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The Ethics of Innovation: How Life Scientists Learn to Think about the Broader Contexts of Their Research

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EUROPEAN UNIVERSITY INSTITUTE
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This Working Paper has been written in the context of the 2004-2005 European Forum programme on ‘The Role of Universities in the Innovation Systems’, the overall direction and coordination of which was carried out by Professor Rikard Stankiewicz, EUI, and Dr Aldo Geuna, EUI and SPRU, University of Sussex.

The growing role of universities in the ‘knowledge economy’ is well known. A dynamic and well-balanced academic system is a key engine of innovation and economic development. Doubts persist however as to whether Europe’s universities are fully capable of fulfilling that role. The members of the Forum approached these issues by focusing on the following research themes: (1) Universities and the changing dynamics of knowledge production; (2) Patterns of the division of labour in research and innovation system; (3) The internal organisation of academic systems: tensions and adaptations; and (4) Diversity, innovativeness, and the governance of academic systems.

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Abstract

Biotechnological innovations are some of the most sought after economic outcomes of science, but also form the basis of some of the most hotly debated political issues worldwide. The increasingly complex, internationally fraught ethical issues arising from the biological sciences provide impetus for policymakers to compel basic scientists to consider the societal context of their research. Both national (US National Institutes of Health) and international (European Commission) science funding agencies set policies in the early 2000s to require investigators to be certified as educated in research ethics. Do policies for faculty members trickle down to graduate level training? Do formal courses themselves provide the locus of substantive discussion about the broader social and ethical context of the life sciences?

Data from the United States, Italy, and the United Kingdom provide answers to these questions. A content analysis of information on 161 graduate programs in life sciences with implications for human health (mainly molecular biology and biochemistry) shows that where course offerings do exist, they tend to be pro forma. While between one third (Italy) and two-thirds (UK) of the programs that list courses on their websites teach something in the way of ethics, these have been partially implemented on the margins of the curricula.

Accounts from 25 interviews across these three industrialized nations—the United States, the United Kingdom and Italy—reveals a rather traditional ethos (much like Robert Merton's norms of science) towards required ethics training: scientists should give their energy to the 'objective' curriculum, and take other requirements only as far as necessary to secure funding. About a third of the interviews, however, point to local stories where scientists do take ethical and social issues in the life sciences seriously. These scientists tend to view their activities as the exception to global science norms and their efforts as outside of, rather than in response to, national and international science policy. The paper discusses the implications of this gap between bioethics education policy and behaviour. The institutions of science are often slow to change and hollow educational requirements are ineffective at doing more than eliciting shows of compliance. More effective changes seem to occur through informal networks; further research observing the professional socialization of scientists is needed to develop more meaningful policy.

Keywords

sociology of science, bioethics, graduate education, science policy, ethical innovation

Introduction[*]

On 2 November 2004, the residents of California voted to advance $3 billion over the next ten years to fund embryonic stem cell research in their state. In this way, Californians bypassed President George W. Bush's 2001 moratorium on federally funded labs' development of further stem cell lines. A local-regional solution was made for entering into global competition in embryonic stem cell research. Tiny stem cells have thus raised huge political, ethical, and global issues. Life scientists are more often required to reflect on such complex social and ethical dilemmas posed by research in their field.

Rapid changes in the organization of the life sciences as well as in the research itself are associated with increasingly complex ethical issues for scientists. For example, increasing ties between university labs and industrial firms have created complexities for how life sciences faculty guide their graduate students' research (Slaughter et al. 2002). Jeremy,[1] a faculty member with whom I spoke in the UK, described the situation as depending on how much of a graduate student's funding came from a collaborating firm:[2]

> Jeremy: If a student were purely funded by a company, we would have to negotiate more. If the company wanted to dictate exactly what a student did, I'd have to decline the money.
>
> Author: That's quite a strong statement!
>
> Jeremy: [laughing nervously] well, I meant that sort of tongue in cheek. Clearly there would just have to be careful negotiation.

Relations with industry are not new to academia (Noble 1977). The 1880s saw many pharmaceutical industry develop ties with university (Swann 1988). There are now greater expectations that faculty will have a significant portion of their research funded by industry, particularly in the biological sciences (Mowery et al. 2004). And as Jeremy's awkwardness about the dilemma over funding students with industry money shows, ethical issues arising from the changing organization of university science do not lend themselves to simple answers.

The large and growing literature on university-industry relations demonstrates an academic self-reflexivity about the role of the university in society. Attention to the 'social responsibility' of science is not new: during the 1960s scientists in Europe and the US (particularly students) self-organized to bring attention to broader issues like nuclear power (Moore 1996; Ravetz 1971; Blume 1974). Recent science policy developments (i.e., for research funding) that require scientists to consider the social and ethical implications of their work, however, put a post-modern twist on this reflexive turn (Rip 2004). All scientists, even if they never actually lived in an ivory tower, are now expected to be more

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* This paper was presented at the final symposium of the European forum on The Role of Universities in Innovation Systems in June 2005 at the European University Institute in Florence, Italy. I thank the forum organizers Rikard Stankiewicz and Aldo Geuna for many helpful comments on this project. Thanks to Paula Rayman, Stéphane Malo and Sydney Halpern for insightful suggestions on the paper. I thank Pier Patrucco and Petri Rouvinen for practical help with data and analysis. An earlier version of the paper was presented at the Sociology of Bioethics conference, March 2005, Washington DC. I am grateful to Kaat Smets for research assistance. The Robert Schuman Centre for Advanced Studies at the European University Institute kindly supported me with a Jean Monnet Fellowship during this research. Any errors or omissions are my own.

1 All respondent names are pseudonymous to protect confidentiality.

2 Note that the Medical Research Council, a major funder of life science PhD students in the UK, has a program precisely to elicit industry funding for graduate students. The professor in this interview, Jeremy, did not have graduate students funded under these 'Collaborative Studentships,' but did have students working with him on industry funded projects. Collaborative Studentships, however, do not guarantee clear guidelines. Beyond the firm's required amount of student funding and the student's required time working in the firm, the rules are not very clear. In the Handbook on MRC Studentships (www.mrc.ac.uk/handbook_04-05.doc, accessed 2 May 2005) the brief guideline is that partnerships with industry should spell out intellectual property issues beforehand and, 'the agreement should not in any way prohibit the student from achieving a PhD within a reasonable time.'

than specialists. Scientists must discuss the broader implications of their work, including the ethical components. How do life scientists learn about the complex ethical dilemmas posed by innovation in the research and organization of their field? Furthermore, do scientists' responses to ethics training policies differ by national contexts or display more of a global rationalization process? This paper addresses these questions with an analysis of ethics education for PhD students in US, Italian and UK universities. To assess whether the routinization of ethics training for graduate students has occurred across nations and universities by ranking, content analysis of available information on graduate programs is employed. Interview data gathered in the three nations addresses how academic scientists perceive the policy requirements and their views about discussing and teaching the broader contexts of science. But first of all the policy, national, and theoretical contexts of this study are described below.

