Pedagogical Approaches to Data Ethics

DRAFT VERSION
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Produced for Council for Big Data, Ethics, and Society[1]

I. Introduction

Fostering effective data ethics curricula and pedagogy is likely one of the primary foci of the Council for Big Data, Ethics, and Society moving forward. The National Science Foundation (NSF) has also indicated that this is a funding priority. This document is a survey of existing courses and curricula, situated with a brief literature review about science and engineering ethics pedagogy. The last section of the document provides a summary of existing courses and curricula we were able to locate online and through our networks.

II. Brief review of the current landscape of science and engineering ethics education

The NSF's and other federal funders' priorities have set the tone for much of the landscape in science and engineering ethics education. The 2007 AMERICA COMPETES Act Section 7009 established responsible conduct of research as a federal priority by tying research ethics to economic competitiveness in science and engineering. The NSF's response in the federal register in 2009 introduced a requirement that:

> "[E]ach institution that applies for financial assistance from the Foundation for science and engineering research or education describe in its grant proposal a plan to provide appropriate training and oversight in the responsible and ethical conduct of research to undergraduate students, graduate students, and postdoctoral researchers participating in the proposed research project."

The NSF intentionally provided very little guidance to educational institutions regarding what these ethics training programs should consist of and how the training should be conducted. In order to create new educational resources and establish pedagogical models, the NSF established the multi-directorate Ethics Education in Science and Engineering Program (EESE). EESE established a number of key pedagogical resources that function as repositories for case studies and syllabi, including the National Online Ethics Center, the National Center for Professional & Research Ethics, and the Ethics Education Library. The majority of these resources were situated

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in a Responsible Conduct of Research (RCR) framework: negative, focused on compliance, scaled toward micro-ethics and largely attendant to individual behavior instead of institutional cultures. In the face of the NSF's open-ended mandate, many institutions have come to rely on online tools alone, such as the [Collaborative Institutional Training Initiative](#) (CITI), which has been characterized as a "race to the bottom" because it requires so little of the training institution in terms of time and resources (Kalichman, 2013; Layne 2015). The administrative culture and widespread austerity common across universities militates against time- and resource-intensive responses to such open-ended federal mandates.

Ethicists and Science & Technology Studies (STS) scholars have levied a number of critiques at the dominant RCR model that was fostered with federal funding. Multiple studies have demonstrated that stand-alone RCR training successfully increases awareness of rules, but either fails to increase, or actually harms, broader moral reasoning skills that operate beyond compliance (Anderson et al., 2007; Anderson, 2007; Hollander 2009). Similarly, others have demonstrated that "active learning" approaches that emphasize interaction and group reasoning exercises are much more successful in fostering ethical reasoning (Prince, 2004; Schmaling & Blume 2009; Bagdasarov et al., 2012; Seiler et al., 2011; Waples et al., 2008; Antes et al, 2010; Heitman et al., 2001). Sekerka (2009) has shown that in a professional context ethics training is often focused on the point of hire and following specific lapses, but best practices indicated that engagement should be ongoing. Others have noted the importance of training in macroethics (the broad societal consequences of science and technology) to complement the standard microethics (the norms necessary to maintain scientific practice) approaches of RCR (Hekert, 2014; Vallero, 2007). Some scholars have noted that RCR training was originally formulated for the biomedical sciences, and as federal mandates have moved it outside of its original scope, existing curricula have not responded to the specific conditions of other science and engineering disciplines nor integrated insights from social sciences and humanities (Kline, 2001; Bulger & Heitman, 2007). Schienke et al. (2009) argue that leveraging the NSF's broader impacts criterion in RCR training would enable students to see that successful scientific endeavors require a broad responsibility to social welfare.

Additionally, scholars have examined how to establish curricula that address broad social goods. Cech (2014) recently demonstrated via a substantial longitudinal survey that standard engineering education results in a *decrease* in attention to professional responsibility to public welfare. Cech identified a "culture of disengagement" in engineering education that defines public welfare out of the problem sets around which engineers conceptualize their everyday work. Creating cultures of engagement, defining science and engineering ethics broadly and integrating ethics with interdisciplinary inquiry has become the focus of some ethics training programs (see examples: Science & Justice Research Center, 2013; Knobel & Bowker, 2011; Schneider et al., 2009). Feminist philosophers of science have also argued that the traditional RCR curricula suffer from stunted epistemic assumptions, which lead inevitably to a rather limited view of ethical responsibility that prima facie separates knowing from acting (Tuana, 2011; Barad, 2000, 2007; Reardon et al., forthcoming).

