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Professional ethics instruction in engineering is commonly conducted by examining case studies in light of the code of conduct of a suitable professional body. Although graphical presentations of spectacular failures, sobering stories of the repercussions and the solid framework provided by the tenets of a code of ethics may leave a lasting impression, students generally gain their professional identity from relatives and colleagues. Their professional ethics tend to be mostly an extension of their personal ethics. Instruction on ethics generally serves only to reinforce students' inclination to act ethically and provides encouragement to act on these beliefs. In this study a survey based on previous investigations was conducted (n = 1136) to examine the personal ethical perceptions of engineering students. The survey measured how engineering students perceive their own ethical beliefs and how they perceive the ethical beliefs and actions of their peers. As a learning exercise, students were then challenged by examining their personal ethical beliefs in light of the professional ethics requirements of the Institute of Engineers Australia (IEAust) code of conduct. After familiarisation with the Engineers Australia code of ethics, students were also invited to comment regarding their beliefs regarding adherence to this code.

Keywords

identity, ethics, engineering, perceptions, student, professional, development, their

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ETHICS IN ENGINEERING: STUDENT PERCEPTIONS AND THEIR PROFESSIONAL IDENTITY DEVELOPMENT

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Abstract

Professional ethics instruction in engineering is commonly conducted by examining case studies in light of the code of conduct of a suitable professional body. Although graphical presentations of spectacular failures, sobering stories of the repercussions and the solid framework provided by the tenets of a code of ethics may leave a lasting impression, students generally gain their professional identity from relatives and colleagues. Their professional ethics tend to be mostly an extension of their personal ethics. Instruction on ethics generally serves only to reinforce students' inclination to act ethically and provides encouragement to act on these beliefs. In this study a survey based on previous investigations was conducted (n = 1136) to examine the personal ethical perceptions of engineering students. The survey measured how engineering students perceive their own ethical beliefs and how they perceive the ethical beliefs and actions of their peers. As a learning exercise, students were then challenged by examining their personal ethical beliefs in light of the professional ethics requirements of the Institute of Engineers Australia (IEAust) code of conduct. After familiarisation with the Engineers Australia code of ethics, students were also invited to comment regarding their beliefs regarding adherence to this code.

Keywords – Ethics; Engineering Education; Engineers Australia; Student Perceptions.

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1 INTRODUCTION

Professional engineers have a personal and professional obligation to society to act in an ethical manner (Passino, 1998). Buckeridge (2011) argues the importance of ethics training for engineers in light of the significance this is given in the Washington Accord and subsequently in the Institute of Engineers Australia (IEAust) code of conduct. Although psychologists have long studied the development of moral identity (e.g. Flanagan & Rorty, 1990; Kohlberg, 1984), there has been little investigation into the effect of professional engineering ethics education on students' moral growth (Self & Ellison, 1998; Sindelar, Shuman & Wolfe, 2003). Those studies that have been conducted (e.g. Steneck, 1999; Bauer & Adams, 2005) suggest that ethics cannot be taught. Abaté (2011) argues that if we interpret “teaching engineering ethics” to mean instructing engineering students to be moral members of society, then engineering ethics cannot and should not be taught. Although these studies conclude an inability to teach ethics they do propose that ethical reasoning can. This viewpoint generally leads to ethics education that focuses predominantly on abstract ethical frameworks and moral justification. Lynch (1997) cautioned that such a theoretical approach needs to be contextualised in engineering activities to act as an effective mode of instruction for engineering students.

The traditional approach to teaching professional engineering ethics then is to use a series of case studies (e.g. Hoke, 2012), typically detailing breaches of professional codes of conduct with subsequent dire consequences. Buckeridge (2011) describes the implementation of one such method of instruction employed at RMIT.

Adopting this educational approach introduces the risk of turning an ethics course of instruction into one on engineering disasters. Generally this results in entertaining lectures and associated student activities but has been shown to generally have little impact on students' ethical development (Bauer & Adams, 2005). Graphical presentations of spectacular failures, sobering stories of the repercussions and the solid framework provided by the tenets of a code of ethics may leave a lasting impression; however students generally gain their professional identity from relatives and colleagues (Loui, 2005). Students' professional ethics tend to be mostly an extension of their personal ethics.

The ethical and moral development study conducted by Loui (2005) revealed that the greatest benefit of professional engineering ethics education is to reinforce students' inclination to act ethically. The instruction on moral reasoning frameworks and professional codes of conduct providing encouragement to act on the personal ethical and moral convictions already held. Naturally then, the question arise regarding how ethical our engineering students are and what can be done to promote and encourage further personal ethical development.