Policy Contexts: Criticisms of Current Bioethics Education and Policy

In traditional philosophy, ethics is defined as a rather static set of standards for conduct based on a system of moral values. Casper (1998: 138) offers a more practical definition of ethics as 'a set of concrete social practices that can be captured [by] examining the social processes and judgments underlying what comes to count as an acceptable practice.' Casper's definition points to the difference between practical and analytic philosophy. Another important dimension to ethics, however, is described by Evans (2002: 14) as a thinning of ethical discourse to calculable argumentation in which 'not only the link between means and ends, but the features of these preferred ends…make the debate feel thin.' Specifically, the 'means' of biological scientific developments are now only required to respect individual autonomy (human subjects), while societal ends are ignored (e.g., what do we owe to future generations). This paper takes both of these sociological contrasts to analytic philosophy—ethics as more practical and thicker substance for discussion—as key to understanding how life scientists learn to think about ethical issues.

Scientists tend to dislike policies for required bioethics education. But the increasingly complex, internationally fraught ethical issues arising in the biological sciences provide impetus for policymakers to compel traditionally 'objective' basic scientists to consider the societal context of their research. Both national (US National Institutes of Health) and international (European Commission) science funding agencies set policies in the early 2000s to require investigators to be certified as educated in research ethics. The adage comparing attempts at moving academics in the same direction to herding cats seems an apt metaphor for discussing policies that require conformity from scientists. Unlike cooperative sheep, cats scatter in all directions at efforts to round them up. Scientists are curious cats who scatter, feline-like, at attempts to corral them with policies. Politicians and policymakers point to public distrust of science in their attempts to herd scientists. David Guston (2000) argues that the establishment of the Office of Research Integrity and other moves by the US Congress to regulate science shows that the social contract—the trust in science to monitor itself—had broken down by the 1980s. Guston notes academic misconduct scandals as one source of public distrust in science.[3] The rapidity with which American biotechnology firms formed Ethics Advisory boards in the late 1990s following the splashy news of Dolly the sheep's cloning in the UK might also be interpreted as means for coping with a generally distrustful atmosphere toward science.

Thus in the US at least, we might expect that Ph.D. students in the life sciences would receive some training in research ethics. The main federal funding agency in the US for life scientists, the National Institutes of Health (NIH), began in October 2000 to require grantees complete certified trained in

3 Of course, other visible issues also raised serious concerns about science during this time. The public had reason to distrust the development of nuclear power with the 1979 Three Mile Island accident in the US and the 1986 Chernobyl radioactive contamination in Russia. The pharmaceutical industry had its problems with public trust also, as when thalidomide was found to cause congenital malformation in the 1960s.

research ethics (primarily in the treatment of human subjects). In so doing, the NIH asserted that life scientists and scientists-in-training, not just clinicians, need to consider the social implications of their work.

One common way for investigators to attain certification is via a website. Closer investigation reveals that passing the course is mostly accomplished by clicking through dozens of web pages, and by answering a few simple multiple choice and matching questions along the way (see Box 1 for illustration). Overall, the 'certification' seems a rather superficial way to ensure the diffusion of knowledge about protecting human subjects and research ethics generally. Yet this is a significant change from the previous policy of no ethics training at all. Because so many pre-doctoral students are funded through NIH resources, graduate courses in research ethics should also be in evidence. In 1997, 44.9% of all biomedical graduate students educated in US universities received federal funding, and about 75% of those received funds from the NIH (NRC 2000: 24). Accordingly, NIH mandates such as this ethics training certification should have an effect on graduate programs. However, the majority of programs provide ethics training only to those students who are funded on NIH training grants, because they are required to do so (Mastroianni and Kahn 1998).

Box 1. Sample question from 'Human Participants Protection Education' online course to certify investigators as educated in ethics

An institutional review board is:

- A. A group of pharmaceutical experts within the Food and Drug Administration that has been given authority to regulate research involving human participants.
- B. A diverse panel of men and women over age 65 established to represent the health and safety issues of elderly human research participants.
- C. A diverse group of qualified individuals, authorized by Congress to regulate federally supported research that involves human participants.

The overview of the web-based course can be found at:
http://cme.cancer.gov/clinicaltrials/learning/humanparticipant-protections.asp

The picture in US universities reveals that the attitude of life scientists toward NIH ethics education policy is fundamentally one of minimal compliance (Smith-Doerr 2005a). In 2001, relatively few courses appeared in the ethical and social implications of research in biochemistry and molecular biology graduate programs. Two-thirds of the 50 universities sampled did not list any required or elective courses in their graduate program information online. Graduate programs interpret the federal policies so that while ethics courses are formally offered, departments have isomorphically adopted a model of giving no or low credit (and legitimacy) to them. US graduate programs decouple formal policy from practice (i.e., the partial implementation of ethics courses on the margins of curricula). In conversational interviews with academic life scientists in the US, however, Smith-Doerr (2005a) found variation in how seriously individuals took the importance of the broader implications of their work. Some are very serious and thoughtful about the issues, but view their interest as something to be pursued *outside* of NIH enforced policies. Others view the policies as bothersome and the issues as beyond their purview as 'objective' scientists. The professionalization of bioethics may encourage scientists' hands-off attitude if bio ethicists claim the domain for themselves.

Yet this paper goes beyond noting that the bioethics policies as designed are not working out in scientists' minds. This paper joins the sociological literature that tries to understand the social context of bioethics (De Vries 2003).[4] Bioethics is now an institutionalized niche, and has been criticized by social scientists for its narrow and shallow treatment of a set of standardized ethics issues such as informed consent (Evans 2002; Corrigan 2003). The broader policy context of bioethics in the United States, as John Evans (2002) charts in the Human Genome Project and Sydney Halpern (2005) illustrates in clinical vaccine research, is one in which an earlier, deeper debate thinned into a rationalized formula. Part of this thinning can be attributed to the role played by Congress in calling for simple ethical principles that could be enforced by federal funding agencies. But it can also be attributed to the active professionalization of bioethics. As analytic philosophers and lawyers formulate standard bioethics case studies with 'answers' that often reveal a narrow legalistic view, they edge out more complex perspectives on ethical issues (e.g., theological, social scientific). Indeed, some bio ethicists have themselves criticized their burgeoning profession for its narrow treatment of ethical issues. Turner (2004), for example, chastises the bioethics agenda for leaving out the links between poverty and health.

Scholarship from the growing literature on the interaction between social movements and science (e.g., Moore 1996; Kleinman 2000; Frickel 2004; Halpern 2004; Hess 2004) supplies a perspective often ignored by conventional bioethics. For example AIDS activists' relations with life scientists help shape what Epstein (2005) calls 'bio political paradigms,' such as how governmental science agencies define minority groups like gays and lesbians. On the other hand, Reardon (2005) illustrates the barriers to indigenous people groups for entering dialogue with life scientists during the process of defining racial categories. The ways power and organization of activist groups shape their relationship to the life sciences is an ethical issue which bioethics ignores. A better understanding of social movements is just one way a sociological perspective can usefully inform ethics education.