Tracking these critiques of the RCR model from STS scholars (some of which were funded under EESE), the NSF decided to reformulate the EESE program to emphasize the cultural dynamics of science and engineering ethics in the Cultivating Cultures of Ethical STEM (CCE-STEM) Program in 2014 (Layne, 2015). While the EESE program successfully created a bevy of pedagogical materials, it did not often fund research that rigorously tested best practices within or across institutions. Thus the CCE-STEM program is focused on funding comparative research that establishes best practices for fostering ethical cultures. Projects funded so far by CCE-STEM have: reached outside of university settings to include broader communities and professional societies; directly compared integrative and stand-alone modules; developed integrative approaches to ethics in computer science, engineering and design curricula; collaboratively addressed the needs of underserved populations; and developed empirical or quantitative measures for ethics education comprehension and success. For the most part, projects that primarily produce pedagogical materials to be shared and archived are not being funded.

All told, we can see the following trends in science and engineering ethics education both in the scholarship and federal funding priorities, which should inform the Council's push for data ethics curricula and best practices:

1) Integrative approaches are preferable to stand-alone modules. Nonetheless, there are many incumbent resources for distributing case studies and stand-alone modules.
2) When possible, integration with design/practical work should be encouraged. Ethics should be associated with problem-solving, not just rule-following or prevention of harm.
3) The micro-ethics of research should be intellectually and practically associated with broader social goods. Neither the RCR approach nor broad social goods alone are adequate.
4) Culture, collective responsibility, and collaboration are critical components of successful research ethics education.

III. Analysis of existing data ethics syllabi and programs

We categorized existing courses and curricula along criteria relevant to the major differences and debates in ethics pedagogy.

A major topic in science and engineering ethics pedagogy literatures concerns whether ethics should be taught as stand-alone units or integrated throughout the curriculum. A common criticism of ethics training (and ongoing inspiration for innovation in the literature) is that ethics has traditionally been treated as an after-thought worthy of a module or guest lecture at the conclusion of, or outside of, regular coursework. Here we looked at the temporality of ethics training as a good proxy of the approach instructors have regarding the centrality of ethics: if ethics occurs "after the fact" in a course or curriculum we take that as an (admittedly rough) measure of the instructor's approach. Of course, situating ethics at the end of a course could indicate that it is viewed as a high-level activity requiring data science foundations as a prerequisite instead of indicating that ethics are not well integrated. However, we are limited in terms of understanding why instructors made such decisions in these cases.

Somewhat to our surprise, a solid majority of the courses and curricula we surveyed used an integrated ethics approach (according to the syllabi and available course/program descriptions). This is certainly higher than many other science and engineering programs of recent vintage. We suggest several preliminary reasons for this: 1) data ethics is relatively new and so we should expect new programs to reflect more recent pedagogical literature; and/or, 2) data ethics and computer science ethics are favorable to integrative ethics pedagogy because coursework often includes a design element, unlike many other science and engineering courses.

Another substantive difference in ethics pedagogy is whether to adopt a "negative ethics" (do not do X) or "positive ethics" (aspire to do Z) framework. Negative ethics will tend to focus on engineering disasters, research ethics scandals and obeying norms and regulations, whereas positive ethics will tend to focus on accomplishing social goods through science and engineering. Half of the courses we surveyed focused on avoiding ethical problems or examining worst-case scenarios, sometimes (roughly ⅓) in combination with using ethics to launch social good projects, and only one course focused solely on generating social good. This wide gap between positive and negative ethics curricula indicates that one plausible approach to increasing the presence of data ethics could be to emphasize the positive side of ethics as something that strengthens computer science work rather than threatening it. Similarly to the matter of integrative ethics pedagogy, we might expect that the design-driven curricula of data science would be amenable to a positive ethics framework.

Many of these courses or programs are relatively new, which raises the question of whether students have applied these lessons in the real world yet or whether they are still somewhat hypothetical discussions. Further analysis can be done to compare old versus new ethical issues within data ethics curricula.