The study by O'Clock and Okleshen (1993), examining the personal ethical beliefs of engineering and business undergraduate and postgraduate students, provides some interesting insights to these questions. Business students generally display a self selection bias toward less ethical behaviour and less developed ethical values relative to students from a range of other disciplines (e.g. Arlow & Ulrich, 1980; O'Clock & Okleshen, 1993). The investigation by O'Clock and Okleshen (1993) reported no significant statistical difference between business and engineering students' ethical perceptions and behaviour, indicating that the ethical values of engineering students are perhaps also less developed than their peers in disciplines other than business.

Notably however, the study also reported a marked difference between engineering and business students returning to postgraduate studies to pursue an MBA. The postgraduate engineering students demonstrated a significantly higher level of ethical values and behaviour compared to the undergraduate engineering students. Postgraduate business students displayed the opposite trend, indicating a lower level of ethical values and behaviours. From this study it would appear that the engineering profession has a positive influence in promoting and encouraging further personal and professional ethical development. In contrast to this Buckeridge (2011) describes a general perception of a lack of a clear moral perspective in young engineers with an accompanying decline in ethical awareness in engineering graduates over the past several decades.

In light of the limited data available to assess whether the perceived drop in ethical awareness is valid or fallacious, the present study aimed to present a snapshot capturing the current state of engineering students' personal ethical values and their beliefs about others, including practising professional engineers. Students were also challenged by examining their personal ethical beliefs in light of the professional ethics requirements of the Institute of Engineers Australia code of conduct.

2 METHODOLOGY

A survey was conducted over three years (n = 1136) examining the personal ethical perceptions of first year engineering students. The students were all enrolled in a subject where professional ethics was taught. All had completed at least one semester of full time engineering studies. Approximately 15.0% of the participants were international students and 85.0% Australian. The sample group had a female to male ratio of 0.21. Just over 75% of students had completed one semester of engineering studies and 24% had completed more than one semester. The survey measured how engineering students perceive their own ethical beliefs and how they perceive the ethical beliefs and actions of their peers.

A list of unethical acts or behaviours was developed by adapting the set of twelve from the study by O'Clock and Okleshen (1993). These are presented below. The acts were carefully selected so that they could later be discussed in light of the IEAust code of conduct during class activities. Although most are not overtly unethical, many of these seemingly minor ethical breaches in the set can be shown to potentially lead to the sorts of catastrophic engineering failure case studies commonly discussed in professional engineering ethics education.

1. Accepting gifts/favours in exchange for preferential treatment
2. Undertaking work in an area you know little about
3. Passing blame for errors to an innocent co-worker
4. Not supporting a colleague who is trying to do the right thing
5. Giving gifts/favours in exchange for preferential treatment

6. Claiming credit for someone else's work
7. Not reporting others' violations of organisation policies
8. Divulging confidential information
9. Withholding relevant information from a colleague or client
10. Calling in sick to take a day off
11. Pilfering organisation material and supplies
12. Doing personal business on organisation time
13. Not keeping up to date with the latest developments in your area
14. Concealing one's errors
15. Taking extra personal time (lunch hours, breaks, early departure)
16. Using organisation services for personal use

The survey administered, instructed students to rank the sixteen unethical acts according to the following ratings. They were asked to rate both their personal beliefs and what they believe their colleagues believe.

1. Very unethical
2. Basically unethical
3. Somewhat unethical
4. Not particularly unethical
5. Not at all unethical

Following the survey, students received instruction regarding the Institute of Engineers Australia code of ethics, several case studies were discussed and formal ethics education, covering utilitarianism, Kant's theory and virtue ethics frameworks and moral justification was provided. To allow students to form the conceptual link between personal and professional ethics, the survey, dealing with students' personal ethical beliefs, was discussed in light of the IEAust code of conduct. Following this discussion, the succeeding questions were posed to students:

1. Do you believe you always act in accordance with the tenets of the IEAust code of conduct?
2. Do you believe that most practicing engineers always abide by the IEAust code of conduct?
3. Do you believe that professional engineers can realistically be expected to abide at all times by the IEAust code of conduct?

Space was also provided for student comment regarding their responses to these questions. Several weeks following the questionnaires, two small focus group discussions were conducted to further elucidate responses from students.

