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Professional engineering ethics education: just how effective is it?

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ABSTRACT: Professional engineering degrees that are endorsed through independent protocols, (such as the Washington Accord), must ensure that students are given sufficient background to enable them to practise in an ethically professional manner. Graduates are expected to have a full understanding of the pertinent code(s) of ethics under which they can be expected to function as engineers. Further, they need to be able to appreciate the nuances involved in issues such as "conflict of interest", sustainability, resource use, quadruple bottom line (the "4Es") as well as "good practice". This paper provides a review of the course *Ethics and the Professional,* currently being offered in four universities in three countries, that was established to directly address the need for professional ethics education. Over the last few years, student satisfaction surveys of this course have been undertaken in Australia, New Zealand and Germany; the results of these are provided herein. In addition to these assessments a further, novel approach, devised to assess the overall effectiveness of the professional ethics course is presented. This assessment provides a valuable tool through which we may monitor any apparent change in student attitudes that developed during the course.

INTRODUCTION: The teaching of ethics is not new. Some 2300 years ago, Aristotle championed a new, *Nichomachean Ethics* at his Lyceum [1] and this, now known as "virtue ethics", has become one of the key elements of modern ethical dogma. What is relatively new, however, is the incorporation of ethics in professional engineering education. In the early 1990s, the importance of ethics in engineering education was widely acknowledged in both the engineering profession and in universities. This was primarily in response to a widespread perception that *engineers* were, in part, to blame for the global decline of the environment. The resultant professional and public pressure led to incorporation of ethical theory within most engineering degrees by 1995 [2,3]. The short course (or seminar), "Ethics and the Professional" is the subject of this paper; it was designed to challenge and expose senior undergraduates to ethics within a professional practice environment, and ranges through topics including conflict of interest, sustainability, resource use, quadruple bottom line (the "4Es") as well as good practice. The course is taught in three countries (New Zealand, Australia and Germany)[4]. It is also part of an international benchmarking programme that permits evaluation of both attainment and attitudes in international engineering education [5]. This paper reports on a project, carried out over 2002-2003, which was designed:

1. To gain an appreciation of how senior undergraduate engineering students perceive aspects of morality.

2. To ascertain whether student's attitudes in moral issues show any change following the course.

If the course was successful, the postulate would be:

> *That there would be a change in student attitudes, and that this would be for the better.*

The principal objective of this research project was to determine whether the course "Ethics and the Professional" made any difference to the way in which engineering students thought about their obligations and responsibilities within a "professional morality" context (i.e. ethics). Although this would only provide a partial assessment of the value of the course, it would none-the-less provide a very useful insight into the effectiveness of the learning environment – a learning environment, revolving around case studies, that has been designed to encourage maximum participation and interaction between students and lecturer. It is, however, stressed that the teaching of ethics is now mandatory in all engineering degrees accredited by professional engineering bodies within the Washington Accord, such as Institution of Professional Engineers New Zealand and the Institution of Engineers Australia [6]. From this viewpoint it was hoped that the study would provide some insight into how the course should be taught, rather than whether the course should be taught.

RESEARCH METHODOLOGY

Phase 1: The survey: Course assessment is not new in universities. Indeed, many students now contend that they are being surveyed at unacceptably high levels on issues as diverse as *course delivery* and *the ambience of the learning environment*. Comprehensive surveys have also been carried out to evaluate the academic integrity of engineering students, and this is partially the intent of this research. One of the authors (JB - who designed the survey used herein) rejected earlier survey formats on the basis of student time consumed in their completion. One survey, carried out in 2002, involved students making choices in response to more than thirty questions [7]. A good questionnaire needs to be of sufficient depth to provide valid information, whilst remaining sufficiently interesting to capture positive and honest student participation. It was decided that a maximum of 10 questions

should be asked, thus taking no more than eight or nine minutes to complete. Students were supportive of this model.

Phase 2: Questionnaire design (Table 1). An earlier questionnaire [7], aimed to provide an appreciation of academic honesty amongst engineering undergraduates. In this, questions focussed on issues such as cheating in class, in order to identify the pressures that may have led to cheating and to devise schemes to mitigate this. It had a somewhat different objective to this project, which was designed to evaluate how engineering students perceive morality.

