What is Science For? Incorporating Ethics Education into the Life Sciences Curriculum at Manchester

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Introduction

The importance of integrating ethics into the educational curriculum is increasingly recognised across a range of disciplines. In medicine, for example, ethics is an essential component of the recommended tertiary curriculum, while in other areas, such as law and engineering, there is growing demand for professional ethics education. Recently this trend has begun to extend to the sciences, particularly biological science, from which many new sources of social controversy have emerged. Educators and science researchers, alike, are beginning to acknowledge the need for an ethics component in tertiary science education.

This development is entirely a welcome and appropriate one, not only because of the issues posed by contemporary science research, but the problems that are faced by humanity at large for which science is placed to address (*e.g.*, the challenges of globalisation, the need for sustainability and the ever-developing notion of social responsibility). These issues all argue in favour of the cultivation of a new generation of scientists with greater ethical awareness. The need and the demand for ethics education in the science curriculum generate a requirement for suitable educational materials and tools to fill this niche. These materials must not only encompass relevant content, but be appropriate for the manner of delivery and the learning environment provided to science students. As such, some of the methods of Enquiry-Based Learning may be particularly appropriate to ethics education in this context.

This report describes the development and pilot-phase implementation of a new undergraduate course within the Faculty of Life Sciences (FLS) at the University of Manchester, supported by CEEBL, and aimed at incorporating a compulsory element of science ethics education into the curriculum in a relevant and achievable format. The course includes elements of EBL and makes use of online learning tools to increase coverage, delivery and student interaction. Preliminary evidence indicates a positive response to the course from

educators and students, and it is planned that the course will continue in future years and perhaps expand to other Faculties and institutions.

Overview

'What is Science For?' was designed as a 5-credit equivalent course for delivery, in the first instance, to all second year undergraduate students in the Faculty of Life Sciences.

The stated aims of the course were as follows:

- To equip students with an understanding of the broader social and ethical context of science;
- To introduce students to key concepts and issues in science ethics;
- To encourage students to reflect on the role of science in society and their own part in this as students of science and as scientists-in-training.

Pilot-phase implementation

The first implementation of the 'What is Science For?' course commenced in September 2009. The course was delivered to all second-year undergraduate students in the Faculty of Life Sciences over a period of approximately ten weeks, from the introductory symposium to the submission of assessment task, peer-marking and final grading. The enrolment for the course during this period was approximately 475 students.

In this first phase, the course was implemented through the existing Faculty of Life Sciences second-year tutorial programme, to accommodate the credit-weighting and workload of the course within the current degree programme structure.

The online components were delivered using Blackboard, the VLE currently in use at the University of Manchester. This system is an integral part of the learning environment for all FLS undergraduates and students are expected to be familiar with and to use the Blackboard system throughout their studies.

The assessment was also conducted through the tutorial programme, with the components of the assessment as described above. The tutorial subject (BIOL20000) is a hurdle requirement for the degree and is currently assessed on a pass/fail basis, but there is scope for individual marks to be awarded for various components of the subject, of which 'What is Science For?' forms one.

Course Content and Delivery Methods

The course was deliberately designed to focus on general issues relevant to science ethics, rather than specific problems (*i.e.*, ethical issues in bioethics). This was primarily because we intended the course to be relevant, not only to biological scientists engaged in research of an especially controversial nature (such as human embryo research or genetic modification), but to all science students, *qua* scientists. We hope the course may eventually be made available to science students outside the biological sciences. Additionally, the Faculty of Life Sciences at the University of Manchester already provides a more specialised unit at third-year level focusing specifically on bioethics (BIOL30152), which enables students with a particular interest in this area to pursue these issues; thus, it was felt it would be redundant to cover such issues within the compulsory course.
Issues touched upon during the "What is Science For?" course included:

1. Ethics and its relevance to science
2. Scientific integrity
3. Scientific responsibility
4. The dual-use dilemma
5. The purposes of science and motivations for research
6. 'Blue-skies' versus applied research
7. The governance of science
8. Regulation of science – ethics, law and policy
9. Intellectual property: patents and copyright in research
10. Commercialisation of research and the public-private divide

Teaching delivery took place using a variety of methods, including face-to-face and online teaching; small group work and large group lecture-style sessions; and use of supplied reading materials and student-led discussions. The course format combined these teaching elements according to the following structure:

Course component	Methods	Aim
Symposium and Case Study This session consisted of short talks presented by scientists and ethicists active as researchers in the field, followed by a case study exercise in which students worked in small groups to identify issues for further plenary discussion.	L; SGD; LGD; EBL	To introduce students to subject and related concepts in an engaging and relevant manner; to increase awareness of issues that may be directly relevant to students at this level; to develop students' communication skills and ability to work in small groups.
Electronic Learning Modules (4) These consisted of materials provided online with self-assessment questions, followed by focus questions for further enquiry and discussion by students using the VLE.	SGD; EBL; VLE	To develop understanding of relevant issues in science ethics; to encourage students to take responsibility for their own learning; to develop students' communication skills and facilitate discussion.
Tutorial: discussion of topics for essay Students were provided with a range of topics and were encouraged to identify relevant issues and topics for further investigation within a small group, student-led discussion within tutorial sessions.	SGD; EBL; T	To assist students to formulate their ideas on relevant topics; to encourage students to identify their own questions for further study.
Essay preparation, peer-marking and presentation Students prepared an essay individually and then marked the work of their peers. The marking process involved a tutorial with presentations and group discussion.	SGD; VLE; T	To consolidate students' understanding of key concepts and develop their written communication skills; to engage students in and give them an understanding of the assessment process; to develop group work and communication skills.