IV. Data and Ethics Course Summaries

Data Science & Analytics

Data Preparation and Analysis

- Illinois Institute of Technology – USA
- Graduate level, course cross listed in Applied Math but a part of their Master's in Data Science track
- Core, required course for the degree program
- Unclear how recently this was taught
- More Information

A core course for the Master's in Data Science program. Ethics comprises a unit during the coursework, and the focus is on utilizing case studies in computing, stats, and communication to explore ethical concerns in the use of data. This course can be categorized as *research ethics* (versus *ethics as social good*) but is distinct from more common courses on the same topic.

The course description mentions "exploration of ethical issues" in the first sentence, in the context of case studies. "Ethics in the profession" is listed as the last of six course topics, indicating that it comes at the end (though it could be interwoven in other lessons). The ethics lesson mentions two parts: "cases in computing, statistics, and communication" and "professional ethics codes: ACM, IEEE, Am. Stat. Assoc." The textbooks do not mention "ethics" in the titles, and the required text does not mention ethics in the summary on Amazon.

Data Science Capstone & Ethics

- Columbia University – USA
- Graduate level, a part of the offered Master's in Data Science program
- Core, required course for the degree program
- More Information

A capstone course: the teaching focus is on a semester-long project utilizing data science in local applications as a means of addressing social issues raised by data science in industry, government, and non-profit settings. Data ethics are addressed in practice.

In a video about the program, Executive Vice President David Madigan says there are "components of the program that focus on ethical questions that arise in conducting data science" as well as privacy and legal issues. He notes that the program goes beyond the purely technical. Cybersecurity is one vertical in which additional training is offered. Ethics seem to be integrated into the program beyond this course, which can be categorized as *research ethics* (versus *ethics as social good*). There is also a Columbia Data Science Society, started by students, to network and interact with professionals in the field.

Ethics of Big Data

- University of Virginia – USA
- Graduate level, a part of the offered Master's in Data Science
- Executive VP and Provost are listed for Academic Group; no instructor listed
- Not currently scheduled, typically taught in the winter session
- More Information

A core course in the data science program, the course focuses on teaching students to deal with difficult situations and questions in big data science by providing frameworks, contexts, concepts, and theories. This is a professional program with emphasis on real world application versus theory.

Ethics, Law & Policy is listed as a focus area of the overall program, indicating that ethics are integrated into the program. A conference was held in 2014, with danah boyd as the keynote speaker. This course can be categorized as *research ethics* (versus *ethics as social good*).

Data Ethics in an Information Society

- George Mason University, School of Physics, Astronomy, and Computational Sciences, College of Science – USA
- Undergraduate online course
- Led by Dr. Kirk Borne, Professor of Astrophysics and Computational Science
- Current (Fall 2014)
- More Information

Course designed entirely around data ethics and ethics in IT as well as computer science. Utilizes case study and "practical ethical challenges" to address ethical concerns in tandem with best practices in research. Topics include data ownership and access, privacy and confidentiality, use and misuse of statistics and data visualizations, plagiarism and fraud, objectivity versus bias, and the ethical and legal handling and use of human subjects data. This course can be categorized as *research ethics* (versus *ethics as social good*).

Data Science (Program Track)

- City University London – United Kingdom
- Graduate, MSc degree
- Current
- More Information

Offers a core module in research methods and professional issues directly relating to information and data science work. Not explicitly ethics focused but does include the examination of legal, ethical and professional aspects of information professions and industry practices as the fourth and final goal for the core module (it is unclear whether this means that ethics comes at the end). Additionally, course topics such as aggregation and representation, knowledge extraction and explanation, Big Data tools and methods, data acquisition, management and analysis, and social dimensions of data systems and technologies involve ethical decisions. This course can be categorized as *research ethics* (versus *ethics as social good*). Another UK data science program (here) has a very similar design.

Master of Science in Analytics (program)*

- Northwestern University, Engineering program - USA
- More Information

Program has a business focus. Courses include Analytics for Big Data, Data Mining, Data Visualization, Healthcare Analytics, Social Networks Analysis and Predictive Analytics. There is limited course information on the website and it is unclear when and where ethics are incorporated. For example, the Predictive Analytics course covers quality control methods, which may include ethics.

