



## The Online Resource Center for Ethics Education in Engineering and Science

### Dr. Joseph R. Herkert, Arizona State University

Joseph R. Herkert, D.Sc., is Lincoln Associate Professor of Ethics and Technology (Emeritus) in the School of Letters and Sciences and the Consortium for Science, Policy & Outcomes, Arizona State University and Visiting Scholar at the Genetic Engineering & Society Center, North Carolina State University. Herkert has been teaching engineering ethics and science, technology & society courses for more than twenty-five years. He is editor of *Social, Ethical and Policy Implications of Engineering: Selected Readings* (Wiley/IEEE Press, 2000) and co-editor of *The Growing Gap between Emerging Technologies and Legal-Ethical Oversight: The Pacing Problem* (Springer, 2011), and has published numerous articles on engineering ethics and societal implications of technology in engineering, law, social science, and applied ethics journals. Herkert previously served as Editor of *IEEE Technology and Society Magazine* and an Associate Editor of *Engineering Studies*. He is or has been an active leader in many professional organizations including the Society for Ethics Across the Curriculum, the Society on Social Implications of Technology (SSIT) of the Institute of Electrical and Electronics Engineers (IEEE), the National Institute for Engineering Ethics, and the Engineering Ethics and Liberal Education/Engineering and Society (LEES) Divisions of the American Society for Engineering Education. In 2005 Herkert received the Sterling Olmsted Award, the highest honor bestowed by LEES, for "making significant contributions in the teaching and administering of liberal education in engineering education." Herkert is a Senior Member of IEEE and served a three-year term on the IEEE Ethics and Member Conduct Committee. He was recently elected a Fellow of the American Association for the Advancement of Science. Herkert received his BS in Electrical Engineering from Southern Methodist University and his doctorate in Engineering & Policy from Washington University in St. Louis.

### Dr. Frazier Benya, National Academy of Engineering

Frazier Benya is a Program Officer in the National Academy of Engineering's Center for Engineering Ethics and Society (CEES). She manages the projects run by CEES including the Online Ethics Center (OEC) for Engineering and Science website. Her work at the NAE has focused on ethics education for engineers and scientists; climate change, engineered systems, and society; energy ethics; and ethical and social issues with advancing military technologies. She received her Ph.D. in History of Science, Technology, and Medicine from the University of Minnesota in 2012 and her M.A. in Bioethics, also from the University of Minnesota, in 2011. Her Ph.D. thesis focused on the history of bioethics and scientific social responsibility during the 1960s and 1970s that led to the creation of the first federal bioethics commission in 1974. Her M.A. thesis analyzed different types of institutional methodologies for considering the social implications of science with a focus on those that integrate scientific research with ethics research in the United States and Canada.

### Dr. Karin Ellison, Arizona State University

Karin Ellison's research and teaching spans the disciplines of research ethics, ethics education development, and the history of American science and technology. Working with colleagues at the National Academy of Engineering and ASU, she is leading enhancement of Life and Environmental Science ethics education materials for the Online Ethics Center as part of a National Science Foundation sponsored project to improve the site. In the School of Life Sciences, she teaches core graduate courses in Responsible Conduct of Research.

Ellison also fosters graduate education at ASU through her positions as director of the Masters in Applied Ethics and the Professions, Biomedical and Health Ethics, executive director for the Biology and Society graduate programs, and a founding member of the university's interdisciplinary doctoral degree program in Human and Social Dimensions of Science and Technology.

### Dr. Rachelle D. Hollander, National Academy of Engineering



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Rachelle Hollander directs the Center for Engineering, Ethics, and Society (CEES) at the National Academy of Engineering (NAE), which manages the NAE Online Ethics Center ([www.onlineethics.org](http://www.onlineethics.org)), a widely used resource for engineering and research ethics education. She is principal investigator on a current National Science Foundation (NSF)-funded project. For many years Dr. Hollander directed science and engineering ethics activities at NSF where she was instrumental in the development of the fields of research ethics and professional responsibility, engineering ethics, and ethics and risk management. She has written articles on applied ethics in numerous fields, and on science policy and citizen participation. Dr. Hollander is a Fellow of the American Association for the Advancement of Science (AAAS) and received the Olmsted Award "for innovative contributions to the liberal arts within engineering education" from the ASEE Liberal Education Division in 2006. She received her doctorate in philosophy in 1979 from the University of Maryland, College Park.