Table 1. *The Questionnaire: This was translated into German for students from Wismar University in order to minimise any misinterpretation. The questionnaire was given prior to, and at the conclusion of each seminar.*

	cheating	Unethical but not cheating	Neither	I have never done this	Done it a couple of times	Done three times or more
1. Copying from another student during a test.						
2. Permitting another student to look at your answer during a test						
3. Delaying taking an exam with a false excuse						
4. Adding false references to a term paper to expand the bibliography						
5. Copying a laboratory report from a previous year						

	strongly disagree	disagree	neutral	agree	strongly agree
6. It is wrong to cheat no matter what the circumstances					
7. It is wrong to cheat even if the tutor is incompetent					
8. It is wrong to cheat even if the course material seems useless					
9. It is wrong to cheat even if I didn't have time to study					
10. It is wrong to cheat even if I am in danger of failing					

Ideally, problems relating directly to immorality in engineering practice should have been used in our questionnaire, but these problems tend to be complex, and require detailed contemplation and response. This was compounded by the fact that few of the student set we surveyed had worked in the professional engineering environment; as a consequence, a reduced version of the model and question type used in Carpenter *et al* [7] was adapted and utilised.

Phase 3: Approval: A survey focusing on an individual's ethical standards, carried out in an ethics seminar, provided some interesting challenges. As students could perceive the potential for self-incrimination, and with little imagination could predict dire consequences, we had to have a mechanism to ensure maximum anonymity. The questionnaire was designed with no written response required other than ticks, and completed questionnaires were collected by fellow students (rather than lecturer). Approval is required in most universities before any student survey can be carried out. Fortunately, the nature of this questionnaire and the apparent anonymity of respondents ensured that approval was readily obtainable.

Phase 4: The survey. The decision to survey students before **and** after the seminar was taken primarily to assess whether any change in attitudes had occurred during the seminar. A single survey, although capable of producing interesting results, would only have provided a brief window upon attitudes. A comparison between students in different educational systems was also considered a worthy objective. Class sizes varied in the three universities: Hochschule Wismar University of Technology Business and Design (19); RMIT University, Melbourne, Australia (27) and Auckland University of Technology (54). Results provided here are all expressed as percentages.

RESULTS

Because of page limitations, this paper evaluates only the first three questions in the survey. Further, only sections that are of particular interest are discussed in detail. Other results will be discussed in a future paper. Question 1, dealing with cheating shows a pre-post survey difference of ± 8 percentage points (Table 2).

Table 2: *Question 1. Shows moderately consistent responses for whether students consider copying to be cheating (i.e. ± 8 percentage points). The larger data set for AUT is reflected in a smaller percentage change. The most significant change occurs in the second part of the question, where a complete reversal as to whether Wismar students ever cheated occurs.*

University	*Copying from another student*	Cheating (pre-seminar)	Cheating (post-seminar)
AUT		95	98
RMIT		93	85
Wismar		80	76

	I've never copied from another student	pre-seminar	post-seminar
AUT		61	56
RMIT		73	76
Wismar		58	13

Not surprisingly, most students indicated that they considered cheating to be immoral. The largest variation is with the two smaller data sets, where a change of one student can effect a about 4 percentage points change.

Of particular interest in this question was the change in acknowledgement of personal deceit by students at Wismar, where there was a dramatic reversal. In light of this the full results of that question are given in Table 3. If these results are

a true reflection of what students thought at the time they answered the questionnaire, the seminar could be interpreted as having a profound effect on how they view morality. Unfortunately the results, as they stand, can only indicate that attitudes deteriorated during/after the course.

Table 3: *Copying from another student. Results from the Wismar survey. The bottom line is the results post-seminar. (refer to Table 1 for complete wording of question).*

Copying from another student during a test	never	2-3 times	often
	58	37	5
	13	87	0

Question 2, where cheating is passive, provides an interesting insight, as a high proportion of students considered that there was a distinct difference between "cheating", and "being unethical" when one is not actively doing the cheating (Table 4.). AUT students form an out-group that was most confused about the terms *unethical* and *cheating*, with about half indicating that these terms could be interpreted differently. Another out-group in this survey was a small, but significant group of Wismar students, who apparently did not believe that there was any wrong-doing associated with passive cheating. Again an attitudinal swing occurred with the Wismar students, with more indicating that they had done this *pre*-seminar. The reasons for this are unclear.

Table 4: *Question 2. Passive cheating – where students wittingly help others in an examination or test.*

Question 2: Permitting another student to look at your answer during a test	cheating	Unethical	Neither	Never done this	Done 1-2 times	Done > 2 times
AUT pre-seminar	53	47	0	41	46	13
AUT post-seminar	59	41	0	35	51	14
RMIT pre-seminar	67	22	11	64	36	0
RMIT post seminar	70	22	8	68	32	0
Wismar pre-seminar	63	16	21	26	58	16
Wismar post-seminar	75	6	19	6	81	13

The RMIT students also formed an out-group, for although they may have permitted others to copy from the one or twice, it was a relatively uncommon phenomenon.

In instances where students were asked whether they had permitted "passive cheating" more than twice, there was no statistical variation.

The third question investigated attitudes toward the *lesser* crime of simply "delaying" the taking of an examination (Table 5). This it is stressed, does not necessarily mean that cheating in the traditional sense took place. All the action involved was delaying the sitting of the examination (presumably students would need to provide an acceptable excuse, such as the death of a close relative, or illness). There was of course the potential for students to use this extra time to find out what the examination contained.