Table 1. What Is Science For? Course components and structure. [Key: EBL (Enquiry-Based Learning); L (lecture); LGD (large group discussion); SGD (small group discussion); T (tutorial); VLE (virtual learning environment)].

Assessment

The major assessed component for the course was an individual essay of 1,000 to1,500 words. A small group discussion was held prior to submission to facilitate students' choice of topics. Students were also assessed on their completion of a short group-work task following the symposium; their participation in discussions using the VLE; and their participation in the peer-marking process and associated presentation.

The breakdown of marks allocated for these components was:

1. Symposium group task - 5%
2. Essay - 85%
3. Participation in VLE - 5%
4. Peer-marking & presentation - 5%

Although the minor components of assessment do not contribute greatly to the overall mark, it was felt that attaching some weight to these in the assessment process would encourage participation in these elements of the course. Furthermore, these components were congruent with broader learning aims.

Discussion and Future Directions

Outcomes and evaluation

The course proceeded successfully as planned, with no major discrepancies from the outlined structure. Preliminary feedback from students and tutors indicated that the course seemed to have been on the whole well-received and successful in enabling students to achieve key learning outcomes.

Formal evaluation of the pilot phase is currently in progress. We plan to use a combination of questionnaire and focus groups, with both students and tutors, to measure attainment of learning outcomes, including core knowledge and understanding of science ethics and development of EBL skills. The results from the evaluation will enable us to improve the course further for future sessions.

Teaching ethics to science students

One aspect of cross-disciplinary ethics education within science is that educational programmes must meet the challenges of delivering ethics teaching (small-group, discussion-based) to a large cohort of students (*i.e.*, an entire undergraduate year level). Courses focusing on ethics and philosophy in a Humanities setting often have smaller student cohorts, which facilitates seminar-style classes and small group, discussion-based learning. This method is well-suited to employ some of the techniques of Enquiry-Based Learning. With a much larger student enrolment, some degree of innovation is required to achieve a similar learning experience.

'What is Science For?' was designed to use a combination of teaching and learning techniques. The initial symposium was held as a large group session to maximise the value of lecture-style teaching and used high-profile researchers in science ethics to deliver the lectures. In the case study exercise, small group work was incorporated in the form of student-led discussion. Part of this involved students defining their own questions for further inquiry, which were then used as the basis for a panel discussion with the entire class and provided starting points for subsequent discussions.

The remainder of the course used online learning and face-to-face tutorials, both involving groups of approximately 6 to 7 students.

A novel peer-marking protocol for student assessment

Another challenge in teaching science ethics is conducting appropriate assessment. One element of the assessment for 'What is Science For?', which we believe to be something of an innovation, was the use of a peer-marking protocol for the main essay component of assessment. Students were asked to mark the essays of two other students within their tutorial group, according to marking criteria that were distributed in advance of the essay submission. Each essay was, therefore, assessed separately by two student markers (double-marking by tutors, though not in a peer-marking context, has been for many years a standard and successful procedure used in ethics assessment at the Centre for Social Ethics and Policy, University of Manchester). For the tutorial session, students were required to prepare a five-minute journal, club-style presentation on one of the essays they had marked, including critical analysis and a justification for the mark awarded. This was followed by discussion with the second marker and agreement of a final mark, moderated by the tutor only where necessary (*i.e.* if markers were unable to agree or if the agreed mark was clearly inappropriate to the standard of the essay).

We believe that this procedure has several advantages to enhance the student learning experience. By involving students directly in assessing the work of their peers, we hoped to give them a better understanding of the assessment process; how their own work in this subject would be assessed; and, therefore, how they might improve their own relevant skills of ethical analysis, critical thinking, writing and argumentation. The possibility for tutor moderation of marks ensured consistency in standards on a level equivalent to that achieved by tutor-marking, while the attachment of a small component of assessment to the marking process was intended to improve participation. Finally, the presentation and discussion in the tutorial session required students to exercise critical analysis skills in their evaluations and facilitated development of communication and group work skills.

Preliminary feedback from individual students and tutors indicates that, anecdotally at least, the peer-marking was successful in these respects. We intend to conduct more specific evaluation of this component within the formal evaluation process, to substantiate this further. If this protocol is demonstrated to be successful, it may prove a valuable tool for ethics education in a wider range of contexts.

Future directions

The 'What is Science For?' course has been well-received by FLS and will continue to be delivered to all second-year FLS undergraduate students at Manchester. In the short-term it will continue to run in a pilot phase format through the tutorial subject. If this pilot can be incorporated into the degree programme structure, it may in time develop into an independent course. It may also extend beyond FLS to students in other sciences (*e.g.*, Engineering and Physical Sciences) providing further opportunities for cross-Faculty education.

Components of the course, such as the Case Study used in the Symposium and the electronic modules, may also be suitable for use in science ethics education at other institutions. We intend to disseminate the results obtained so far through journal publication and conference presentation. If requested, we will make the course available to other institutions, in order to maximise the value gained by the University of Manchester and CEEBL from the development of this new educational innovation.

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