**Ms. Kelly Laas, Center for the Study of Ethics, Illinois Institute of Technology**  
**Dr. Simil L Raghavan, National Academy of Engineering**

Simil Raghavan is an associate program officer with the National Academy of Engineering (NAE). She has worked with both the diversity and ethics programs in the National Academy of Engineering (NAE) in Washington, DC since 2007, where she manages both the EngineerGirl website and the Online Ethics Center (OEC) for Engineering and Research. In her work at the NAE she has led redesigns of both of these websites and also coordinated numerous online events including competitions and focus groups. Simil received her PhD in biomedical engineering from Johns Hopkins University in 2008 where her PhD thesis focused on neural and vocal plasticity in primates.

## **The Online Resource Center for Ethics Education in Engineering and Science**

Ethical<sup>1,2</sup> and social justice<sup>3,4,5</sup> concerns are integral to how science and engineering get done as well as their consequences; ignoring them can undermine research efforts and the social institutions sustaining those efforts, as well as lead to unintended and undesirable outcomes<sup>6</sup>. As science and engineering become more multidisciplinary, global, and complex, it is increasingly important that scientists and engineers actively consider not only the practical (“Can this be done?”) but also the ethical questions (“Should this be done? Who should make that decision?”). Most scientists and engineers need resources and support to recognize and address the ethical implications of their work. Current, dynamic resources are needed to help them examine such questions and to teach students about ethics in engineering and science.<sup>7</sup>

This paper reports on the progress of a project to address these needs. The project intends to expand the Online Ethics Center (OEC) of the National Academy of Engineering (NAE), to become the “go-to” online source for these critical resources and support for ethics and ethics education in science and engineering. It focuses in particular on the work of two of the project’s Content Editorial Boards (in Engineering and in Life and Environmental Sciences).

### **Project Background**

The NAE’s OEC ([www.onlineethics.org/](http://www.onlineethics.org/)) is upgrading and expanding its resources to include: case studies, essays, topic focused bibliographies, presentations, and videos. Redesigned and augmented material (e.g., enhanced with new pedagogical resources and ethical commentaries) as well as the collection of new content will provide information for practitioners, educators, and students about ethical, social justice, diversity, and globalization considerations associated with engineering and science. Also highlighted will be other macro-ethical<sup>8</sup> considerations associated with science and engineering such as public engagement, sustainability, and diversity. These resources will be helpful in teaching ethics modules, designing courses and in continuing education on ethical and social issues in engineering and science. Content editorial boards have been formed and are reviewing, identifying, and developing materials and working with various communities to meet their needs.

The OEC is also redesigning and strengthening technical and communal aspects that support both the resource collection and the community of users and authors. The new site will offer expanded searching abilities and content sorting; discipline specific (e.g., engineering) homepages that highlight resources and content specific to the discipline; and more extensive resources that include associated links to supplementary materials that assist in understanding and teaching the material. The new site will also feature a new users’ community that will connect author profiles to resources, allow direct submission of materials for inclusion in the database, and enable users to comment on the value of resources. Collaboration with the Ethics Education Library (EEL) ([ethics.iit.edu/eelibrary](http://ethics.iit.edu/eelibrary)) of the Center for the Study of Ethics in the Professions at the Illinois Institute of Technology (IIT) is providing access to a wider array of materials and promoting interactions with other repositories of ethics-related information. A new look for the OEC and some of the new site features will launch by the end of 2015, with further

enhancements to features that support community interactions with the resources and site users occurring in 2016 and 2017.

This five-year project, undertaken with the National Academy of Sciences and the Institute of Medicine, is funded by the National Science Foundation (NSF). The NAE Center for Engineering, Ethics, and Society (CEES) manages the OEC and is responsible for managing this project with the advice of a Joint Advisory Group of distinguished members of the National Academies and experts in ethics in science and engineering. Further information about the project can be found at [www.nae.edu/OECexpansion.aspx](http://www.nae.edu/OECexpansion.aspx).

### **Project Goals and Expected Impacts**

The major goal of the project is to expand the NAE OEC to be the go-to online source for critical resources and support for ethics education in science and engineering. The project will enhance OEC content, capabilities, and user base as well as its position at the National Academies. Additional objectives for the enhanced OEC are to incorporate international materials; connect those knowledgeable about teaching ethics with those new to it, as well as those encountering ethical issues in practice with those teaching future practitioners; and promote and support the teaching of ethics using active learning strategies by providing pedagogical guidance on teaching ethics generally and on teaching specific case studies or topics.

The project encompasses all the science and engineering disciplines. The fields of science (natural, social and behavioral), engineering, and research ethics as well as science and technology studies provide its core, but it is a resource for all fields that NSF supports. Besides reviewing current content and developing the specifications for new user friendly functionalities, project staff and participants are currently working on identifying and collecting the metadata of key ethics educational materials and determining the needs of these disciplines. Once finished, the new OEC will be a major resource for all science, engineering, or social sciences instructors interested in integrating ethics into their courses, and for practitioners interested in addressing ethics topics. The site will also provide resources to develop students' and practitioners' abilities to identify ethical problems, understand ethical norms and standards, and solve ethical problems.