National Contexts: Life Scientists in the US, the UK and Italy

The US, the UK and Italy lend themselves to this cross-national study because there are enough similarities to make a comparison, but key variations that provide enlightening contrasts. All three nations are among the top ten in the world in their percentage of highly cited scientific publications (King 2004). While all three national governments aspire to innovation in biotechnologies, the US clearly has had the central role in biotech industry worldwide, and the UK has a strong lead in Europe. Comparative analysis of university and industry biotech innovation networks has shown Italy to be much less involved than the US or UK, but Italy is still a player unlike other isolated European nations such as Spain and the Netherlands (see Owen-Smith, Riccaboni, Pammolli and Powell 2002: Figure 1).

These nations vary in research funding sources and levels. The US is viewed (especially by Europeans) as having generous federal funding, UK science is more often funded by private foundations (such as the Wellcome Trust), and Italy has the lowest research funding among industrialized nations. For example, private sector R&D spending is almost 2% of the US GDP and about 1.2% of the UK GDP but only 0.5% of Italy's GDP (King 2004). Although Italy has a rich history in science since Galileo, currently Italian scientists are on the periphery in terms of research funding. Consider the comment recently made to the author by an Italian life scientist who has given up applying for research funding from the European Commission: 'When you have to write an application for the EC, you have to keep in touch with agencies that know how to write these proposals, it is so complicated…. There are some questions and forms we do not even know what they are asking.' The severe competition for limited euros means labs in European nations without the

4 Although this paper differs somewhat in focusing less on bioethicists themselves and more on how bureaucratization of bioethics policies facilitates a gap for life scientists, that which De Vries (2003: 288) notes 'between 'paper values'—what people say—and 'real values'—what people do.'

funds to hire the subcontractors to write their grants will continue to go unfunded. And while Italian university labs are much more likely to receive funding from their national government than from the EC, the amounts are so small that faculty often lack basic necessary funds for research. Another respondent in an Italian university explained that they even have to share glassware for experiments with other labs. In my observations, this level of equipment worry was never expressed by American or British life science professors. (The closest I've heard is an American technician complaining about how much glassware the undergraduate RAs break). It is important to learn from settings where scientists have to struggle for basic resources to predict what will happen if support of science stagnates in the US and UK. Will there be similar or different ethical dilemmas facing scientists?

Political cultures for the nations vary greatly as well. Consider embryonic stem cell research. The US currently seems ambivalent toward stem cell research; the UK has landed on the side of no legal restrictions to this scientific inquiry; while Roman Catholic Italy currently forbids any preservation of embryos resulting from in vitro fertilization, which is the source of most stem cell lines. Generally, European publics are more critical consumers of biotechnologies, more sceptical of corporate sponsorship of research, and more willing to engage in public debate on science and technology issues than Americans. For example, the European Union evinces greater nuance in the debates over genetically modified food and bovine growth hormone, attending to broader issues such as how new technologies will affect the cultural tradition of small European farms and dairies (Kleinman and Kinchy 2003). In Italy, funding bioethics is a national priority and there seems to be public awareness of potential pitfalls in new biotechnologies (Berlinguer 2003).

Higher education systems also differ. Italian universities have granted a PhD only since 1985.[5] The doctorate in the US in many ways builds directly on the undergraduate curriculum. The UK has long used a tutorial system and is only now beginning to introduce curricular requirements to the doctorate. The US is a much larger university system, also. As Table 1 shows, there are 261 doctoral granting universities in the US, compared to 77 Italian and 76 UK universities.

While Table 1 describes a variety of relevant points of comparison between Italy, the UK and the US (in university systems, life sciences research funding and regulation, and religious affiliation) a detailed comparison is beyond the scope of this paper. One generally occurring difference in Table 1 is the much greater diversity within the US than within the European nations.[6] The United States has more kinds of universities, more inter-regional mixture of students, a greater variety of research funding sources, a more complex legal approach to stem cells, and greater variety of Christian religiosity.

5 Prior to 1985, the old Italian laurea degree with its research thesis requirement was considered ample educational preparation for university teaching and scientific research positions. In 1999 Italy signed on with the standardized 3 cycle European 'Bologna process' of university education. The first cycle of university education is 3 years (the new laurea degree). The laurea specialistica is the second cycle, +2 years of specialized study (this is somewhat like the old laurea degree and compares to a Master's degree). The doctorate constitutes the third cycle.

6 Perhaps greater diversity generally in the US is due in part to a much larger American population, a larger and varied landmass, the country's geopolitical history of immigration waves from different continents, and its frontier conquering mentality. Diversity among American universities has been attributed to the decentralized, regional system. The Morrill Act designed land grant colleges to meet provincial, practical needs and to educate a wider population in contrast to a nationally centralized, elite scholar focused European system (Rosenberg and Nelson 1994).

Table 1. Brief comparison of national contexts: a few relevant illustrations

	Italy	United Kingdom	United States
Universities' ownership	Of 77, about 80% are public at national level, with a few private (often Catholic).	76 public/national universities, reform in 1992 made polytechnics into universities.	Of 261 doctoral granting universities, 166 public/state funded and 95 private (some religious and some secular).
Early history of universities	First university in Europe: Bologna in 1088.	Oxford University founded in 1249.	Harvard University founded in 1636. Morrill Act founds land grant universities in 1862.
Regional mobility of university students	Low	Medium	High
Prominent university in life sciences, for example	Milano: with 15 of Italy's top life sciences research institutes and hospitals nearby.	Cambridge University: 13 Nobel laureates since 1958 at the Laboratory of Molecular Biology.	Stanford University and UCSF: Cohen and Boyer genetic engineering patents grant over 350 licenses and $27 million in royalties.
Life science research funding	National, overall low research funding.	Research Councils (MRC, BBSRC), private trusts (Wellcome foundation), some industrial.	National Institutes of Health are main source, also funding from industry, NSF, foundations, regional governments.
Legal approach to embryonic stem cell research	Banned, as any frozen storage of IVF eggs is illegal (but see 2005 referendum).	Legal and supported for legitimate research purposes.	Legal but 2001 moratorium on developing any new lines with federal funds, CA votes in 2004 to support in-state research.
Religious background of population	Roman Catholic (strong Vatican lobby).	Anglican Christian majority, with atheist minority at least 15% of population.	Protestant Christian (various denominations) majority, increasing conservative vs. progressive polarization on political issues.

Data sources include: Eurydice; US National Center for Education Statistics; UK Census; Nobel Foundation.

The European comparison, however, goes beyond the national policy level; there are also the effects of international policies made by the European community to consider. In 2001, the European Science Foundation formed an advisory group that recommended national level certification for clinical investigators, including training in ethical issues (ESF 2003). The European Commission's 2002 requirements for research funding applicants to consider 'Science in Society' under the '6th Framework Programme' is probably a closer parallel to the NIH's ethics education requirement in funded research. Yet the Science in Society measures are wider, calling for scientists to consider issues such as how their research can be best communicated to public audiences.

