Ethics problems that challenge engineering research students

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Abstract

SESSION

C3: Integration of teaching and research in the engineering training process

CONTEXT

Australian PhD students engage in a problem-based learning pedagogy, focussed on a single research question. Not only project-specific details, but also general research-related knowledge, including ethics expectations, is learned within the supervisor-student relationship. The past decade has seen changes to include some formal, lecture-based teaching of more generic material such as ethics. What should be emphasised in this teaching of research ethics?

PURPOSE

The purpose of this work was to see which type of ethical problems would be most challenging for research students, and thus needing of more class-room time.

APPROACH

Research students in their first year of study were provided with one class exploring the general ethics principles under-pinning research integrity. Following this, the students worked in groups to decide whether various actions were ethically appropriate or not. The results of each group's deliberations were collected and examined for feedback purposes. Approximately 400 students were involved over 3 semesters.

RESULTS

The actions were grouped into categories. Students did well with the ethics of the more familiar topics of intellectual property, publications and data integrity. They show some confusion about how projects should or should not impact human participants, but the seriously challenging issues for students centre on conflicts of interest, indicating that this last-named needs extra attention.

CONCLUSIONS

Providing a general introduction to research ethics can ensure students have a balanced awareness of the types of challenges they may face in their future work as researchers. In particular, it is necessary to explore topics that (i) come up less frequently and so may not arise during the PhD research project or (ii) are complex and need wider perspective to better understand.

KEYWORDS

Engineering ethics, ethics education, research training, research integrity

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Introduction

This paper explains how engineering research students, when asked to make judgements about a variety ethics problems, found those related to conflicts of interest by far the most difficult to deal with. It argues that formal teaching time be invested to address this problem. The discovery was somewhat serendipitous, coming from some routine student feedback collected after delivering classes about research integrity.

There is a widespread desire that research students learn more about research integrity (see e..g. Steneck & Bulger, 2007). At one level, this is in the hope of reducing cases of research misconduct. There is, though, a more fundamental issue, namely that practising research integrity is needful so that the research enterprise may continue: undertaking research depends on trust between researchers and resourcing it and successfully transferring its results to social benefits depends on public trust. Exactly how this preferred behaviour follows from students learning about research ethics is not immediately obvious. There is, thus, some confusion about the true purpose of such learning and, thereby, the content of ethics education. Is it simply knowledge about research ethics that is needed? Or is it inculcating an ethical approach? At the very least students should become skilled at recognising and discussing ethics problems, a necessary, but not sufficient, precursor to ethics maturity. The first step, then, toward achieving this is to identify the sorts of ethics problems that students find difficult. This is the discovery reported in this paper. It is a question of sociology or human nature why knowledge of research integrity principles is not always put into practice. Behaviour is about choices, albeit ones based on knowledge.

Formal, course-based teaching of engineering ethics has been much examined, particularly at the undergraduate level, where it is becoming more common to find engineering courses in which something about ethical practice is an explicit learning outcome. Debate continues, though, about whether or not these courses work as a way of improving ethical practice. For example, both Anderson et al (2007) and Cech (2014) showed it makes scant difference; in contrast, Borenstein et al (2010) and Skinner & Bushell (2013) claimed some success, at least in developing students' awareness of problems and expectations. When it comes to engineering research students and ethics, though, there is very little published work (and none found directly useful to this study). Nevertheless, it seems reasonable that courses will be equally effective with research students as with undergraduates and this will be assumed for the purposes of this paper. How effective such coursework may be in reducing (research) misconduct is unknowable, even though it is seen to be effective in helping students identify and engage in a shared discussion about these critical issues.

There is, however, much more literature investigating research students in the health disciplines, wherein experiments are much more commonly conducted directly with humans. For example, Schmaling & Blume (2009) and Plemmons et al (2006) both showed that formal instruction improved knowledge but not attitudes, and Heitman et al (2007) and Langlais & Bent (2014, and who also included social scientists) did not examine the effectiveness of course-work so much as pre-existing attitudes and understandings.