Along with providing ethics education material in the disciplines supported by NSF, the OEC and EEL will have an impact on the field of library and information science. These online repositories will serve as a model for other institutions interested in developing similar web resources. In particular, the EEL is being developed on Drupal, an open-source content management platform that allows innovations developed by one developer to be freely used and expanded upon by others.

In addition, the project leaders are beginning to form the basis for an ongoing group of interdisciplinary scholars who participate in and support the site and ethics education across science and engineering. The OEC is working to be a unifying resource for staff at the National Academies and has the potential to grow to become the source for ethics related content created by the Academies. The EEL is proving to be a major resource internally for both the Center for the Study of Ethics in the Professions and IIT itself, as faculty and students use it to find relevant ethics resources for their teaching, research, and practice. For example, faculty can search the

EEL to find example syllabi, lesson plans, case studies and relevant accompanying readings for integration into their existing courses, and students are able to use the faceted search function to find materials that address specific issues they are interested in, such as the use of social media in research or ethical issues related to the rise of Do-It-Yourself biology. As the EEL is updated on an almost daily basis with new published and unpublished material, it is fast becoming one of the most exhaustive collections of professional and applied ethics materials available on the Internet.

Many of the cases and resources collected in the OEC and EEL can also be used by a wider audience than just students, teachers and practitioners in the areas of science, technology, and engineering. For example, students and teachers from disciplines such as business ethics can use many of the case studies being collected. High school teachers interested in either starting ethics clubs or looking to integrate some kind of ethical discussion in their classrooms may also find these resources useful.

### **Audience Research**

Based on feedback from team members, project staff created an initial draft of Audience Profiles for the OEC. To inform these profiles, staff also created a request for feedback from instructors and faculty and distributed the request to over 14,000 people; 434 responses were received (note, this was not a statistically rigorous survey or questionnaire, rather it was a request for comments to help inform our audience profiles and decisions regarding website development). The form asked about instructor and faculty members' experiences teaching ethics and what resources and tools they have or would find valuable. Initial results from this request suggest that instructors and faculty find case studies to be the most useful item for teaching ethics (see Figure 1 in the Appendix), and that a simple and straightforward contribution process would encourage them to contribute materials (see Figure 2). The leadership team will be working to get more feedback from faculty and instructors in the sciences, because engineering was over represented in the responses.

To get a better idea of the OEC's existing audiences, staff also created and posted an audience questionnaire on the OEC. This questionnaire asked about people's discipline, role/group (student, faculty, professional, etc.), why they were visiting the OEC, and then asked a few of the questions that also appeared in the request for feedback for instructors and faculty. The results from the OEC audience questionnaire are consistent with previous polls that show that a large audience of undergraduate students visit the site to work on class assignments (see Figures 3 and 4) and that the current primary audience group is in engineering (see Figure 5). Most of the respondents were visiting the OEC to use the "Ethics Codes and Guidelines" or "Cases and Scenarios Collection" sections (see Figure 6). The results from questions regarding the usefulness of resources were consistent with the feedback from instructors and faculty that showed that case studies were considered the most important. These and other results from the questionnaire will be used as a base line to evaluate progress on expanding the audience to those in the sciences.

## **Content Editorial Boards**

Content Editorial Boards in five areas focus on evaluating, identifying and developing materials, and on reaching out to and meeting the needs of their communities. The Content Editorial Boards are:

- Engineering
- Life and Environmental Sciences
- Research Ethics
- Computer, Mathematics, and Physical Sciences
- Social, Behavioral, and Economic Sciences

The remainder of the paper focuses on the work of the Engineering and Life and Environmental Science editorial boards. Since the OEC historically focused on engineering ethics, the primary initial task of the Engineering Editorial Board is to review existing materials and identify gaps and areas that need improvement. In addition to reviewing existing website materials, the Life and Environmental Science Editorial Board, in collaboration with Arizona State University, is overseeing development of new materials in these fields.

### **Life and Environment Sciences Editorial Board**

Unlike the other content Editorial Boards, the Life and Environmental Sciences Editorial Board (LES-EB) is organized in the form of a subcontract of the NSF funded project award to the National Academies through an agreement with Arizona State University (ASU). The ASU agreement has two main parts: 1) direction of the Life and Environmental Sciences Editorial Board (LES-EB), and 2) development of ethics education materials on social responsibilities and social justice in research and practice in the life and environmental sciences.