Theoretical Context: Institutionalizing Science

The sociological literature on institutions considers them to be broader patterns of behaviour than are represented by specific governmental policies. For example, Edelman and colleagues (2001) demonstrate how policies that are supposed to bring greater diversity into US firms come to be watered down and flow into established institutional channels. Managers came to define 'diversity' as hailing from different regions of the US or having different religious backgrounds. In this way, managers' rhetoric sounds like new policy but their behaviour conforms to well institutionalized practices of hiring and promoting others who look much like themselves. Generally speaking, institutionalists tend to focus on the ways policy operates as myth more than do political sociologists who instead emphasize how policy shapes peoples' behaviour.[7]

Neo-institutionalism describes a global ethos of science. Drori, Meyer and colleagues argue that a world system of rationalized, homogeneous science policy has arisen since World War II (Drori et al. 2003; Meyer et al. 1997). During this period the rise of science ministries that make formal science policies has created similarity among the nations of the world (Drori, Meyer, Ramirez and Schofer 2003). In focusing on social conformity, this line of research connects to the 'old' institutionalism of science led by Robert K. Merton (1973). Merton outlined an ethos of science, norms that ideally would be universal among scientists. New institutionalism of science departs from the old by focusing less on the functional necessity of institutions and more on the standardized discourse of rationality. Although good at predicting organizational level homogeneity, Drori and Meyer's version of neo-institutionalism fails to provide analysis of scientific actors who strategically define their domain of expertise (Gieryn 2004).

Although not often applied to scientific institutions, some recent neo-institutionalist scholarship seeks to understand heterogeneity as well as homogeneity across the globe. Moving beyond mere criticism of the neo-institutional emphasis on stability and similarity, a literature has developed on institutional change (Clemens and Cook 1999; Lounsbury and Ventresca 2002; Colyvas and Powell 2005). For example, in broadly considering institutional change, Schneiberg (2005) synthesizes a more instrumental, economic perspective (where change represents an efficiency gain) with a more cultural, sociological view (challengers de-legitimate the old ways). Yet equating institutional change with 'new replaces old' leaves out the possible coexistence of old and new modes (Smith-Doerr 2005b). The practice of science in its heterogeneous, contested detail seems to belie the assumption of institutional change as a unidirectional transformation from one way of thinking to another. The boundaries of science are one particularly conflicted region, for example (Guston 2000; Gieryn 1999). Where social and ethical issues meet science, we might expect to find contested terrain.

Data and Methods

To assess the extent of ethics training in life science graduate programs, I conducted a content analysis of course information available on the websites of US universities in 2003, UK universities in 2004, and Italian universities in 2005. In order to understand the more informal side of educating scientists to think about broader social issues of their work, I interviewed life scientists working in universities in these same three countries.

For the content analysis, the US sample was selected randomly to provide a more representative picture. The sampling frame was provided by the list of all American universities with life science PhD programs ranked by the National Research Council (1995). I selected a stratified random sample of about 25% of the schools (N=50). The sample was stratified by the prestige of the university's ranking in Biochemistry and Molecular Biology. I coded all of the top ten programs because these are the most visible. If mimetic isomorphism (DiMaggio and Powell 1983) is in progress, these are the schools that would be the source of copying. Also, the elite ten confer nearly a third of life science PhDs (see Smith-Doerr 2004 for further discussion of the graduate program categories). I randomly selected 20 schools in each of the other two categories: ranked 11-50, ranking 51+. Life science is an evolving area of knowledge, and the lack of standard departmental/program names reflects the interdisciplinary nature of the enterprise. Based on conversations with knowledgeable interlocutors, I chose to focus on Molecular Biology as the most central to life science. When searching a university selected from the NRC list, I searched for the department most closely representing the study of molecular biology.

7 I am indebted to Ann Orloff for this observation.

To have a comparable number of cases in the European countries, I analyzed the entire population of universities in the UK and Italy that have graduate programs in the life sciences applicable to human health (e.g., molecular biology, biochemistry).[8] The number of UK universities analyzed is 58, the list comes from the UK's Research Assessment Exercise (2001). The British government assesses all of its university programs every six years, and gives rankings on the effectiveness of the research departments. I used the list for the Biological Sciences and deleted those universities that only had zoological or agricultural programs. The RAE rankings range from 2 (lowest score) to 5*. Only nine programs were allocated the 5* ranking, so this is similar to the US top ten ranking by the NRC. The Italian university list was compiled from the online database of the Italian science and technology ministry (MURST), statistics office (http://www.miur.it/ustat/). The list includes all universities in Italy. A search collected 53 Italian universities that include graduate education in the life sciences. The ranking for Italy is more problematic, because as yet there is no government or scientific community organization ranking of all schools. However, the Conference of Italian University Rectors (Conferenza dei Rettori Università Italiane-CRUI) has conducted a study of research universities by impact of citations to their publications (per researcher) in ISI journals (Breno, Fava, Guardabassa and Stefanelli 2002). The CRUI lists for biological and chemical sciences (Appendix tables 33 and 35) were used to select the top ten Italian universities. It was assumed that the several universities not included in this report would not have been among the top ten.

One caveat of studying website content is reliance on a particular type of information. Perhaps some schools have more resources for web design than others. In 2003-4, every school sampled in the US and UK had a professional-looking website for a biochemistry/molecular biology related program. All Italian universities sampled in 2005 also have professional websites, and the vast majority have a website for some related life science program. There are differences in the extent of information provided about PhD programs on the web, and this was taken into account in the analysis. I did use a rather conservative measure of whether a program had ethics training. For example, Harvard was coded as having an ethics elective solely because one course, 'Stem Cells and Cloning,' was described as: 'An advanced course in developmental biology. Embryonic and adult stem cells in different organisms will be examined in terms of their molecular, cellular and potential therapeutic properties…. Current findings will be considered in a historical context; *ethical and political considerations will not be ignored*' (www.msb.harvard.edu/Education/Graduate/courses.html, accessed 30 September 2003, emphasis mine). The range of information available online about the ethics courses does vary considerably. Boxes 2a and 2b furnish a comparison of the range of information provided by two graduate programmes. The University of Piemonte Orientale's doctoral program in Molecular Medicine simply lists the scheduled courses, which includes *Bioetica* (Bioethics). The University of Exeter's postgraduate taught programme on Biological Chemistry, however, has nearly a full syllabus for their course, 'The Social Aspects of Biological Chemistry,' including assignments and weekly topics.

Box 2a. Sample information regarding courses on ethical issues at the University of Piemonte Orientale (Alessandria, Italy).

Doctoral program in Molecular Medicine (http://www4.med.unipmn.it/edu/corsi/dottorato/medicina-molecolare/2003/percorso; accessed 3 May 2005):

The scheduled courses are: '1) Basi molecolari del funzionamento delle cellule e dei tessuti; 2) Basi molecolari delle malattie; 3) Diagnostica e terapia molecolare; 4) Biostatistica e bioinformatica; 5) Bioetica; 6) Inglese scientifico e presentazione dei dati in forma orale e scritta.'

8 In order to compare the European programs to the taught PhD programs in the US, the comparable UK programs selected were often taught Master's degree courses (ones that described themselves as preparation for a PhD). In Italy, any available information on relevant graduate level programs was analyzed; taught doctoral programs are appearing in some places.