Australian PhD students engage in a problem-based learning pedagogy, focussed on a single, unified research project. Not only project-specific details, but also generic research-related knowledge, e.g. ethics, is learnt within the supervisor-student relationship. This means that, unless a topic is germane to the project, it is unlikely to be on the student's learning agenda. The past decade has seen some changes to this practice, with many institutions now including some formal, lecture-based teaching of more generic materials, at least in an induction course. The principles of research integrity are a natural inclusion in such coursework.

As part of a formal induction course at UNSW, engineering research students in their first year of enrolment were provided with a single lecture exploring the general ethics principles under-pinning research practices. Following this lecture, students worked in groups to decide whether or not each of a list of simple actions was ethically appropriate. The results of each group's deliberations were collected and examined for feedback purposes. In total, approximately 400 new research students were involved, over three semesters. By a wide margin, conflicts of interest proved to be the most difficult issues for them to assess. Indeed, the amount of difficulty for these problems, compared with others, was astonishing. The research-teaching nexus is usually about taking research to the 'class-room.' This work suggests that the strengths of class-room teaching should be brought to the learning of research practices.

The next section provides more details about how conflicts of interest were identified as the key problems for students. It is followed by a discussion of the implications for teaching ethics to research students.

The Discovery

This study is concerned with the thinking of higher degree research students during their first year of study at UNSW. The students did the task described below while completing the research induction course GSOE9510.

During this course, the Faculty's new research students receive a one-hour lecture introducing the formal principles under-pinning ethical research. This focusses on research integrity, as defined by the *Singapore Statement on Research Integrity* (World Conf Research Integrity, 2010) and the *Australian Code for the Responsible Conduct of Research* (NHMRC, ARC & UA, 2007). Following this lecture, to reinforce learning, a staff member spends about 20 minutes discussing six simple examples with the students, to determine "what is wrong here." For example,

> *Not informing people the project is sponsored by the military.*

The remainder of the three-hour class involves the students working in self-organised groups of six to eight, seated around a table and facilitated by a tutor. They are given a list of 38 simple actions, each described in a simple statement, e.g.

> *Quoting someone with acknowledgement but without permission.*
>
> *Purchasing lab supplies from a friend's company.*

Students must collectively decide whether or not each action was ethically acceptable. They may also choose 'it depends,' and provide a reason. In practice, less than half of the 'it depends' answers come back with a reason indicating that this answer might be also interpreted as 'don't know' (though blank answers were that). Each table records its decisions on an anonymous worksheet, as a quality assurance measure to allow staff to check what students were thinking. The aim is simply to see how well they translate the theoretical ethics principles to real situations and so to crudely assess the effectiveness of the state of knowledge of the class. To complete their formal education about research integrity, students later complete an online module. After that, it is entirely up to what is learned from the supervisor and other people while prosecuting the research project.

This activity occurred for a total of 3 sessions in 2015 and 2016, when a total of 57 different tables completed anonymous worksheets which were collected and analysed. The result of this fed back into subsequent teaching. With six to eight students per table, approximately 400 students in total will have been involved in this exercise. The exact number is unknown as attendance was imperfectly recorded. Hence, it is also impossible to know the exact make-up of the student population involved. However, the research student cohort as a whole comprises approximately 72% male (28% female) students, 93% PhD (7% research master) students, and 91% full-time (9% part-time) students. There is a wide mix of cultural backgrounds: 21% citizens, 23% permanent residents, 55% international students, and 1% New Zealanders. There is no reason the students involved in this task departed far from that mix. The students are from all engineering disciplines. Proportionately more will be from the larger disciplines (civil and computing), but this is rarely more than 20% of the entire cohort.

For analysis, the 38 questions were grouped into eight different categories: publication and review, human research, handling data (processing and management), intellectual property, conflicts of interest, procedures, supervisor relationship, & safety. These eight groups are convenient for most problems associated with research integrity, but they have no theoretical basis. The questions were presented to students in random order.