The goals of the LES-EB include:

- Developing a Life and Environmental Sciences Portal Page for the OEC site
- Developing and implementing a process for soliciting, reviewing and posting externally developed content in LES
- Collaborating with other editorial boards (especially on webinars and blogs)

The goals with respect to development of LES ethics education materials concern both topics and outputs. The ASU agreement originally called for new materials in the following areas:

- Biodiversity and conservation
- Biofuels and energy system transitions
- Developmental biology
- Neuroscience

The LES-EB will determine specific materials to be developed. Examples of possible materials are:

- Syllabus for a one-credit graduate course
- Materials for one 75-minute upper-division undergraduate class session
  - o Reading assignment
  - o Podcast (based on graduate student interviews of researchers)
  - o 10-12 session discussion questions
- 4-12 ethics cases developed by graduate students

The LES-EB main activities in the first year of the project have been recruiting members and reviewing current site materials. The LES-EB reviewed a number of existing OEC case materials; key measures concerning content—including the content “area(s)” portrayed in each case and whether the case raised “ethics and society” (macroethical) issues—reinforced the need to develop additional materials. Regarding content areas, the review showed that the existing collection only has substantial sets of resources for “genetics and genomics” and “biomedical sciences.” Only these fields had more than 15 resources when reviewers assigned cases to subfields within the life and environmental sciences using a modified version of the taxonomy of life science graduate programs used by the National Research Council. The options for categorization were: agricultural sciences, biochemistry, biomedical sciences, cell and developmental biology, ecology and evolutionary biology, genetics and genomics, microbiology, neuroscience and neurobiology, physiology, systems and synthetic biology, bioengineering, and laboratory animal research. Reviewers chose as many categories as appropriate for each case, so one case could be assigned multiple “fields.”

The modest number of substantial materials addressing ethics and society issues likewise suggests further development of resources. For ethics and society topics, reviewers indicated when cases addressed one of the following subjects of interest: diversity/discrimination, environment/sustainability, global/international, human rights, public/community engagement, social justice, and social responsibility. Of these areas, more than 15 resources were only identified for social responsibility and social justice.

This review of existing cases has also suggested that the plans for resource development in the LES area may need to be revisited. The original work plan called for focusing resource development to address social responsibility and social justice issues in specific sub-disciplines within the life sciences. Resource collections were to focus on the specific areas identified above. The existing cases, however, do not cluster around sub-disciplines; rather they cluster around research ethics topics. To integrate with current strengths, it may make more sense to cluster resources around key ethics and society themes in the life sciences such as: 1) communicating science and public engagement, 2) safety and security, 3) intellectual property, and 4) sustainability. This revised organization scheme would not necessarily eliminate the development of disciplinary specific resources. The LES-EB could focus on addressing macroethics themes by considering the themes in a variety of fields in the life sciences. For example, a cluster of resources on safety and security could include materials related to dual-use research in microbiology, applications of neuroscience for military personnel, and other significant cases from a diverse set of sub-disciplines within the life and environmental sciences. As the project moves forward the LES-EB will be completing reviews of current site materials, identifying materials to be highlighted on the LES portal page, reviewing and revising the plans for developing new materials, and after such materials are drafted, reviewing materials. With

input from the LES-EB, the ASU team will finalize plans for developing and piloting new materials in 2015 in graduate and undergraduate research ethics courses. The plan for summer 2015 is to have students focus on both developing a cluster of disciplinary resources and developing a cluster of resources around an ethics and society theme to test which organization is more compelling.

### **Engineering Editorial Board**

To date most of the work of the Engineering Editorial Board has focused on reviewing existing OEC cases. Reviewers were recruited from various organizations including the Engineering Editorial Board itself, the ASEE Engineering Ethics Division, the National Institute for Engineering Ethics Advisory Board, and staff and past advisors of the OEC. The first round of reviews did not complete the task, due to a number of factors including the large number of cases and the failure of some reviewers to submit their reviews. Plans are underway to complete the reviews in the spring of 2015. Nevertheless, with about 375 total reviews submitted for 237 cases, some patterns have emerged.

The coverage of major engineering disciplines (Industrial, Biomedical, Chemical, Civil, Environmental, Mechanical, Electrical, and Computer) in the cases reviewed is reasonably broad; although Civil Engineering is most prominent, all of the major fields indicated are well represented. It is apparent, however, that certain specialized disciplines are not given much attention in the cases including aeronautical engineering, materials science and engineering, and agricultural engineering, and so an effort will be made to encourage development of cases in these areas.

Reviewers were asked to identify whether the cases they reviewed addressed the macroethical issues identified by the project team including: social responsibility, social justice, public/community engagement, human rights, global/international, environment/sustainability, and diversity/discrimination. Of these, social responsibility had the most significant coverage, with public/community engagement and environment/sustainability also faring well; an effort will be made to encourage development of cases in the less represented categories. In particular, the scope of the original grant has been expanded through a supplemental grant from NSF to add members to each editorial board with international expertise.