Program not included in numerical survey.

Certificate of Advanced Study in Data Science (program)*

- Syracuse University - USA
- [More Information](#)

There is no mention of 'ethics' in the program summary but the topics noted in brief course descriptions indicate that ethics might come up in class. The course Foundations of Digital Data includes the topic: "sociopolitical environment for digital libraries." The Text Mining course includes social behavior analysis. The Research Methods in Information Science and Technology course includes "philosophies, approaches, and practices of research in information transfer."

Program not included in numerical survey.

Information

Legal, Policy, and Ethical Considerations for Data Scientists

- University of California, Berkeley, The School of Information – USA
- Graduate, part of the [Master's in Information and Data Science program](#)
- Current (Spring 2015)
- [More Information](#)

Excellent example. Approaches the legal, policy, and ethical concerns relevant to data scientists through the use of case studies from a variety of different disciplines. Aimed at approaching these concerns at every stage in the data collection process for a more robust discussion and understanding. Has a multi-disciplinary curriculum. Includes a look at ethical issues in data management (collection, storing, processing, analysis, and use). Syllabus unavailable. This course can be categorized as *research ethics* (versus *ethics as social good*).

Privacy in the Digital Age

- Carnegie Mellon University – USA
- Undergraduate
- Current (Fall 2014)
- [More Information](#)

This course does not explicitly concern data and ethics, but it appears to present (in part) 'ethical' concerns from a different angle, discussing issues of privacy as it relates to data mining and other aspects of IT. This course takes a holistic approach and integrates ethics throughout. It is a cross between *research ethics* and *ethics as social good*.

Law

Advanced Privacy Seminar

- New York University – USA
- Graduate (JD), part of Intellectual Property and Information Law

- Current (Spring 2015)
- Led by Ira Rubenstein
- [More Information](#)

This course has a particular focus on issues of privacy and data mining. It draws in discussions of government policy, big data, personal data sharing, and other data gathering sources (i.e. face tracking/recognition, GPS). This course focuses on *research ethics* but incorporates social and political perspectives rather than focusing on computer science.

Statistics

Introduction to Data Science

- Columbia University, Department of Statistics – USA
- Undergraduate
- Launched by Dr. Rachel Schutt
- [More Information](#)

[Syllabus (2015):](#) Interdisciplinary, case study-based approach to data science that discusses ethics and data at various points throughout the semester. A very basic introductory course, it doesn't go into extreme detail about any of the concepts it tackles, but attempts to discuss the implications of the kind of research practiced by data scientists and the gravity of their effects in the real world. The course website is very thorough. Dr. Rachel Schutt, who launched the course in 2012, is co-author of *Doing Data Science*, a book based on the course.

Ethics are mentioned in the course description but not in the summary of weekly content for the current term so it is unclear how well ethics are integrated into the course, though privacy and data security are listed in the second to last week. In the 2012 syllabus, ethics appeared in week 5 of 14. Ethics seem to be integrated rather than added at the end. This course can be categorized as *research ethics* (versus *ethics as social good*).

Business

Foundations of Enterprise Data Analytics – Concepts and Controls

- University of Toronto – Canada
- Certificate in Management of Enterprise Data Analytics
- Required course
- Current (Winter 2014-15)
- More Information can be found [here](#) and [here](#).

Addresses big data as an aspect of the curriculum, which focuses more closely on data analytics for business and doesn't explicitly name 'ethics' as a part of the course description, but includes managerial and organizational aspects of the use of big data. The course is presented as a general survey but with no apparent focus on practice or particular approaches. Course description includes "the often unappreciated CSR/ethical aspects of predictive research." In this

program, the course that includes ethics is the first one. This course can be categorized as *research ethics* (versus *ethics as social good*).

Computer Science

Computer Science and Philosophy (Program Track)

- University of Oxford – United Kingdom
- Undergraduate program, graduate with an additional year in the program
- Current
- [More Information](#)

This course is more general in scope. The program's goals are to thoroughly address ethical concerns in computer science, including several courses in data mining etc. Students are expected to understand the ethical concerns of data and its use, though it doesn't appear any explicit 'data and ethics' courses are being taught. The program is a hybrid of two programs, blending philosophy with computer science. Ethics are addressed in relation to privacy and intellectual property, according to the program description.

