The University of Kansas
Initiative in
Ethics Education in Science and Engineering

Final Report[1]

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Executive Summary

The University of Kansas Initiative on Ethics Education in Science and Engineering (KU-EESE) brought together experts in ethics, educators and graduate students in the sciences, social sciences and engineering to explore and extend best practices in teaching ethics in science and engineering. The project was undertaken in cooperation with Kansas State University (K-State) and the University of Missouri-Kansas City (UMKC).

KU-EESE had three primary objectives, to:

1. Enhance instruction in ethics in the STEM disciplines through development of stand-alone courses in scientific ethics and support for faculty development of ethics modules embedded in field-specific courses.
2. Disseminate instructional approaches to ethics instruction through the documentation of both the stand-alone and embedded ethics modules using on-line course portfolios that included both relevant assignments and sample student work. And
3. Assess the relative impact of standard graduate-level exposure to ethical concepts, enrollment in stand-alone ethics courses, and enrollment in courses incorporating embedded ethics modules.

As this report documents in detail, all three objectives were met, though a number of unanticipated complications were encountered.

Enhanced Ethics Instruction

- Between January 2007 and December 2009 three faculty workshops were offered providing an intensive introduction to several approaches to ethical reasoning as guidance in teaching practices. After the workshop, faculty participated in two half-day follow-up sessions and worked one-on-one with student assistants from the KU Center for Teaching Excellence to develop assignments and document the results.
- At the University of Kansas an existing stand-alone course in scientific ethics was substantially expanded through the participation of Professor Richard De George (Philosophy) who co-taught the course with Professor George Wilson (Chemistry). Professor De George provided instruction in ethical modes of thinking that had not previously been part of the course. At K-State, Associate Professor Steve Starrett developed a stand-alone course in engineering ethics.
- Twenty six faculty members completed the workshops, and undertook development of some form of embedded ethics module or stand-alone course.

Dissemination of Instructional Approaches

- Materials from the faculty workshops have been collected and are being made available as part of this report.
- Faculty participating in KU-EESE worked with the KU Center for Teaching Excellence to develop on-line course portfolios documenting their objectives, assignments, grading schemes and sample student work. Nine complete course portfolios documenting teaching practices were produced, and another 8 courses were partially documented.

Assessment of Relative Impacts of Different Approaches To Ethics Instruction

- Quantitative assessment involved a quasi-experimental pretest-posttest design in which students were administered two test instruments—The Vanderbilt University Medical College Responsible Conduct of Research Test, and the Defining Issues Test as well as several scales intended to measure positive psychological outcomes. A total of 422 students were included divided between a control group and two treatment groups—embedded ethics module and stand-alone ethics course. Only 154 participants completed at least one measure for both pre-and post-tests and only 69 completed all the dependent measures at both tests.
- In no case did we find a statistically significant difference in outcomes between the courses with an embedded ethics module and the stand-alone courses.
- We did not find any statistically significant difference in the change in scores from pre- to post-test between the treatment and control groups on scores for *moral judgment* or *knowledge of responsible conduct of research*.
- We did, however, find that the treatment group experienced greater gains in several of the positive psychological outcomes examined. Specifically, scores for *perspective taking*, *moral efficacy and moral courage* all increased more for both treatment groups than the control group. Scores for *moral meaningfulness* increased relative to the control group for students in embedded ethics courses, but not for those in the stand-alone course.
- In addition to the quantitative assessment we also assessed the impact of the courses through an examination of samples of student work provided by faculty participants. Two graduate students at the KU Center for Teaching Excellence developed a standard rubric to assess the student work for evidence of which assignments best exhibited student understanding of ethical decision-making.
- This qualitative assessment yielded several important insights, including:
    - Students were more successful in identifying facts and issues and making decisions about actions, and they were less successful at explaining or explicitly describing the processes and reasoning used to reach a decision.
    - Students performed better on assignments that provided specific, discipline-oriented case studies and in courses in which they had multiple opportunities to use the decision-making process.

- Students performed more successfully on assignments from ethics units incorporated into discipline-specific courses than on assignments from stand-alone ethics courses.

Implications for Future Research

- Carrying out the proposed research design proved more difficult than had been initially anticipated. Time in the graduate curriculum proved to be very valuable. Even instructors who were deeply committed to the goal of enhanced ethics education were reluctant to devote the time necessary to conduct the assessment activities that the project required. Obtaining control group responses also proved more difficult than initially supposed.
- There is a trade-off between the use of standardized instruments and course-specific ones. Standardized instruments allow comparison with broader norms, but they may do a poor job of reflecting the learning objectives of individual instructors. As a result the instruments used in this study may not have captured meaningful variations in learning.
- The results of this study are suggestive, rather than conclusive, but they appear to indicate that students learn best when they are introduced to a concept through inductive, engaged teaching, while first exposure to high-level, abstract, and theoretical concepts through lecturing only works well for those who already have a highly developed understanding in the area, such as advanced learners and faculty peers. Although stand-alone ethics instruction may provide more in-depth exposure it may be more effective to provide instruction in embedded ethics modules.