Box 2b: Sample information regarding courses on ethical issues at the University of Exeter (UK)

Postgraduate MSc in Biological Chemistry; (www.ex.ac.uk/chemweb/postgrad/resources/modulelistings/CHEM024.pdf ; accessed 3 May 2005) Excerpts from online module syllabus:

‘MODULE TITLE Social Aspects of Biological Chemistry

TOTAL STUDENT STUDY TIME 150 hours

AIMS
This module explores a selection of important interfaces between Biological Chemistry and social sciences. Biological Chemistry is a scientific discipline with enormous social impact. The question ‘What is Biological Chemistry?’ is addressed from an epistemological point of view. This discussion includes a critical review of scientific reduction to either chemistry or biology and a study of the in vitro-in vivo problem. Epistemological aspects of scientific statements will be addressed to explain scientific reasoning and common logical fallacies. The definition of Biological Chemistry already contains the seeds for a discourse in Bioethics that supplements the epistemological discussion. The wider acceptance of Biological Chemistry in Society critically depends on the perception of its benefits and potential dangers. This module will engage students in a discussion on the impact of Biological Chemistry on Society in the framework of an open debate that allows for different and controversial views on this subject. Students will therefore learn to critically reflect on their discipline and to justify their activities. This debate also includes a brief review of the economical side of Biological Chemistry where rational drug design and screening, combinatorial chemistry, drugs from genetically engineered organisms and biocatalysis (‘green chemistry’) will be addressed. The final part of the module uses the ethical and social issues to discuss laboratory safety, contamination criteria, the use and handling of genetically altered organisms and ethics clearance related to the use of human tissue.
INTENDED LEARNING OUTCOMES
Subject specific skills: At the end of the module, students will have gained a deep understanding of the context of Biological Chemistry that will allow them to become responsible and socially aware practitioners of this discipline. They will understand that Biological Chemistry is a discipline closely linked to chemistry and biology and that this interdependency on two different Sciences implies a number of important epistemological questions. In addition, students will have a critical awareness of the most important legal implications of their work. They will be able to employ the wider legal framework governing the use of GM organisms and follow the specific safety regulations when dealing with such material. Students will also be able to assess the ethical implications of work with human material and will have learned how to file an application for ethics clearance (from the local NHS Trust).
Core academic skills: The students will be able to engage in a critical epistemological debate of scientific reduction and emergence and the demarcation of different sciences. They will also be able to perform a critical ‘statement analysis’, i.e. critically assess statements made in Biological Chemistry (e.g. in publications) and will be able to spot common logical and epistemological fallacies in arguments. Students will have learned how to engage in an ethical discourse on questions related to molecular biology, genetic engineering and the impact of these disciplines on society. They will be able to reflect on the impact of their work on society and will understand to real and perceived benefits and dangers of their discipline.
Personal and key skills: Students will have well-developed skills to participate in controversial multidisciplinary discussions involving scientists and non-scientists. They will be able to defend a particular opinion in debates without ‘right’ or ‘wrong’ positions. They will also have developed skills in essay-writing and critical argumentation in areas that do not have a ‘right’ or ‘wrong’ answer. This module will therefore enhance students’ social competence since it transfers skills commonly associated with social sciences and humanities rather than chemistry or biology.
LEARNING/TEACHING METHODS
This module is designed to integrate classroom teaching with group discussions and student-centred learning and uses lectures, seminars, debating sessions, independent study, independent and group project reports. ..’

The real question is whether a website does an adequate job of reflecting the priorities of an educating organization. Certainly online information tells us little about the informal organization of graduate programs, such data must be gathered through qualitative observation. What a website does provide is information on the public face of an organization. It may be the case that ethical issues are taught to PhD students informally although they are not mentioned on a program’s website.

Nonetheless, a program's website provides an interesting message about 'what's important about us.' The publicity given to ethics training for scientists is information about organizational goals and the framing of proper roles for life scientists. Qualitative content analysis also reveals whether including some ethics training is mostly 'window-dressing' to appear legitimate to funding agencies, university administration, or other audiences.

I conducted 25 semi-structured, conversational interviews (10 in US, 10 in Italy, 5 in UK) with life scientists. The questions covered the topics of: respondent's professional background, significant changes in the life sciences related to society, with whom the respondents discuss ethical issues related to their field, typical attitudes of colleagues toward ethical issues, opinions on and experiences in graduate student ethics education, national styles of science, and ethics education requirements attached to research funding. Interviews were conducted in English and lasted between 30 minutes to over 2 hours. Eight interviews were conducted by telephone, one was conducted by email (at the respondent's insistence), while the rest were face to face interviews. In analyzing the interview data, I sought to identify common themes that arose across respondents.

Discussion of Results

In this section I first present data from the quantitative content analyses of course offerings, and then interpretations of what the coursework means from qualitative interviews with scientists in the US, UK and Italy.

Comparisons between the US and UK life science graduate programs course listings for ethical and social issues seem to show few differences. Table 2 describes the overall similar picture in the Anglophone nations—somewhat over half of all programs (58% and 57%) offer either an elective or required course on the topic.[9] When considering only those programs with any course listings at all, sixty percent of US and 66% of UK programs have some course that mentions ethical issues. This similarity is demonstrated visually in Figure 1.

Italy is different. Only about half of Italian universities with PhD programs in the life sciences relevant to human health list course material on the web, compared to nearly all of the US and three-fourths of UK programs. Perhaps this lack of information is related to the fact that the PhD as a degree was nationally established in Italy only since 1985. However, even when considering only the Italian universities that do have course listings online, just 30% of the programs have courses covering bioethical issues. Apparently, life sciences graduate students in Italian universities are only half as likely to find coursework in ethical issues as their counterparts in the US and UK.