3 RESULTS AND DISCUSSION

The results of the survey are presented in Tables 1 and 2. The mean ratings in Table 1 indicate that students generally understood all acts or behaviours listed in the survey to be unethical to some degree. Students rated items 3, “passing blame for errors to an innocent co-worker” and 6, “claiming credit for someone else's work” as the most unethical. This was closely followed by item 8, “divulging confidential information”.

The least unethical acts as rated by the students were items 2 and 13, respectively, “undertaking work in an area you know little about' and “not keeping up to date with the latest developments in your area”. Over 45% of students considered item 2 as not unethical and over 41% of students identified item 13 as not unethical. Mean ratings for both of these items was above the arguably minimum ethically aware response of a rating of three (i.e. “somewhat unethical”). In light of the Australian cultural traditions, these items rated least unethical were predictably followed closely by item 10, “calling in sick to take a day off”.

The rating of items 2 and 13 as least unethical is somewhat alarming. The response to item 2 was justified by students during the focus groups as a necessary requirement at their current stage of development as an engineer. They were all in the early years of their studies and continually being forced to work (in an educational context) in areas they had little understanding. The rating of item 13 by students as one of the least unethical behaviours points strongly to the need to reinforce the relevant lifelong learning related graduate competencies in the engineering curriculum. Students in the focus groups generally displayed little appreciation

of the need to continue learning beyond their degree. The personal ethical belief responses to the overlapping items in the present study with that conducted by O'Clock and Okleshen (1993) showed reasonable agreement.

Act/Behaviour	1	2	3	4	5	Mean	SD
1	40.1%	35.0%	18.1%	5.8%	0.9%	1.92	0.94
2	6.9%	16.2%	31.9%	35.4%	9.7%	3.25	1.06
3	78.0%	15.7%	4.2%	1.1%	0.7%	1.30	0.67
4	26.8%	39.1%	24.8%	7.4%	1.9%	2.19	0.98
5	41.4%	31.3%	18.7%	7.2%	0.9%	1.94	0.99
6	76.2%	17.6%	2.8%	2.5%	0.4%	1.32	0.68
7	16.2%	34.5%	35.7%	10.7%	2.6%	2.49	0.97
8	54.0%	31.9%	10.9%	2.6%	0.5%	1.64	0.82
9	25.0%	47.0%	19.0%	7.6%	1.1%	2.12	0.91
10	15.8%	18.7%	34.7%	21.0%	9.9%	2.90	1.19
11	28.3%	34.0%	26.6%	8.1%	2.6%	2.22	1.03
12	10.2%	31.5%	38.6%	15.0%	4.6%	2.72	0.99
13	6.7%	19.4%	32.6%	28.5%	12.7%	3.21	1.10
14	13.0%	33.5%	34.9%	14.1%	4.4%	2.63	1.02
15	11.1%	29.6%	33.8%	19.5%	5.8%	2.79	1.06
16	9.9%	32.4%	34.2%	18.1%	5.1%	2.76	1.03

Table 1. Engineering students' personal beliefs regarding unethical behaviour (rating 1-5)

From the comparison of the data in Tables 1 and 2, presented graphically in Figure 1, it is evident that in the present investigation there is evidence of a self-versus-other disparity. For more than half of the unethical acts in the surveyed list, the null hypothesis that the means of the data for self and colleague perceptions are not equal, must be accepted at the alpha levels indicated in Table 2. In contrast with the American study by O'Clock and Okleshen (1993), the direction of this deviation between self and colleague beliefs is not consistent. Students tended to rate themselves as more ethical than their peers when the act was perceived more strongly unethical. When the act was not perceived as strongly unethical, students tended to rate their peers as more ethical. This is in disagreement with the study by O'Clock and Okleshen (1993) where a pronounced “halo” effect was evident with students rating themselves consistently and significantly more ethical than their peers. This result may reflect a fundamental cultural difference between Australia and America.