The responses from all 57 student tables were tallied for each of the 38 questions, and then the average response was obtained for each question category. Table 1 shows the results. Number of questions is the number in that category. Average unsure is the average fraction of 'it depends' answers. The average score requires more explanation. For each question, there is an answer which most (if not all) ethics theorists would support. Call it the Better Choice. It is not always 'no' (to keep students alert). Discard the 'it depends' answers for a question; subtract the number of Worse Choice answers from the number of Better Choices; normalise this difference. The score is +1 if all committing tables agree with the Better Choice and -1 if all tables disagree.

Table 1: Aggregated student replies for each ethics problem category, ordered by average score.

Ethics focus category	no. of questions	average score	average unsure
Procedures	3	0.96	0.07
Handling data	6	0.86	0.14
Publication & review	8	0.79	0.11
Intellectual property	5	0.72	0.13
Supervisor relationship	2	0.64	0.24
Safety	1	0.48	0.23
Human research	8	0.46	0.22
Conflict of interest	5	***-0.13***	***0.36***

The startling result of Table 1 is how challenging issues in the conflicts of interest category proved to be. Something had to be most difficult, but it is the magnitude by which it comes last that surprises: it is the only category for which the average choice—when a definite choice was made—is a Worse Choice and just over one third of student tables chose 'it depends' (or were unsure). When compared to other categories, the degree of this difficulty is so large that, despite not being designed as a rigorous piece of research, this is worth reporting.

Human research ethics proved second most difficult. This is less surprising because most new research students will have had very little formal experience of research with humans. Indeed, most will never need to learn about this during their project work either, and it suggests a gap in the training of young researchers that needs filling by such class-room activities.

The safety score is interesting. Why is it so low? This single question was included to see the response, as a form of calibration. Maybe its answer is the cavalier attitude of youth, or maybe an expression of the perversity when confronted with a 'trivially obvious' question. Or maybe something else altogether. A more rigorous piece of research is needed to explore this further.

You can see that the students did reasonably well with the ethics associated with the other categories, including publications and data integrity.

The categories of ethics problems in Table 1 are somewhat arbitrary; problems could be grouped otherwise. However, references were scanned to see whether any theme had been ignored. The categories here compare favourably with the chapters in the Australian guide (NHMRC, ARC & UA, 2007)—management of data, supervisor/trainee relationship, publication, authorship, review, conflicts of interest, collaboration, and breaches process—and the chapters in Steneck (2007)—protecting humans, protecting animals, conflicts of interest, data management, mentor/trainee relations, collaborative relations, authorship, peer review, and misconduct processes. Thus, we believe that they are adequate to cover the range of problems engineering students need to cover in their education as researchers and there do not appear to be gaps that need adding to the limited class-time and missed by these recommendations. Note that animal research was not considered as a relevant category in this paper.

Given the differences in methodology, it is difficult to compare the results here with others. However, it is worth noting that the large survey of commencing biomedical students by Heitman et al (2007) had conflict of interest at the bottom of issues with data management matters at the top, and they were also concerned by relatively poor scores on conducting human or animal research, given their focus on experimenters on people or animals. Similarly, Langlais & Bent (2014) found conflict of interest to be worse understood than data management and publication ethics.

Discussion and conclusion

Providing generic teaching of ethics can ensure students have a balanced awareness of the sorts of challenges they may confront in their future work as researchers. However, three hours of formal learning is insufficient to cover all the nuances of research integrity, so those ethics problems needing most urgent attention must be identified. As a first step, this paper shows that conflicts of interest are the class of problems that our engineering research students found most difficult. Changes have been made to the one-hour introductory lecture, to better explain and illustrate the ethics associated with conflicts of interest. First results from 2017 have shown an improvement, but this remains a work in progress.

Anecdotally, some supervisors don't appear to understand conflicts of interest very well either. Certainly the highest levels of leadership of our society provide plenty of examples of conflicts of interest not being identified, not challenged, and thus indulged. Given this example, perhaps we should not wonder at their being the most difficult challenge for students. Also, the aggregated nature of student responses used in this paper meant that no information became available about whether or not any particular sub-group (e.g. cultural backgrounds) may find these problems more confusing than others do. Heitman et al (2007) surveyed individual students to show that this was the case.