Ethics is the final course in the second year of the 3-4 year program. The ethics course focuses solely on philosophy, not computer science. This course is a cross between *research ethics* and *ethics as social good*.

Astronomy

Ethics & Practice in Astronomy

- Harvard-Smithsonian Center for Astrophysics - USA
- Led by Charlie Conroy, Assistant Professor of Astronomy
- Current (2015)
- [More Information](#)

This mini-seminar covers the philosophy of science, the status of minorities and women in the physical sciences, and other issues related to ethics and practice in astronomy. It can be categorized as *research ethics*.

Research Ethics

Ethics & Research: Practices, Problems, and Principles

- Stanford Graduate Summer Institute (SGSI), McCoy Family Center for Ethics in Society, Stanford University - USA
- Four-day course
- Current (2015)
- [More Information](#)

The Center for Ethics in Society was launched in 2003 by law professor Deborah Rhode, and

is directed by Professor Debra Satz. It is integrated across the university, including the research and education programs, and includes a postdoc fellows program and curriculum development for the undergraduate honors program in Ethics in Society. All Stanford undergraduate students are required to take one ethics course (not focused on data science), according to the Ethical Reasoning Requirement. The 2014 summer course was Ethical Dilemmas in Research: Reflecting on Problems, Principles, and Practices Beyond the IRB.

Speakers and instructors represent anthropology, psychology, integrative biology, medicine, and computer science. Topics address data ownership in partnerships between researchers and communities, and issues of policy, academia and private industry. This course is a cross between *research ethics* and *ethics as social good.*

The Ethics of Data Analysis

- Cornell University - USA
- Undergraduate course (3 credits)
- Current (2013-2014)
- More Information

This program examines the life cycle of research and the decisions that are made in design and analysis. It covers decision-making, accountability, and ethical issues in data design and analysis (but does not mention computer science), and focuses on *research ethics.*

Journalism

Algorithmic Transparency in the Media *

- Tow Center for Digital Journalism/ Columbia Journalism School - USA
- Led by Nicholas Diakopoulos
- One-day workshop (2015)
- More Information

This one-time event invited student participation in a discussion with journalism and research experts on the transparency of algorithms used in news gathering, mining, and presentation, in part to address ethical concerns.

Workshop not included in numerical survey.

Data Journalism (Program Track)

- Columbia University Graduate School of Journalism - USA
- Master of Science degree (specializations include data journalism)
- More Information

Ethics are mentioned in the overall program description in terms of teaching students to think ethically about their work. The data journalism track teaches both qualitative and quantitative

reporting methods and ends with a Data Master's Project that includes an algorithm, API, or computational project. Ethics are not specifically mentioned in the summary of the data journalism track and the syllabi are not available to determine how well ethics are integrated. This program combines *research ethics* with *ethics as social good*.

Computation + Journalism

- Georgia Tech - USA
- Has been offered to graduate and undergraduate students
- Current (2014)
- Led by Irfan Essa
- More information

Course includes ethics, morality, and subjectivity, as well as mobile computing for news, information quality and bias in reporting, automated reporting and programming in journalism, web crawling/ scraping, data mining for personalization and aggregation, and information accessibility. It combines *research ethics* with *ethics as social good*.

Computation + Journalism Symposium*

- The Brown Institute for Media Innovation - USA
- Two-day event (2014)
- More Information

Sessions include algorithms, data-driven storytelling, data mining, and crowdsourcing. Journalism ethics are mentioned as an overall topic but not listed on the agenda.

Event not included in numerical survey.

Computer-Assisted Reporting Boot Camps*

- Investigative Reporters and Editors - USA
- More Information

A series of week-long programs that cover data acquisition and analysis, use of spreadsheets, mapping with GIS software, statistics, and coding to clean data. Program descriptions do not mention 'ethics' specifically.

Programs not included in numerical survey.