Act/Behaviour	1	2	3	4	5	Mean	SD
1	35.9%	38.9%	18.3%	6.0%	0.5%	1.96	0.91
2	9.0%	22.9%	34.3%	24.3%	8.6%	3.01**	1.09
3	64.3%	21.1%	8.5%	6.0%	0.2%	1.57**	0.89
4	26.4%	37.0%	23.9%	8.1%	3.7%	2.25	1.05
5	40.1%	29.9%	19.0%	7.4%	3.2%	2.03*	1.08
6	65.8%	21.7%	7.2%	1.8%	3.4%	1.55**	0.95
7	17.8%	33.1%	32.7%	14.3%	1.6%	2.48	0.99
8	48.2%	31.3%	14.3%	2.6%	3.2%	1.81**	0.99
9	24.5%	40.1%	25.9%	4.6%	4.8%	2.25**	1.03
10	17.4%	25.9%	29.4%	19.4%	7.0%	2.72**	1.17
11	26.4%	35.4%	25.4%	9.3%	3.3%	2.28	1.06
12	13.9%	31.2%	36.1%	14.1%	4.4%	2.64*	1.03
13	14.0%	20.1%	34.0%	19.4%	11.8%	2.95**	1.20
14	17.1%	29.9%	34.5%	14.6%	3.5%	2.57	1.05
15	14.3%	25.9%	37.9%	16.4%	5.3%	2.72	1.06
16	15.1%	28.7%	37.0%	14.1%	4.8%	2.64**	1.05

Table 2. Engineering students' perception of their colleagues' beliefs regarding unethical behaviour (rating 1-5) (statistically significant difference in means between self and colleague ethical perception ratings at α = 0.05 level; ** at α = 0.005 level)*

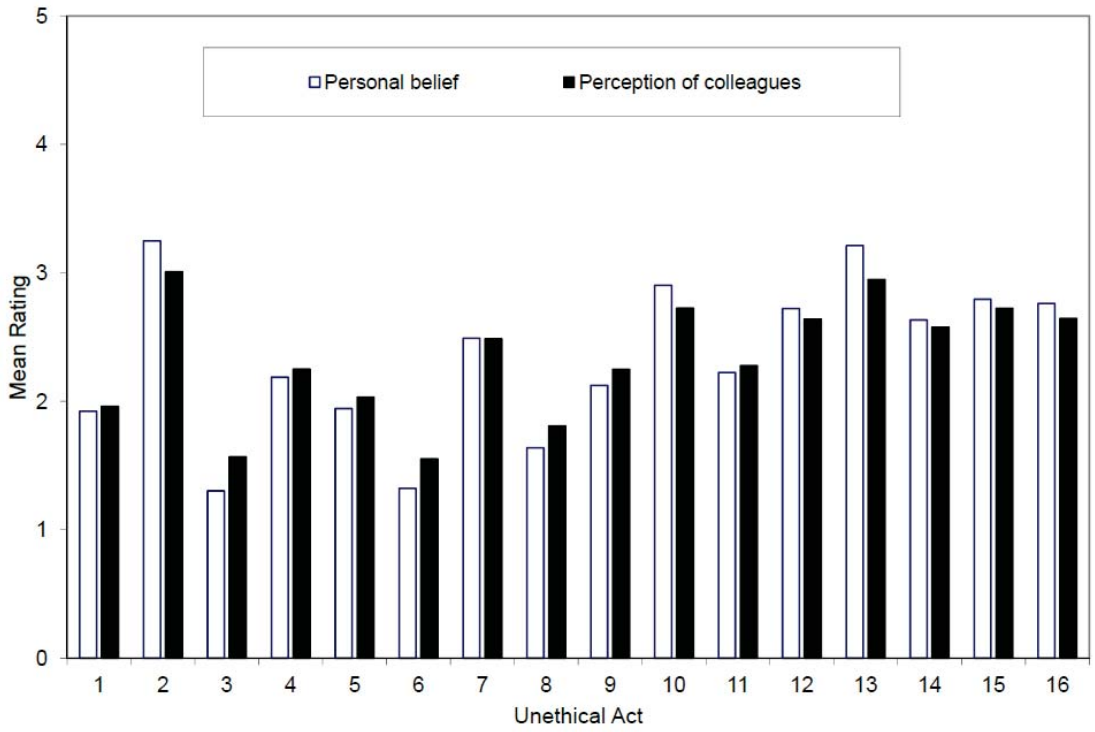

Figure 1. Mean ratings of Engineering students' personal and their perception of colleagues' beliefs regarding unethical behaviour

The post IEAust code of conduct instruction and discussion question responses, regarding adherence to the code, are presented in Tables 3-5. The breakdown of responses to the first question is consistent with the personal ethical beliefs reported by students. Table 4 indicates a stronger belief in adherence to the code of conduct in the female engineering students. Gender differences are also noted in the perception of practising engineers and the belief that the code of conduct can realistically be adhered to as a professional engineer. Female students report greater uncertainty regarding the ethical conduct of practising engineers relative to the male students who generally believe practising engineers do not act ethically. The female engineering student cohort does display a stronger relative belief that the code of ethics can be adhered to during their daily activities as practising engineers. The large number of students who were unsure whether they were behaving in line with the tenets of the code does suggests however that more work is required to translate students' personal ethics to their emerging professional identity.