The overall quality of the cases was rated by the reviewers on a three point scale: “Low-consider removing from site,” “Acceptable;” or “Excellent – Recommend as a resource to highlight.” For engineering cases, the quality distribution was: Low (about 20%), Acceptable (about 47%), and Excellent (about 33%). The project and editorial board leaders are doing further evaluation to determine which cases should be removed from the site or might require updating.

An informal content analysis of comments from those reviews with “Low” ratings indicated that the most prominent perceived problems with cases judged to have low quality were:

- Not relevant to engineering ethics (e.g. business, technical)
- Not enough information
- Poorly written/structured
- Unclear what ethical dilemma/issue is (if any)



- No discussion aids (e.g. commentary, resource links)
- Focus is too narrow (e.g. issue, context)

Conversely, the most common comments on cases with “Excellent” ratings were:

- Good case structure/narration/discussion/ethical analysis
- Good commentaries
- Provokes discussion, critical thought
- Relevant/timely/universal
- Realistic/practical application
- Good questions

By combining this data with that of the other editorial boards the project has identified several quality indicators for evaluation of new material to be considered for the OEC. Though still in a preliminary form the evaluation of new cases is likely to involve something like the following:

**How would you rate this case on the following attributes?**

(Poor, Fair, Good, Excellent)

- Organization and writing (i.e. well-written, understandable, not oversimplified)
- Dimensionality (i.e. includes multiple sides or perspectives, provokes discussion and critical thought)
- Relevance to target audience (i.e. interesting, engaging, relatable, specific to OEC audiences)
- Plausibility (i.e. realistic, likely to happen, either in a historical or current context; or in the US or internationally.)
- Ethics (i.e. ethical issues are explicit or apparent)

**Quality of Supporting Materials**

(Not addressed, Poor, Fair, Good, Excellent)

- Ethical analysis (e.g. includes discussion or associated commentary that is grounded in ethical standards or perspectives)
- Teaching assistance (e.g. includes instructions or advice about effective use in a learning environment)

As we continue with the early stages of the project the Engineering Editorial Board will have the following tasks:

1. Complete reviews of existing OEC cases.
2. Design an OEC “portal” page for engineering ethics
3. Develop helpful “briefing papers” – starting with three papers to assist faculty by identifying good books, articles, and on-line courses/materials (including videos) for teaching engineering ethics.
4. Work with other editorial boards in refining criteria for developing new material for the site.

Engineering educators who are interested in contributing to the work of the Engineering Editorial Board should contact the project directors (see Acknowledgements).

