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Student engagement in an engineering ethics course

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Subject Area: Engineering Ethics

This case study has been developed from data gathered through observations of the teaching component, interviews with the tutor and a student focus group (the focus group was made up of students from different departments at different stages of the course: some had completed the course in the autumn term and some were half way through the course in the spring term).

Background
This case study outlines the development and implementation of an Engineering Ethics course across a number of engineering departments at Imperial College London. It explores students' experiences of the Engineering Ethics course and reflects on Esat's wider engagement with colleagues across the engineering departments to involve them with this course and also to embed components of engineering ethics across the different programmes. The Engineering Ethics course is taught on four programmes in the first year (Aeronautics, Bioengineering, Chemical Engineering, Computing) and other departments are exploring this opportunity to fit in with their own timetables. The course consists of between three to six hours of lectures, typically delivered in a three week block, followed by a two week self-directed design project the students undertake in their personal tutorial groups (five to eight students per group). Where possible, personal tutorial sessions are also used to allow other academic staff to oversee progress of the projects and/or provide feedback to students on their assignments (marked and feedback prepared by Esat). Briefing notes as well as all course materials are shared with tutors and Directors of Undergraduate Studies prior to implementation with students.

Esat's dual background in Chemical Engineering and Psychology of Education has enabled him to design and deliver a course based on strong pedagogic principles yet highly relevant to engineering degrees. The course aims to raise student awareness of the importance and value of ethics in engineering work, study and other professional contexts and provide students with practical approaches and skills for applying ethical frameworks to decision making, problem solving and conflict resolution. The courses are typically three sessions per department (either in the autumn or spring terms). Sessions vary from one-hour lectures to double-lectures. One hour of personal tutorial time is also arranged for assignment support or feedback where possible (academic colleagues are also involved in the second stage of the course, utilising Imperial College's personal tutorial scheme devoted to either the development of the student assignment on ethics, or feedback on the marked assignments).

Students on the course engage with the topic through: (i) the use of multiple learning resources: video, anecdotes for voting/discussion, role play, audio recording; (ii) discipline and student-life specific examples; (iii) connections to later design and project work, work-placement experiences and other skills training – an ethics VLE site has been set up for continued support.

A typical lecture session (as observed) involves an array of teaching approaches to engage students with this key aspect of Engineering. For example, a lecture session will include (and this was borne out in the observation):
- video clips and student discussion/voting to illustrate differences in opinion, and the requirements (skills) for ethical decision making
- anecdotes/videos (some humorous, some discipline-specific) to illustrate the precautionary principle, social experimentation

- student-led extraction of frameworks for ethical decision-making through the consideration of several work and student-life scenarios
- the subsequent connection of these to established ethical frameworks and codes of conduct
- the demonstration of tools for decision making (e.g. line-drawing; creative middle-way) and a design-based approach (analogous to a technical design approach)
- role play and/or audio of an enacted script to illustrate generic categories of occurrences which lead to conflict.

In the last part of the final lecture, an introduction to the course assignment (group project) acts as a summary of ethics in the context of effective group work. The assignment involves the development of a proposal for further ethics engagement of students in that discipline (see below).

In the lectures the students were asked to examine different opinions and to develop and share opinions, whilst considering how an engineer's professional ethics is more than just an opinion – engineers need to consider a lot of viewpoints and ensure they are still doing a professional job. Examples of materials the students cover are varied, from contrasting views on stem cells (using video clips to highlight how an array of facts and perspectives about stem cells are required to consider the many competing factors) to the space shuttle disaster (using video clips and role play in the lecture). Through questions and answers from the students and the use of 'clickers' the students were able to engage with these cases. Students responded positively to these interactive lecturing approaches and found that this was both stimulating and also enabled them to develop their learning, as they were in the lecture and could see scope for including this type of activity in their other lectures. The students in the focus group described only experiencing very traditional lecturers, with little opportunity to interact with the lecturer or consider their learning through an activity.

The course assignment asks the students to develop a resource, method or activity that engages their peers in ethics in a "fun but meaningful way". They are asked to produce a description of the proposal (on two sides of paper maximum), with a statement of the key ethical concept(s) being addressed. Diagrams, illustrations and photographs may be included, as well as any other creative medium to support the proposal. In the assignment remit they are given support to reflect back on the lectures around what ethics topic stood out most for them and to consider if this message could be integrated into their proposal in a creative and student-relevant way. How can the Engineering Council's codes of conduct be used within their proposal? How do they identify aspects that hinder responsible action (such as fear, group pressures, self-deception, self-interest, acceptance of authority, limited perspective)? They are also invited to consider what would be a teaching format that would make the activity interesting (e.g. role play, debate, game, video) and are not restricted to considering only developing a report. The assessment reflects the process and content of the assignment, with grades being allocated equally to all group members based on:
- educational relevance (a clear ethics message learning outcome, originality, feasibility, i.e. can it be realistically applied, clarity of proposal)
- effective group work (creating and supporting a good group climate, open communication which respects and involves all members, idea generation, planning and time management, team roles – e.g. write-up, media support, overall coordination).