The number of students that do not believe practicing professional engineers act ethically is concerning. Over 30% of the students surveyed also stated that they do not believe that professional engineers can realistically be expected to abide by the code at all times. Part of the solution to addressing this concerning result may be to place more emphasis on ethical engineering practice in ethics education to balance the case studies where breaches of the code of conduct are examined. Modelling ethical behaviour and providing outstanding engineering role models for students would appear to be a more positive approach to ethics instruction.

Question	***Yes***	***No***	***Unsure***
Do you believe you always act in accordance with the tenets of the IEAust code of conduct?	*48.9%*	*25.4%*	*25.0%*
Do you believe that most practicing engineers always abide by the IEAust code of conduct?	*45.8%*	*31.5%*	*22.5%*
Do you believe that professional engineers can realistically be expected to abide at all times by the IEAust code of conduct?	*49.5%*	*30.1%*	*17.8%*

Table 3. Engineering students' perception regarding adherence to the IEAust code of conduct

Question	Yes	No	Unsure
Do you believe you always act in accordance with the tenets of the IEAust code of conduct?	*56.5%*	*15.9%*	*27.6%*
Do you believe that most practicing engineers always abide by the IEAust code of conduct?	*39.3%*	*28.0%*	*32.6%*
Do you believe that professional engineers can realistically be expected to abide at all times by the IEAust code of conduct?	*56.1%*	*30.5%*	*13.4%*

Table 4. Female Engineering students' perception regarding adherence to the IEAust code of conduct

Question	Yes	No	Unsure
Do you believe you always act in accordance with the tenets of the IEAust code of conduct?	*46.8%*	*28.0%*	*24.3%*
Do you believe that most practicing engineers always abide by the IEAust code of conduct?	*47.5%*	*32.4%*	*19.8%*
Do you believe that professional engineers can realistically be expected to abide at all times by the IEAust code of conduct?	*47.7%*	*30.0%*	*19.0%*

Table 5. Male Engineering students' perception regarding adherence to the IEAust code of conduct

4 CONCLUSIONS

The present study has provided a snapshot of the current personal ethical beliefs of engineering students. Although generally, engineering students in the sample group agreed that the acts listed were unethical, there were several items that raised concern. In particular, the item concerning “not keeping up to date with the latest developments in your area” was rated by students as one of the least unethical behaviours. This result points strongly to the need to further reinforce the relevant lifelong learning related graduate competencies in the engineering curriculum. The most alarming results of the present study were that almost a third of students do not believe current practicing professional engineers act ethically and a similar number believe that it is unrealistic to expect this ethical behaviour. This suggests that significantly more work is required in engineering ethics education and in shaping our students' professional identities.

In the present study a notable difference was observed between the ethical perceptions the individual and their perceptions of their colleagues' beliefs. This disparity did not consistently reflect the well known “halo” effect. Gender differences were apparent in the perception by students of the ethical conduct of practising engineers. Female engineering students displayed a more favourable ethical view of currently practising engineers and of the expectations that they will be able to act ethically, in line with the IEAust code of conduct, upon entering the profession.

As discussed previously, it has been argued in previous studies that ethics cannot be taught. Regardless, personal ethical change will take place in our students. While these students are under our guidance it is imperative that we engender and enable positive development. Rather than a standalone module of ethics instruction, a move toward a more holistic, integrated approach to teaching ethics would appear a more suitable mode of instruction (Jimenez, O’Neill-Carrillo & Marrero, 2005; Cruz, Frey & Sanchez, 2004). Since personal ethics has previously been shown to be the basis of professional ethics, this ethical instruction embedded across the curriculum does not need to be entirely engineering oriented. Exposure to an ethical academic culture may be as much if not more beneficial in positively influencing personal ethical development than targeted efforts to explicitly teach professional engineering ethics. Students need to be exposed to as many ethical professional engineering role models as possible. This may be in the form of formalised lecture and tutorial type exposure but may be much more beneficial if received in the form of engineering mentors and the modelling of ethical behaviour by academic engineering staff.

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