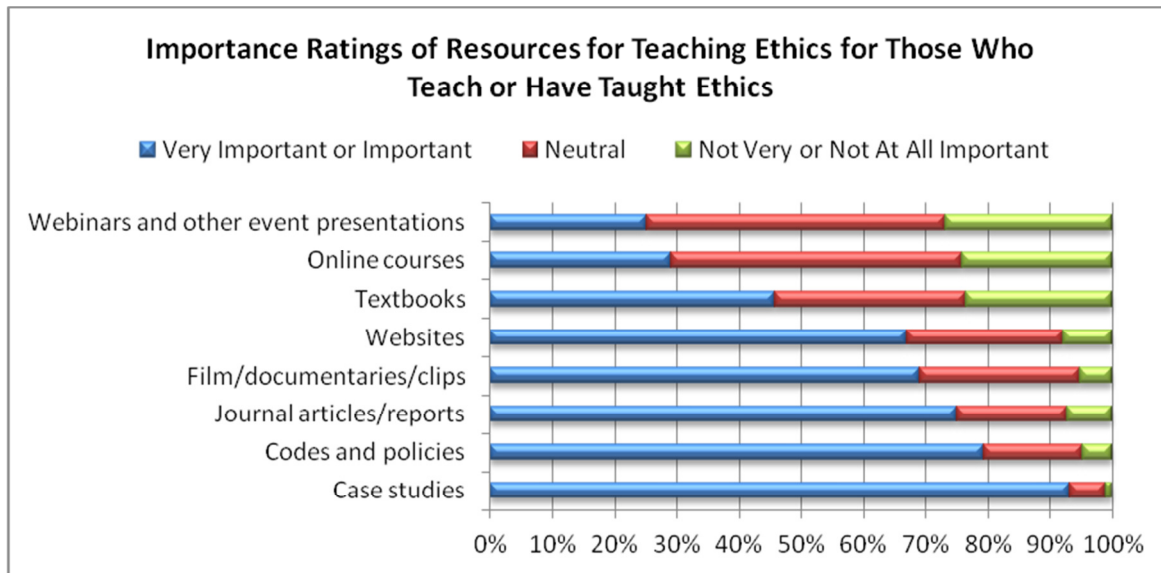
## Acknowledgements

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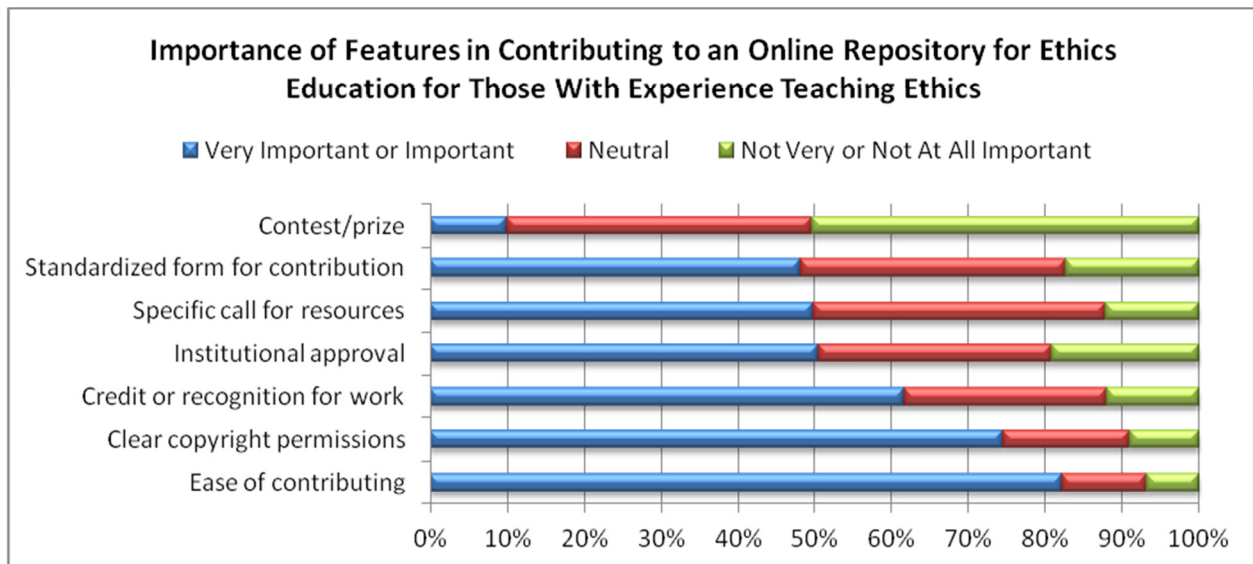
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## APPENDIX



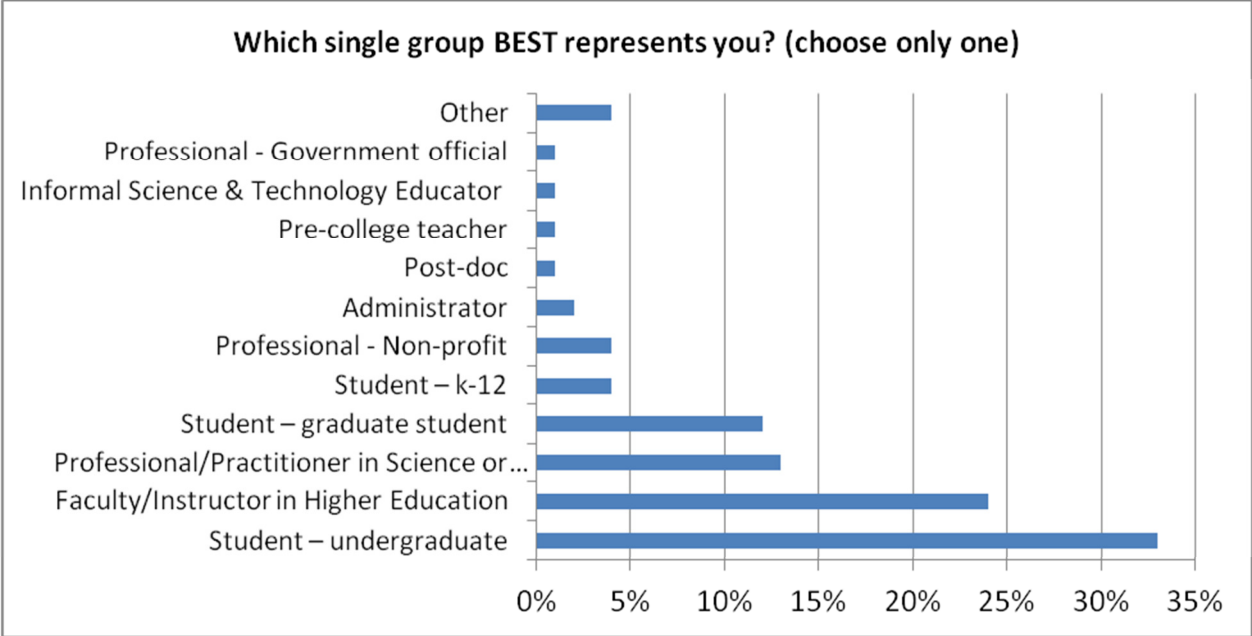
**Figure 1 – Importance of ethics teaching resources.**