It is reassuring that students performed relatively well with topics typically explored from the earliest years of their engineering education, issues such as respect for intellectual property (and avoiding plagiarism) and keeping trustworthy experimental records. This is particularly pleasing given the diverse educational backgrounds of these students.

We conclude that there is a need to cover generic aspects of human research in greater details in the common coursework requirement. This is for completeness. Most students will not need to submit an application to a human or animal research ethics committee during the course of their respective degrees, and so will not learn more about the relevant principles from conducting the project. This missing of a key component is an inevitable risk of relying entirely on a problem-based learning pedagogy.

Ethics values form part of a researcher's identity. Just as parents generally have the strongest influence on an individual's inter-personal ethics, the strongest influence on a student is observing the behaviour of the supervisor and other established researchers, which is intuitive but has also been demonstrated (e.g., Anderson et al, 2014). Coursework will never have an impact to match that. We are all familiar with how work-places disparage the achievements of students in the academic context of universities and this badly affects students' attitudes to study. Learning about ethics in a teaching context will be worthless if the supervisory team downplays its worth. Nevertheless, effective instruction is able to awaken awareness of ethics problems. This paper argues for those topics which need the more urgent attention in the coursework provided for research students.

References

Anderson, M. S., Horn, A. S., Risbey, K. R., Ronning, E. A., De Vries, R., & Martinson, B. C. (2007). What do mentoring and training in the responsible conduct of research have to do with scientists' misbehavior? Findings from a national survey of NIH-funded scientists. *Acad. Med., 82*(9), 853-860.

Borenstein, J., Drake, M. J., Kirkman, R., & Swann, J. L. (2010). The engineering and sciences issues test (ESIT): a discipline-specific approach to assessing moral judgment. *Sci. Eng. Ethics*, *16*, 387-407.

Cech, E. A.. (2014). Culture of disengagement in engineering education. *Sci., Technol., & Hum. Values, 39*(1), 42-72.

Heitman, E., Olsen, C.H., Anestidou, L., & Bulger, R. E. (2007). New graduate students' baseline knowledge of the responsible conduct of research. *Acad. Med., 82*(9), 838-845.

Langlais, P. J., & Bent, B, J, (2014). Individual and organizational predictors of the ethicality of graduate students' responses to research integrity issues. *Sci. Eng. Ethics, 20*, 897–921.

NHMRC, ARC & UA. (2007). *Australian Code for the Responsible Conduct of Research*. Retrieved September 13, 2017, from http://www.nhmrc.gov.au/_files_nhmrc/file/publications/synopses/r39.pdf.

Plemmons, D. K., Brody, S. A., & Kalichman, M. W. (2006) Student perceptions of the effectiveness of education in the responsible conduct of research. *Sci. Eng. Ethics*, *12*, 571-582.

Schmaling, K. B., & Blume, A. W. (2009). Ethics instruction increases graduate students' responsible conduct of research knowledge but not moral reasoning. *Account. Res., 16*, 268-283.

Skinner, I. M., & Bushell, G. C. (2013). *Do ethics courses make engineering students more ethical?* Paper presented at 2013 IEEE International Conference on Teaching, Assessment and Learning for Engineering (TALE), Kuta, Indonesia.

Steneck, N. H. (2007). *ORI Introduction to the Responsible Conduct of Research*. Retrieved September 13, 2017, from https://ori.hhs.gov/ori-introduction-responsible-conduct-research.

Steneck, N. H., & Bulger, R. E. (2007). The History, Purpose, and Future of Instruction in the Responsible Conduct of Research. *Acad. Med., 82*(9), 829-834.

World Conference on Research Integrity. (2010). *Singapore Statement on Research Integrity.* Retrieved September 13, 2017, from http://www.singaporestatement.org/statement.html.