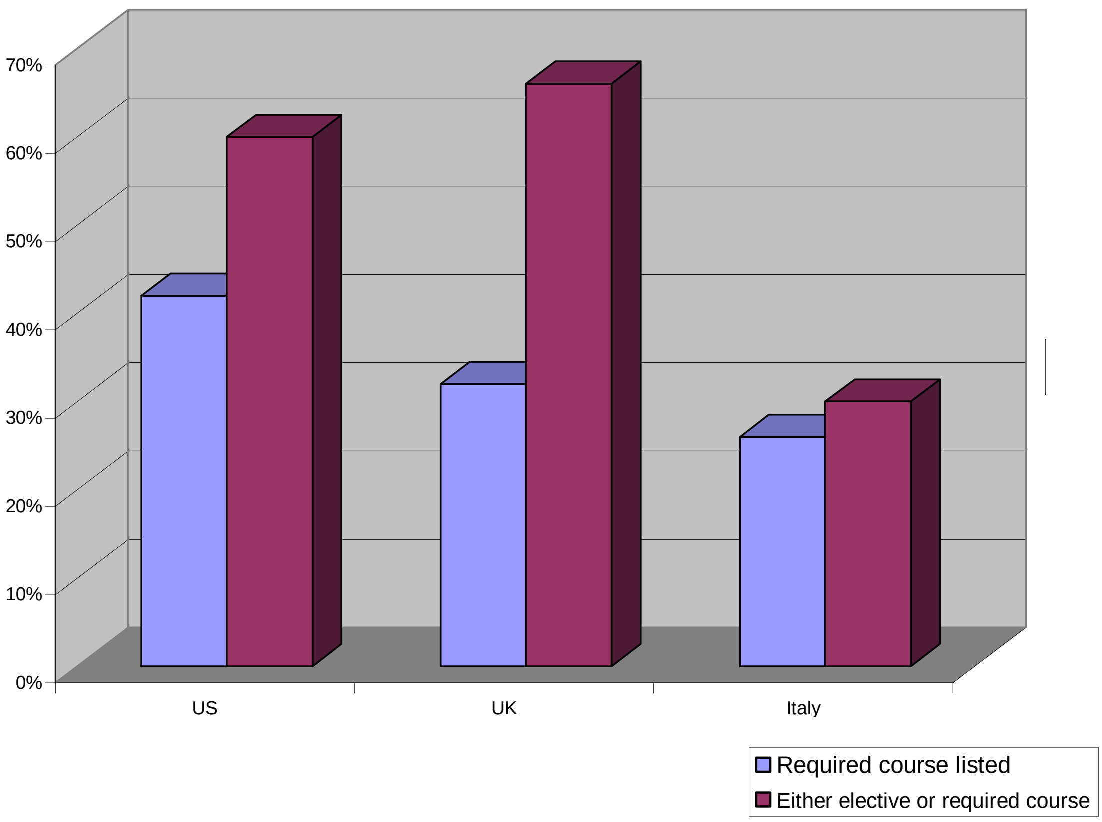
9 In the US, the presence of NIH training grants at the university may affect the visibility of ethics courses, since recipients are required to give these courses to students funded under training grants. An analysis of training grants status by visible ethics courses in 2003, however, surprisingly showed that only 61.9% of the US universities with training grants offered ethics courses. Fewer (37.5%) of the universities without training grants offered courses related to social and ethical issues. Still, training grant status does not fully explain why some universities have visible ethics courses and others do not in the US.

Table 2. Unweighted and Weighted Means (and Standard Deviations) of Life Science Graduate Programs with Courses in Ethical Issues: United States, United Kingdom, and Italy

	US		UK		Italy	
Required course listed	0,40 (0,49)	0,42 (0,50)	0,26 (0,44)	0,32 (0,47)	0,13 (0,34)	0,26 (0,47)
Either elective or required course	0,58 (0,50)	0,60 (0,49)	0,57 (0,50)	0,66 (0,48)	0,15 (0,36)	0,30 (0,46)

Notes: US total N in 2003=50; UK total N in 2004=58; Italy total N in 2005=53. Weighted by programs with any course listings on website: US=48; UK=44; Italy=27.

Figure 1: Percent of Life Science Graduate Programs with Coursework in Ethical Issues



A more noticeable difference appears between the US and UK programs by ranking. Figure 2 shows the top ranked programs in the US slightly more often display an offering of required courses in ethics than other American universities. Specifically, half of top ten programs have required courses and about forty percent of other programs do, as reported in Table 3. The top ranked UK programs are much more likely to list ethics courses as electives than as required coursework. Only about 11% of UK programs with the top 5* rank in 2001 have required coursework in ethical issues listed. This may reflect a difference in pedagogical philosophy at the graduate level; in Europe students are thought to best set their own course, while the US universities are more likely to have a standardized curriculum.

Figure 2: Percent of Life Science Graduate Programs with Coursework in Ethical Issues by ranking

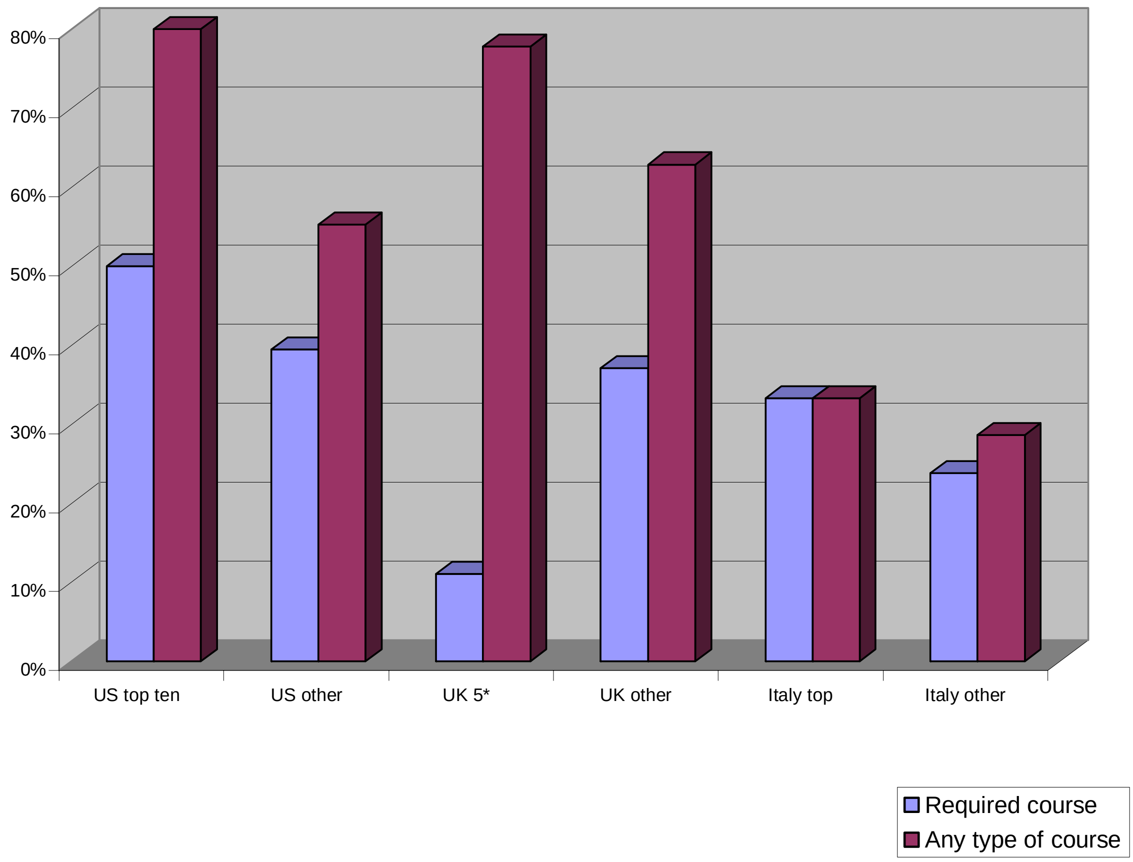


Table 3. Un-weighted and Weighted Percentages of Life Science Graduate Programs with Courses in Ethical Issues by Ranking: United States, United Kingdom, and Italy

	US top 10		US other		UK 5*		UK other		Italy top		Italy other	
Required course	50%	50%	37,5%	39,5%	11,1%	11,1%	28,6%	37,1%	20,0%	33,3%	11,6%	23,8%
Any type of course	80%	80%	52,5%	55,3%	77,8%	77,8%	53,1%	62,9%	20,0%	33,3%	14,0%	28,6%

Notes: US total N=50; UK total N=58; Italy total N=53. Weighted by programs with any course listings on website: US=48; UK=44; Italy=27. Rankings from National Research Council in 1994 (US); Research Assessment Exercise in 2001 (UK); Conferenza dei Rettori delle Università Italiane in 2002 (Italy).

