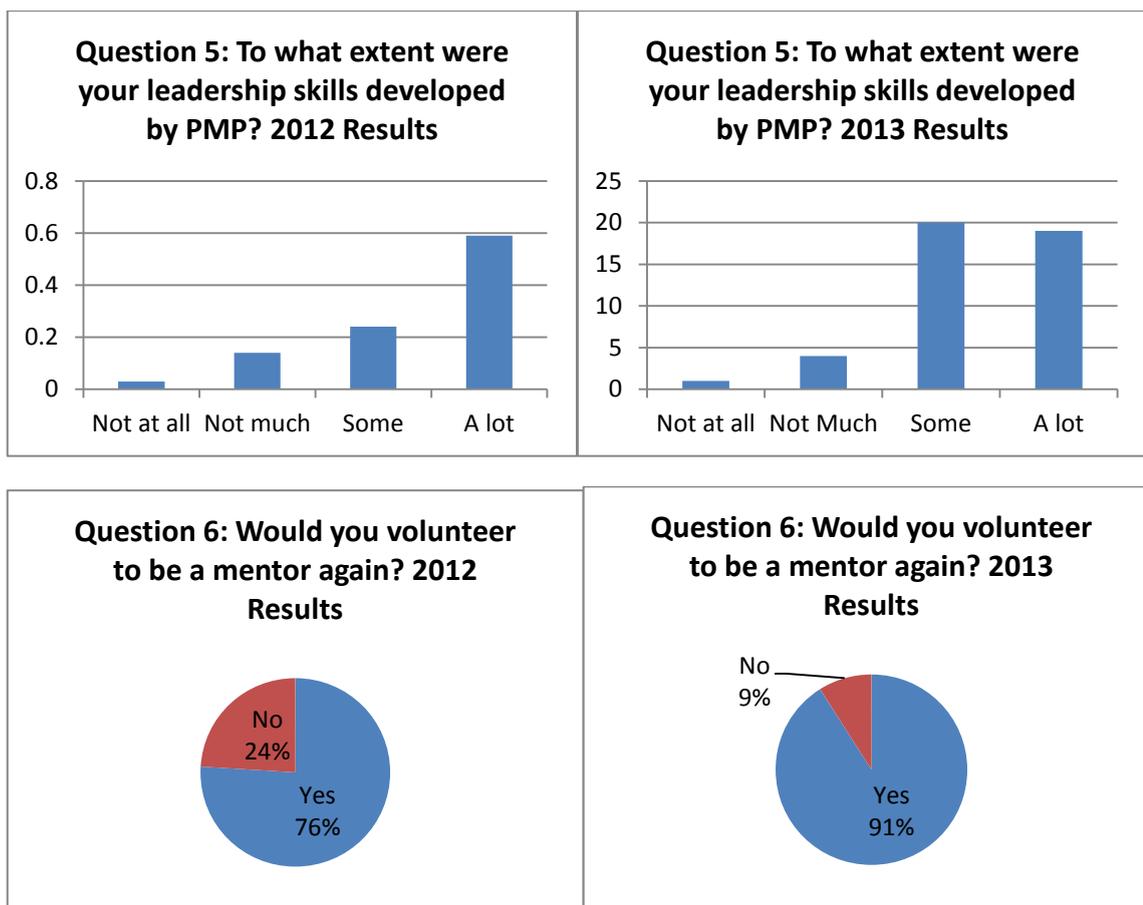


Figure 2: Results from the structured questions posed in the Peer Mentorship Programme questionnaire

When asked in an unstructured question, what obstacles did you experience to being a good mentor?, the mentors cited time management, problems beyond their control, lack of participation and interest from mentees as the main issues they were faced with.

On the question of what suggestions the mentors had for the next PMP programme, they spoke of making the participation from mentees voluntary, allocating marks for mentee involvement, arranging set times for meetings between mentor and mentee, getting mentees to be more proactive and less reliant on their mentors, and involving third year students as mentors.

Finally, mentors were asked about themselves and what they had learned from the programme. Mentors reported on gaining confidence in personal leadership and technical capabilities, having learnt to appreciate the value of communications – especially across cultures, and the realisation of personal growth and development gained by ‘helping’ others.

DISCUSSION

Results from the last three years point to the success of the small group strategy in developing soft skills such as group work and communication. Final year students learned important lessons about soft skills and leadership that they would typically not have learned with the traditional lecturing approach. These learnings should go some way in bridging the gap between what they bring to the workplace as graduates and what is expected from them as employees. Extending this approach to other courses in mining and indeed to other faculties is the challenge. It will require a “paradigm shift” to convince other lecturers who for a whole lot of reasons do not make much use of teaching in small groups. The small group strategy was well

complimented by the peer mentorship programme which provided another thrust to learning soft skills.

After only one year's application it seems fair to declare the peer mentorship programme (PMP) a success; this assertion is confirmed by the positive responses received in the questionnaire completed at the end of the semester. The fact that three quarters of the mentors volunteered to extend their involvement into the second semester would seem to bear testimony to their enthusiasm and recognition for the value of the programme. In spite of these auspicious signs there are a number of operational factors which need attention in the future. Although all forms of communication are permitted the face-to-face meetings between mentors and mentees, between supervisors and mentors, and between supervisors and 'managers' must occur regularly to sustain motivation in all the participants.

The written control and "marking" mechanisms are critically important. These reports must be carefully designed - simple and practical so as not to appear cumbersome and excessively time-consuming. The awarding of marks for successful mentorship becomes an interesting negotiation between supervisor and mentor.

In addition to the above shortcomings extending the programme to other departments should be considered. On the negative side, a major disappointment of the peer mentorship programme was the lack of convincing evidence of the effect that the programme had on first year exam results and drop-out rates. Better feedback mechanisms need to be put in place to monitor these aspects.

CONCLUSIONS

The problem is clear-cut. Industry wants graduates with some semblance of soft skills ability. One survey after another confirms this requirement. It is often being asked in engineering faculties whether it is their (our) responsibility to teach students non-technical/soft skills over and above the overly full technical content curriculum. It is possible to comply and teach these skills without emasculating the present technical courses. The challenge is to change the present mindset and to populate engineering departments with staff (permanent or part-time) who are interested and qualified to teach these skills.

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