The best three proposals (as selected by a team of [department-relevant] academic staff) are announced and in some cases a prize awarded. During the observation of this lecturer I saw the award ceremony and students appeared very proud of the award for their efforts and this small element of competition seems to have been very well received by all.

Reasons for introducing this teaching method

The course has been developed for a number of reasons:

- student desire for engagement in work that is "meaningful to society"; the course emphasises good work and *aspirational* ethics
- preparation for design courses requiring stakeholder considerations and wider social and environmental impact evaluations
- ethics education as a basis for other skills development courses, e.g. leadership and teamwork
- personal motivation (Esat's background in the Psychology of Education and Chemical Engineering and his ongoing interest in embedding social science courses in engineering made the introduction of an Engineering Ethics course natural; additionally to consider introducing an ethics thread throughout the degree programmes)
- course accreditation requires greater student awareness of ethics – the course and approach to embedding ethics at Imperial reflects a clear need from the professional bodies to foreground ethics in the curriculum and this course enables departments to address this aspect of their programmes.

Lecturer's perspective

The lecturer describes the development of this course and an ongoing ethics thread in the array of engineering degrees at Imperial to be "*a natural fit as it builds on my engineering and social sciences background*". The course aims are to really enable students to think differently and critically about the work they do and not just accept the science and traditional design approaches. Esat describes how he worked with the Directors of Undergraduate Studies from across the engineering departments to develop this course that has at its core an engineering perspective that integrates well with the rest of the engineering curriculum. The lecturer designed a course that could be adapted to fit in with the different departments' scheduling, thus the course design is flexible – offering between three to six hours of lectures - but the assignment was kept the same to collaborate with students "*to contribute to raising the profile of ethics in their degree*". The course was piloted last year in the Department of Aeronautics and is now incorporated in the courses of four first year programmes, with more departments exploring the possibility of including it in the next academic year. Another key factor that has led to its successful roll-out across the departments was positive staff and student feedback on the pilot last year and from the autumn term this year, alongside departments being conscious of the Engineering Council's requirements as part of their accreditation processes.

The lecturer explains that the very nature of the topic lends itself to student engagement in the lectures, which he says at first was a little surprising for some students. The lectures and assignment were designed to allow students the opportunity to reflect on ethics from various positions and to foreground the professional requirements of engineers and consider ethics as an integral part of their practice.

The lecturer considers that when developing such courses it is vital to get the right balance between ethical frameworks (i.e. 'theory') and the transferable skills needed for ethical decision making. So it is important to use a lot of anecdotes and case studies and allow students to discuss the issues they raise as well as their thought processes, personal values and any assumptions. The lecturer draws on a lot of existing materials (e.g. from the Engineering Subject Centre, resources from professional societies and some excellent textbooks) and has been creative in contextualising the material for different engineering departments and positioning ethics as essential for all aspects of engineering, be it academic research or industry.

Students' perspective

All the students described the course as "*being very different from their other engineering courses with more interaction in the lectures and not just being told how everything is done*". They all preferred this style of lecturing as "*it was easy to concentrate*". The students went on to talk about the course being about "*what choices engineers have to make and questions we need to consider in practice and open our minds to see what other people think about a range of issues*".

The students described how they enjoyed working through the case studies in the lectures and actually being "*asked to give an opinion on these cases*". All were positive about using the clickers in the session "*to express our opinions without raising our hands*" and said it "*stops people being shy about expressing their opinion and these issues can be controversial so [it] allowed people to disagree without confrontation*". They said that when they are asked to give a show of hands they think this seems to encourage "*a following the crowd mentality and this determines people's responses rather than what they really think*". They all noted that the balance between the lectures and the assignment seemed fair and during the assignment some recalled that "*we had a lot a lot of fun.*" All felt that this interactive approach to ethics seemed very appropriate and the course was to "*teach us how to think about these things and makes us realise things we didn't realise before*".

In addition to talking about the ethics aspects of engineering, students talked about how the course also focused on types of people in teams and how it was useful for them to consider the different types of people needed in a group. The students also noted that for this assignment "*we actually had to write English for it and it mattered*". They identified that being assigned groups had its pros and cons as "*sometimes you work with people you don't get on with and this is more realistic but logistically [it would have] been nicer to choose our own groups*". Students explained how they navigated around some of the practical problems of getting the groups together by using various technologies, e.g. many used Google Docs and Google Wave to meet up and share materials during the assignment phase of the course.