In Italy overall there appears to be minimal coursework visible in what are often considered 'non-science' areas. The few programs that do have coursework in ethical issues indicate that there is little difference between the higher ranked universities and others—the ethics coursework that appears is usually required. In this way also, Italy looks different from the Anglophone nations. Among the top ranked Italian universities only a third of programs with listings have coursework in ethical issues and these are all required courses. For the US and the UK, around 80% of top ranked programs with listings have some course in ethical issues, but these courses are often not required. In sum, the trend for elite universities is that when bioethics courses are not missing altogether (e.g., Italy), they are optional (e.g., UK).

An additional gauge for how seriously programs take the mandate to educate students in the larger social issues surrounding their research is how much credit they give for courses. Of the 20 US schools requiring ethics training in 2003, only three clearly give regular full credit for these courses. European universities rarely list the credits given for courses, perhaps because coursework is still new and standardization (in giving credits) is still in progress. One informant estimated that coursework makes up only about 10% of the PhD student's time in a UK PhD program.

Despite curricular differences, life scientists whom I interviewed in Europe and the US displayed startlingly similar viewpoints about the ethos of science. Generally, they sounded as if they were paraphrasing Robert Merton's (1973) well-known norms of science. Every scientist interviewed described the ideal reaction to political and ethical issues as disinterest. Scientists are supposed to be objective and their research unaffected by anything that goes on outside of their field. For example, Niccolò, a full professor at an Italian university, explained straightforwardly his disdain for mass media reporting on stem cell research; but he discusses this kind of thing with colleagues only rarely:

> Q: What do you think is the most important issue in the life sciences today that touches on the rest of society?
>
> Niccolò: Perhaps the recent advances in the knowledge of the properties and applications of the stem cells. Procedures based on these cells may represent a powerful tool for the health, even if much is still to do, in spite of the stupid triumphalism of the mass media.
>
> Q: I wonder, do you talk about these kinds of issues regularly with anyone else?
>
> Niccolò: No, occasionally. I know only two-three colleagues that are interested to these general subjects, but I meet them rarely.

Within this rather common traditional viewpoint there lies an unspoken gap. While laypeople are not qualified to understand the nuanced implications of scientific research, scientists themselves are too busy with their 'real' work to develop interests in the ethical and social issues.

Yet there are scientists who step into this gap, those who are interested in reflecting on issues such as how science is politically funded or how corporations use research for questionable ends. These scientists describe their interest as atypical and something they have to pursue actively and only in particular places. About one third of my respondents described their informal discussion networks as a place to learn about political and ethical issues, but as an uncommon occurrence in their field. Consider the following excerpt from my field-notes during a conversational interview with two life scientists, Filippo and Luca, held in a university lab in Italy. Filippo was discussing the difficulties of considering the uses to which one's research might be put. A life scientist who discovers a gene associated with cancer might not consider that this research could have harmful effects in clinical settings:

> Filippo: Given knowledge about a gene [MDs] can tell you that you might develop cancer. It's not that you will, but that you might, but people take it as you <u>will</u>.
>
> Luca: Eventually.
>
> Filippo: Eventually, yeah. Even if it does happen it might not happen for many years. Are you better off knowing? I used to think yes, but now I think no. As a patient, you can't feel the <u>possibility</u> in this discussion. And then for ethical issues, also, I read somewhere that in Great Britain insurance companies are trying to push forward these ideas, you know, so they know who to insure. For me this is a sort of <u>disaster</u>.

Filippo, like Niccolo, doubts the ability of laypeople to understand the effects of biomedical developments on their lives. But Filippo is unlike Niccolo and many other life scientists in his strong interest in reading about, reflecting on, and discussing the ethical, social and political aspects of his field.

Luca continued the discussion begun by Filippo by explaining that they commonly had these kinds of conversations in the lab. The fact that they conversed about these issues was *stupefacente* or amazing; this was not normative behaviour for scientists.

> Luca: Here we talk a lot, especially during lunch, about these issues–politics, the social implications of science. These are *stupefacente*–not usual matters that you discuss with people. This is very different from, for instance, when I was in [another Italian university]–at lunch we were talking about soccer, and not much more. Here it is different, we talk much more. I really notice this.
>
> Filippo: We still talk about soccer of course.

We laugh at this remark. Then I ask Luca if he talked about broader issues during his post-doctoral appointments at two universities in the United States. He responds, 'Yes [pausing] sometimes, but not that much. Because maybe you are more targeted toward the work in the US. You know?' I ask why he thinks they are able to have more broad ranging discussions here, but he does not know. When pressed, Luca offers, 'I don't know. Maybe it's just people—common interests.' He cannot explain this exception to the rule. Luca's response to my probing question is probably more an indication that an interviewer can always get someone to respond than a substantive answer to the question.

The global story of objective science ideals is well developed and seems to be recited in a familiar fashion across the developed world. For instance, Antonio, an associate professor at an Italian university, described a group of typical colleagues with whom he could never raise broader ethical or social issues because they saw it as a fundamentally wrong way to think about science. This kind of story illustrating the disinterested ethos of science seems to be an example of institutionalization, but sometimes an exception is noted. Antonio's description of specific conversations in his own lab with students and close colleagues, for example, contrasts to his difficulties in raising such issues in the large faculty at his university:

> Antonio: In Europe there is large debate about the safety of plants that have been developed with transgenic technology… but there are other social issues such as what can be the dependence of third world countries…. Big companies can manage to create dependence of poor countries….
>
> Q: Do you discuss such issues with colleagues?
>
> Antonio: Yes we talk about these issues. For several years in my lab we have had discussion. I have talked with my students about public opinion on transgenic plants. …Patenting is another part of the story. Most plant technology is patented. If the third world wants to use it, to cultivate I suppose they would have to pay money to use the patents. I think that to patent maize, rice, wheat, something that is a primary product is risky….

In the interview Antonio outlined some of these risks to impoverished people and to the environment. Antonio went on to discuss the greater majority of colleagues with whom he cannot talk about the link between poverty, science, and intellectual property rights:

> But there are some people I cannot talk to about these issues. Just regarding transgenic plants, on my faculty people are placing themselves in a group either in favour or against. It is a sort of dualism, there is no average position. Some scientists say okay, that transgenic technology is very powerful without any risk, without any kind of drawbacks. Others say, okay, it is very bad, a risk that we know nothing about. My actual position is in the middle, it is technology with potential for improvement in social and technical areas, maybe a wonderful potential to help with planetary problems like hunger and the environment. But we are working in a delicate part of history, we think we know how plants, bacteria and animals interact but we just know very little—one change can become an effect with complex mechanisms…. People here, scientists in my faculty that believe we have no reason to have any doubt on this technology, it is hard to discuss with them.

Interestingly, Antonio's perspective was that any strong ideological bent made it more difficult to have conversations about the ethical and political issues surrounding life science research.