Faculty and instructors with ethics teaching experience rated the importance of various ethics resources. These ratings were submitted electronically by 396 faculty and instructors with ethics teaching experience from a range of disciplines as part of an Online Ethics Center (OEC) Faculty and Instructor Questionnaire begun on September 24, 2014 and concluded on January 6, 2015. Importance ratings were on a scale of *Very Important*, *Important*, *Neutral*, *Not Very Important*, or *Not At All Important*.



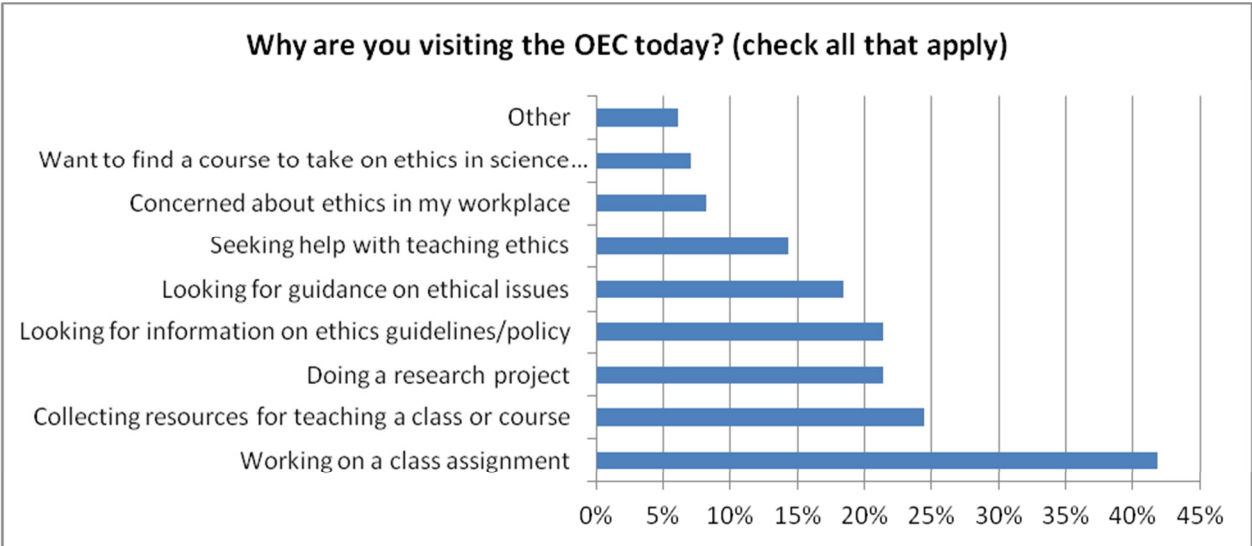
**Figure 2 – Importance of Website Features for Online Contributions**

Faculty and instructors with ethics teaching experience rated the importance of features that would encourage them to contribute to an online repository for ethics education. Responses represent 396 faculty and instructors from a range of disciplines who responded as part of an Online Ethics Center (OEC) Faculty and Instructor Questionnaire begun on September 24, 2014 and concluded on January 6, 2015. Importance ratings were on a scale of *Very Important*, *Important*, *Neutral*, *Not Very Important*, or *Not At All Important*.