There was mixed opinion about the focus of the assignment, some felt it was positive to be given such an open-ended assignment and be creative whilst others suggested it would have been more useful to be give a case-study to analyse. After some discussion, the students generally agreed that the open-ended nature of the assignment was more relevant and supported their learning in considering ethics in engineering. All indicated that they would like to see more ethics in the upper years of their degrees as "…*ethics never stops growing and we still need to consider it in others years and good to have it in [the] first year as we start thinking about ethics in our professional developments but must keep it in mind every time we do anything…so some more sessions [would] be good*".

Issues

- The students noted that it was difficult getting used to there being no right and wrong answer and the lack of proofs and formulae for what is ethical or not. Consequently they would have liked more opportunities to discuss the many grey areas that ethics raises. For example, some said they were still a little puzzled about the boundaries between incentives and bribes and perhaps more case studies about this would be useful in the future. However, Esat's perspective on this is that, given the rather limited number of lectures, it is better that students in the first year are aware of ambiguity in "boundaries" and the possible approaches and sources for clarity, rather than try to give prescriptive guidelines for all possible occurrences.

- The lecturer noted that some staff are reluctant to engage in non-technical aspects of engineering but at the same time his motivation for this course was well received as it ensured that ethics was taught in an interesting and engaging way. In a bid to engage and support staff

with the personal tutorial sessions on ethics, the lecturer provides background materials about the course and assignment and suggestions on tutorial discussions. This should help to integrate ethics into the personal tutorial system in use at Imperial, and thus widely involve academic staff in the discussion of ethics with their students.

Benefits

- It is very positive to see ethics courses in the first year to encourage students to think about ethics from the start of their studies. Additionally, this course is front-ending a threading of ethics throughout the upper years of the degree programmes. Such threading includes opportunities to integrate aspects of ethics into existing courses and design projects, and even reflective reports on work-placement experiences.

- The interactive approach to lecturing and the assignment enables students to develop and express their own opinions and enables the culturally diverse student cohort to freely express their opinions and then review this in light of, for example, the Engineering Council code of ethics and its application to professional engineering. Currently, student ideas for ethics teaching and learning (as generated from the assignment) are being collated in a database and should be of value and interest to engineering teachers. Several student ideas are also being developed for implementation within Imperial. Further details and examples of 'student-inspired activities for engineering ethics education' will be appearing as a publication in the Science and Engineering Ethics journal.

- The use of the clickers and case-studies and various multi-media in the lectures and on the VLE enables students to learn as they progress through the course. The utilisation of votes at the start of the lecture, followed by a discussion and re-voting worked very well and enables both students and lecturer to evaluate the students' learning.

- The lecture's built-in flexibility in the course design ensures this course can be adapted to different departments' teaching needs. The course has core material and then it is contextualised to reflect the different engineering programmes. Additionally, a willingness to be flexible within the lectures (as observed) ensures that there is scope to work more on aspects of the case studies students are more engaged with.

- Lecture provision and supporting course materials reduces the workload of personal tutors whilst still engaging them in the process. For some departments the adaptability of the lectures is leading to more conversations about what can be done together in the future around ethics provisions in their programmes, thus embedding components of engineering ethics teaching across different courses and lectures. This shared approach to ethics in upper years should hopefully ensure a more sustainable and progressive approach to engineering ethics teaching.

- The course encourages students to engage with the ethics codes of professional bodies and at the same time it enables students to develop a number of transferable skills. For example, team work (some students already described that this course had helped them with subsequent group exercises in other courses), time management and report writing. The course design and delivery supports students to learn how to think about and cope with problems that do not have a definite solution, and how to manage disagreement in groups but yet move forward.

Reflections

There are two aspects of this course that are of particular note: firstly, how the lecturer has designed and delivered an interactive, engaging first year ethics course adaptable to different engineering programmes and secondly, the threading of ethics throughout the upper years of the engineering degrees at Imperial. The lecturer has taken great care to ensure the course is appropriate for each degree programme and isn't offering a 'one size fits all' approach. This is further reflected in the notes and supporting materials for the tutors when the assignment phase of the project is underway.

The students were clearly very engaged in the course and felt that a lot of the lecturing approaches (use of clickers, discussions, multi-media) could be applied across all their courses and were very enthusiastic about being given opportunities to discuss these topics in lectures. All agreed the assignment was fun and helped them develop transferable skills as well as making them aware of ethics in engineering.

Supporting quotes from students:

"[in] a computing degree we don't always appreciate the seriousness of what we are doing and the ethical implications of it"

"it was interesting for thinking about [work] placements and ethical companies and helping me think about which company I might want to work for – the questions for the case studies really helped me ask these questions of employers for me to reflect on"

"[it] was useful to have [the] engineering codes of conduct for us highlighted (and was new and different for us) and what is essential for engineers to consider"

"ethics will become more and more important when working so [we] need to be ready for it"