Table 5: *Question 3, using a False Excuse: Showing that many students, upon re-evaluation of past their performance, have not only taken a more moral stance on the activity, but have admitted to the misdemeanour. (refer to Table 1 for complete wording of question).*

University		pre-seminar	post-seminar
AUT	*Using a false excuse is cheating*	34	63
RMIT		50	62
Wismar		32	38

		pre-seminar	post-seminar
AUT	*I've never done this*	97	92
RMIT		96	80
Wismar		74	69

There is one further aspect of Question 3 that is of interest: In all cases, no student in the pre-seminar survey indicated that (s)he had delayed taking an exam with a false excuse more than "a couple of times". This figure did not alter in the post seminar survey.

ANALYSIS

The most momentous aspect of the results was the manner in which Wismar students responded to Question 1 (Table 3). As the student body was constant, at face value, the results can be interpreted in four ways:

1. Students misunderstood the question the first time.

2. Student attitudes changed greatly during the seminar.

3. Student attitudes changed during the time-lapse between the pre-seminar survey and the seminar.

4. Or any combination of the above.

As the questionnaire was carefully translated into German, and as no student indicated confusion with the questions, the first of these causes is unlikely. This indicates that there was probably a change in student attitude. A further compounding factor may have been the length of the time lapse between the two surveys, which was about five months (it was immediately pre- and post-seminar for the other two universities). During the five months there was an important assessment at Wismar. Perhaps many students broke their previously good record at this time?

In all cases, the pre-seminar survey was carried out under the guidance of a third party, and the anonymity of the respondents was stressed. However, it was discovered that for the Wismar students, the professor in charge had asked students to "invent" an I.D. number for their forms, and to place this at the top of the questionnaire. It was explained that this could be useful in later analysis *to ascertain whether particular individuals had changed their attitudes*. It was suggested that students may wish to use their mother's birth date, or some other "untraceable" identification as this I.D. All that was asked was that this identification be retained for use in the survey at the end of the seminar.

At the close of the seminar the survey was again given to students to complete (by JB, who was unaware of the earlier variation in procedure). In this instance, students were not

asked to put their I.D. numbers on their sheets. The change in results was dramatic, and is interpreted here as a reluctance on behalf of students to use any form of identification, no matter how cryptic, in the belief that their professors may be able to identify them. In other words, some were dishonest in the first "anonymous" survey, but were prepared to be truthful in the second, where anonymity was guaranteed. Question 3 (Table 5) reinforces this, but also shows that there was an across-the-board change in moral perception with all students. In all three countries, a greater proportion of students admitted that delaying the taking of an exam was cheating **after** they had completed the seminar. The amount of attitudinal swing was greatest for AUT (85%) Although the swing for both RMIT and Wismar were less, it was still significant (24% and 19% respectively). What was also of interest was concurrent drop in the number of students who considered that this was unethical but not cheating. As in all three questions, prior to the seminar, there appears to have been considerable confusion about the meaning of the terms "cheating" and "unethical".

Considering that from an intelligence perspective, these students represent the upper quartile of the population, it may be deduced that ethical constructs in general are not well understood.

It may also be deduced that any survey of student views is a delicate process, especially when there is:

1. The remotest possibility that individual students could be identified after the survey.

2. If there is a potential for them to incriminate themselves by having completed the questionnaire honestly.

There is a lesson here for future surveys… one must be very careful to ensure that students are fully satisfied with the "moral integrity" of the surveying process. If we are to anticipate and receive honest answers in issues involving ethics, there is an obligation upon the surveyors that students not only to be told that they will be anonymous, but for this to be conclusively demonstrated. Further, time lapse of the length that occurred at Wismar should be eliminated, as they will result in a less clear picture of why apparent discrepancies in student attitudes arise.

CONCLUSIONS

This project shows that student attitudes and perceptions on ethics can change following a course. It also showed that there was no clear difference in the way Australian, German and New Zealand students viewed morality. One could claim that attitudinal change is a lifelong process, arising from environmental stimuli. It would then follow that these results should not surprise us. However, it is the amount of change that occurred here that is of interest. There are some extenuating circumstances associated with some of these, especially the Wismar students who provided us with results that were at first anomalous. Evaluation of these, in light of a possible breach in anonymity, and the time lapse between surveys, provided a further useful dimension to the project. In this instance they were serendipitous indeed.

If one was bold, the results of this project could be used to claim that the seminar was responsible for moral enlightenment. However this is not what we claim. Rather, we believe the results demonstrate that a latent understanding of what is socially acceptable (and thus ethically appropriate) has been re-awakened. The test of this hypothesis will of course lie with the behaviour of our graduates over then next few decades.

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