Biomedical Data

Ethics of Biomedical Big Data

- University of Oxford, Oxford Internet Institute – United Kingdom
- Led by Brent Mittelstadt

- Current (Oct. 2014-15)
- More Information

This is an ongoing research project with the intention to open discussion about and encourage ethical practices regarding big data in biomedical fields. It seeks to draw in a multidisciplinary team/approach to building a formative "blueprint" for ethical conduct in Europe. It will culminate with a workshop of the same name in April 2015. There is a particular focus on potential ethical concerns raised by the collection, storage, and analysis of biomedical Big Data, as well as consent and privacy. The project takes a long-term view of ethics as they impact future uses of data and moves far beyond the compliance approach.

This project is a cross between *research ethics* and *ethics as social good*, as it combines the avoidance of ethical problems with a focus on innovative data uses and improving research outcomes.

Other: Workshops, Projects etc.

Technology and Data Governance (Summer Research Fellowship Program)*

- Federal Trade Commission - USA
- Current and new (2014)
- More information

This 10-week program provides undergraduate and graduate students with the opportunity to gain hands-on experience working on exploratory projects while enabling the FTC to gain knowledge on current technological issues and potential responses. The FTC's mission is to "prevent business practices that are anticompetitive or deceptive or unfair to consumers; to enhance informed consumer choice and public understanding of the competitive process; and to accomplish this without unduly burdening legitimate business activity."

*Fellowship not included in numerical survey.

Applications of Big Data for Social and Economic Development

- University of Hull – United Kingdom
- Led by Professor Richard Vigden, Hull University Business School
- Current (2014)
- More Information

A student scholarship program (doctoral level) seeking proposals related to "projects that consider the organizational change aspects of big data and ethical and privacy issues," along with other, related research into big data. Ethics and Social Justice is one focus area. This program focuses heavily on *ethics as social good*.

Big Data Processes

- IT University of Copenhagen – Denmark
- Undergraduate
- Current (Spring 2015)
- [More Information](#)

Taught in English as a part of the Digital Innovation and Management track, the course is a lecture that addresses big data through a general overview, workshops, and a real-world case study project. Emphasis is on personal data in big data processes and implications/pitfalls of those processes. Draws from analytics and IT. The ethics of personal data are discussed in terms of the potential and limitations of big data processes. It is unclear where this falls chronologically in the course. The primary text, which contains a Data Privacy and Ethics chapter, is described [here](#). This course is a cross between *research ethics* and *ethics as social good.*

Responsible Innovation (minor program track)

- Delft University Technology – The Netherlands
- [More Information](#)

This program explores the ethics and social implications of technological innovation, including tools and approaches such as Value Sensitive Design (VSD). Additional topics are corporate social responsibility; ethical, legal, and innovation aspects of intellectual property; and responsible bioscience and biotechnology. Thematic modules include 'Big Data for Humanity' and 'Ethics, Culture and Biotechnology'. This project is a cross between *research ethics* and *ethics as social good.*

Massive Open Online Courses (MOOCs)*

Wiretapes to Big Data: Privacy and Surveillance in the Age of Connection

- Cornell University - USA
- Current (2014)
- Led by Stephen Wicker
- [More Information](#)

Explores privacy issues such as surveillance through cellular technology, WIFI, and Internet usage, incorporating issues of technology, law and sociology.

Big Data and Social Physics

- Massachusetts Institute of Technology - USA
- Archived one-week course
- Led by Alex Pentland
- [More Information](#)

This course examines the social good potential of big data and predictive analytics. Focuses on

ethics as social good. Ethics are incorporated throughout.

Technology and Ethics

- Coursera/ The Ohio State University - USA
- Led by Robert Bailey
- More Information

This course examines ethical issues related to caretaking robots, surveillance, and biological manipulations used in warfare. The subject matter is theoretical rather than technical. Ethics are incorporated throughout. Combined focus on *research ethics* and *ethics as social good*.

*Courses not included in numerical survey.

Miscellaneous Online Training Courses*

The Forum Guide to Data Ethics Online Course

- National Forum on Education Statistics – USA
- Provided certificate to more than 200 people in 2011; not current
- Industry-specific and doesn't reference big data
- This course can be categorized as *research ethics* (versus *ethics as social good*)
- More Information

RCR (Responsible Conduct in Research) Certification

- George Mason University - USA
- More Information

HSR (Human Subjects in Research) Certification

- George Mason University - USA
- More Information

* Courses not included in numerical survey.

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