Similarly, Celia, a UK professor described her own lab as an exceptional place where they had informal discussion over coffee, or in the hallways, about the implications of the latest scientific journal articles for society at large. Celia's remarks also illustrate another common theme in the interviews when describing policy requirements for ethics training. All but two of the scientists interviewed were emphatic about the ineffectiveness of using bureaucratic rules to enforce learning about the ethical and social implications of the life sciences. Celia specifically addressed the requirements for PhD students in the UK to attend courses in 'transferable skills' including ethics:

> It would seem to put more stress on things that are important, in principle, but it is actually not a very large difference from what students would be doing anyway. So it's not much of a change. To be honest it seems mostly to be bureaucracy, just paper filling. We have to sign their books to say they have done these skills. I guess it might be useful for someone if their supervisor is a flaky PhD director, this way students know what they should be learning outside of their lab work. But then, such a supervisor would probably just sign their book whether they took the sessions or not.

The current bureaucratization of bioethics in graduate education seems to have little impact at best, and may even negatively dispose scientists toward the topic matter.

Concluding Thoughts: New Models for Reflecting on the Big Issues?

In sum, the content analysis revealed much similarity: where bioethics courses are formally offered to PhD students, departments in Italy, the US and the UK have partially implemented them on the margins of the curricula. Interviews in Europe and the US also showed similarity in normative scientific discourse: formal bioethics courses are ineffective, and the average scientist does not feel obliged to reflect on bioethical issues since they are supposed to be 'disinterested' and too busy with their 'real' work. Yet sometimes an exception is added: it is different here where we do have more discussion. A question for further analysis is whether local stories can also be institutionalized (the exception to the rule is also a rule), or whether they signal contestation in hidden science culture around ethical and social issues.

The interview data collected in European universities may offer a fairly straightforward explanation for a seeming lack of variation in how graduate programs visibly present themselves: the majority has been exposed to training in the US. Respondents noted more international similarities than differences in the viewpoints of their scientific colleagues toward ethical and social issues (a lack of interest in general, although there may be a strongly interested minority). Many European life science PhDs spend part of their training in the US (as post-doctoral fellows, graduate students or even as undergraduates on exchange programs), thus the diffusion of a US model for what graduate education in the biological sciences should look like is perhaps not surprising. This fact may complement neo-institutional theory developed by John Meyer and colleagues. For example, Drori, Meyer and others argue that a world system of rationalized, homogeneous science policy has arisen since World War II (Drori et al. 2003). On the other hand, in support of an STS approach, discourse among scientists seems to display local contestation in culture and practice around ethical/social issues. The international connections between graduate programs, science policy, and pedagogical outcomes may seem less homogeneous upon more detailed inspection.

We might look to the historical roots of the European university for an understanding of the origins of simultaneous homogeneity and heterogeneity in science institutions. In contrast to the medieval society from which it arose, the European university was a 'super-national' organization with a common language in Latin, common educational structure, and an international community of scholars (Geuna 1999: 42). Despite this historical similarity, current national approaches to funding universities may be a source of variation. The UK has selective policies for funding universities based on focused research excellence, while Italy has had proportional allocation for universities across regions (Geuna 1999). And in the US public financing of R&D, the federal government funds science through a more individually competitive system. The NIH funded only 36 percent of individual investigator project proposals (RO1s) in 1998 (Stephan 2003).

To truly understand the simultaneous similarity and variation in scientists' thinking on ethics, further study observing the socialization of life scientists during graduate training is needed. Such research may reveal that different networks supply the mechanisms for simultaneous global homogeneity and local variety. More formalized educational networks may diffuse the institutionalized version of the story of science norms about ethics—true scientists focus only on their work. Perhaps through mimetic isomorphism (DiMaggio and Powell 1983), copying the prestigious departments from afar, ethics courses take on a particular formula. Case-based analytic philosophical bioethics seems to be the dominant discourse around the globe. Kerr's (2003) study of the content of bioethics policies in Europe describes how policy networks come to frame the issues uniformly in terms of individual choice and scientific progress. Kerr's study sounds very similar to John Evans's (2002) discussion of the thinning of bioethics discourse in the US But more local, personal networks may permit the emergence of groups who engage in more substantive discussion and education about the social, political and ethical side of the life sciences.

Finding simultaneous global homogeneity and local heterogeneity in bioethics education has implications for both social theory and policy. One of the strong criticisms of the institutional argument about the globalization of science policy is that it lacks the micro level mechanisms for how similarity and difference in science discourse arise (Gieryn 2004). A multilevel analysis may be fruitful. If different levels of scientific networks foster the development of simultaneously global-homogeneous and local-variety in the way scientists talk about ethics, this may illuminate some benefits of the convergence of structural network and cultural institutional perspectives. The implications for policy are a bit less straightforward. It is difficult to create policy to stimulate the deepening of informal networks among scientists. But universities and funding agencies could take their current resources set aside for 'bioethics education' and make them available for the creation of more locally invented ways to encourage life scientists to think about the broader context of their work.

Consider one possible pedagogical innovation based on data collected for this project. A comparative framework itself can be a source of creative ideas for ethics education. Giving scientists this example of a cross-national perspective from an interview in Italy might raise broader discussion than an individual case study of human subjects. An Italian scientist who had also worked in the US compared the different approaches to scientific value in his research on 'bioremediation management, that is, dealing with contaminated wastewater.' In the US, 'the efforts are to develop technologies that will quickly and totally clean up what is seen as pollution,' he said. But in Europe, 'we research how to take out the chemical compounds and see what we might be finding from them, and how we might modify them for pharmaceutical use. I think in Europe we approach resources more carefully–think about how we might make money from waste.' To regard environmental pollution as a source of drug discovery raises its own ethical dilemmas (does it encourage pollution?). Another issue that might be raised is how biased this scientist might be in estimating the benefits of his own research, and whether one can see drawbacks in one's own perspective. Open-ended discussion of social science data—both quantitative and qualitative—may spark scientists' curiosity and may produce the kind of creative reflection often missing in current bioethics curriculum.

The key gift of universities to innovation systems is the supply of human capital, of personnel highly trained in advanced scientific and technological methods. Understanding how scientists are professionally socialized to understand their role in the innovation process, in the increasingly complex ethical and social situations presented by their research, is vital. Yet the institutions of science are often slow to change and hollow educational requirements are ineffective at doing more than eliciting shows of compliance. More effective changes seem to occur through informal networks;

further research observing the professional socialization of scientists is needed to develop more meaningful policy.[10]

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10 One dilemma that would need to be addressed in developing effective educational policy is the tension between over- and under-standardization. We can see the problems of an over-standardized, shallow, web-based curriculum (Box 1, for example). But if coursework in ethical issues is not required, the issues may also be glossed over in this case. Then, lack of attention to ethical issues might be predicted in that professors often perceive that classroom time for graduate students must be limited so that students have ample time for working in the lab and writing up results. The dilemma of over- and under-regulation is developed in the legal regulation literature (e.g., Rai 1999; D'Andrea 2005), but falls outside the scope of this paper. See Stankiewicz and Rouvinen (2005) on how intellectual property laws may foster biotech innovation, but how some patents can also unduly constrain the design space of the field.

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