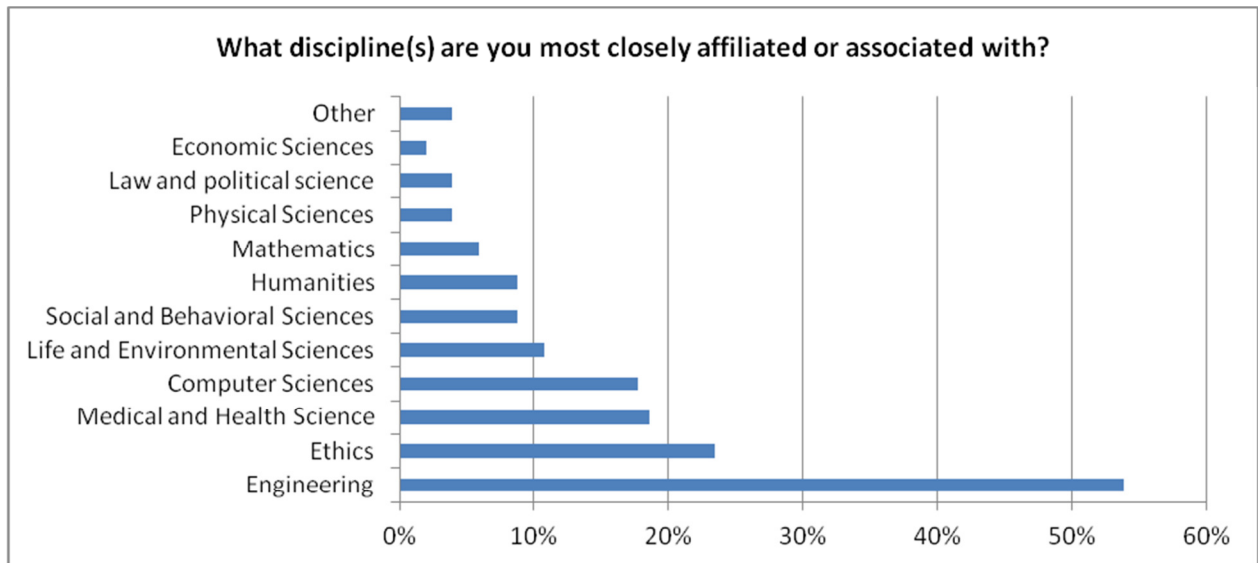
**Figure 3 – Demographics of Online Ethics Center (OEC) Visitors.**

Responses to the question, “Which single group BEST represents you? (choose only one)” given in an informal survey of OEC visitors. One hundred and nine site visitors responded to a request to complete the survey which was active on the OEC between October 8<sup>th</sup> and 21<sup>st</sup>, 2014.



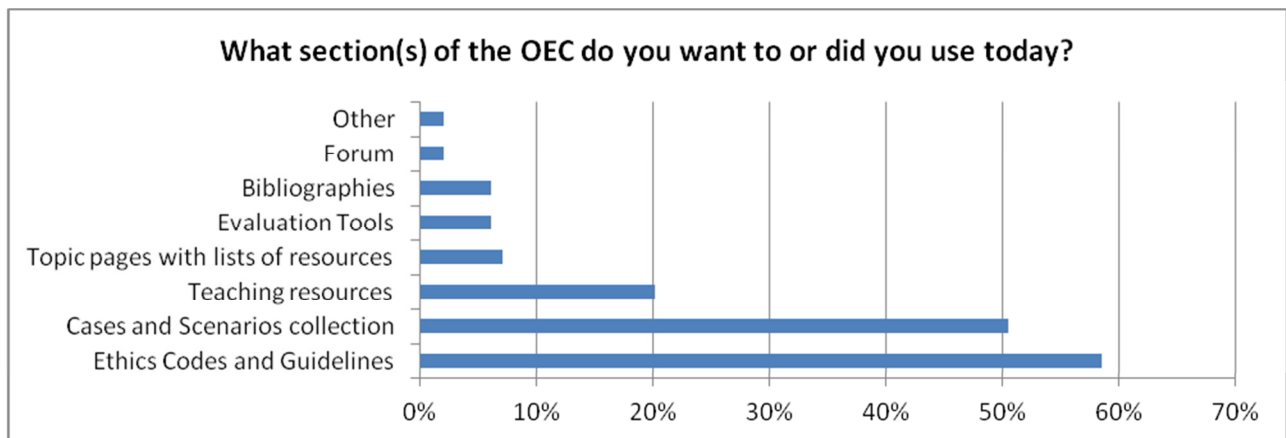
**Figure 4: Reasons for Visiting the OEC**

Responses to the question, “Why are you visiting the OEC today? (check all that apply)” given in an informal survey of OEC visitors. One hundred and nine site visitors responded to a request to complete the survey which was active on the OEC between October 8<sup>th</sup> and 21<sup>st</sup>, 2014.



**Figure 5: Discipline of OEC Visitors**

Responses to the question, “What discipline(s) are you most closely affiliated or associated with?” given in an informal survey of OEC visitors. One hundred and nine site visitors responded to a request to complete the survey which was active on the OEC between October 8<sup>th</sup> and 21<sup>st</sup>, 2014.



**Figure 6: Section Usage by OEC Visitors**

Responses to the question, “What section(s) of the OEC do you want to or did you use today?” given in an informal survey of OEC visitors. One hundred and nine site visitors responded to a request to complete the survey which was active on the OEC between October 8<sup>th</sup> and 21<sup>st</sup>, 2014.