Chapter 1
Introduction and Overview

Ethics instruction in courses in science has traditionally and for the most part been restricted to warning students against plagiarism, the falsification and fabrication of data, and possibly alerting them to problems arising because of conflicts of interest. Depending on the circumstances the scope of this instruction may also include familiarizing students with the legal restrictions of experiments involving human subjects and the care of research animals.

The University of Kansas initiative in Ethics Education in Science and Engineering (KU-EESE) stemmed from the belief that it is both possible and desirable to delve deeper into ethical issues in the conduct of scientific research. The KU-EESE team shared a conviction that academic personnel should understand the reasons behind ethical guidelines and constraints, rather than simply learn to comply with the concrete rules that apply to many parts of academic life. With support from the National Science Foundation, the team undertook the augmentation of ethics education for graduate students in the STEM disciplines through expansion of existing stand-alone courses on responsible conduct of research to incorporate ethical reasoning skills, and the development of a ethics modules embedded in subject oriented courses in science and engineering.[2] KU

[2] The initial impetus to seek funding for the project was developed under the leadership of Diana Carlin, then Dean of the Graduate School and Associate Dean Saeed Farokhi. The substance of the project grew out of a collaboration between Professors Richard De George (Philosophy), Douglas May (Business), and Dan Bernstein (Psychology; and Director of the KU Center for Teaching Excellence (CTE)). Initially Associate Dean Farokhi served as the Principal Investigator for the project, but following organizational changes that resulted in the dissolution of the

faculty members joined with colleagues from Kansas State University (K-State) and the University of Missouri-Kansas City (UMKC) to develop ethics instruction that is embedded within ongoing graduate courses in a variety of fields (including several fields of Engineering, Environmental Studies, Chemistry, Medicinal Chemistry, Physics, Geography, Political Science, and Dentistry).[3]

The objectives of the KU-EESE initiative were three-fold, to: enhance ethics instruction in STEM disciplines, evaluate the relative effectiveness of different approaches to providing this instruction, and document instructional approaches that could be used as models for others seeking to replicate aspects of the project's approach in other courses or at other institutions. Our presumption was that a three-credit course dedicated to the teaching of ethics would be the gold standard and yield the deepest understanding of ethical reasoning. A specialist in ethics would teach such a course, and it would have the greatest amount of time, content, and work directly addressing an understanding of ethical reasoning. An alternative vision that we considered was embedding some instruction on ethical reasoning within courses offered by individual science and engineering disciplines. While there would be less time given to the topic of ethics than in a dedicated course, there might be some advantages to teaching ethics within the context of the students' own area of study and professional future. From a teaching perspective, when students

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graduate school and the formation of a new office of Research and Graduate Studies, that role was assumed by Associate Vice Provost Joshua L. Rosenbloom.

[3] Leadership for the project at K-State was provided by Associate Professor Steve Starrett (Engineering), and at UMKC the project was led by Bibie Chronwall (Vice Provost for Faculty Development).

are engaged in the particulars of a problem or case, studying yields deeper insights and longer lasting understanding.

We also planned to gather samples of ethical reasoning from comparable graduate students who received no particular ethical instruction; their performance would serve as a benchmark of ethical thinking on campus. It was never possible to consider a true experiment, with random assignment to conditions and comparable amounts of time; instead we simply planned to report what we found from the various groups as an interesting observation.

Implementation of the project proceeded through the support of several "stand-alone" courses in ethics offered during the course of the project. To support inclusion of ethical reasoning in discipline specific courses, three faculty workshops were conducted to introduce the most important strands of ethical reasoning and instructional techniques to faculty who wished to embed ethics education into discipline-specific graduate (or in some cases) undergraduate courses offered as regular elements of their respective department's curriculum.

To assess the impact of these different approaches to ethics instruction the KU-EESE team employed two standardized instruments—The Vanderbilt University Medical Center test of Knowledge of Responsible Conduct of Research and the Defining Issues Test (DIT)—to assess knowledge of responsible conduct of research and ethical reasoning ability.[4] As described in more detail below these instruments

[4] Use of standardized instruments has the virtue of facilitating comparison across institutions and consequently providing broader norms for comparison. On the other hand, because the subject coverage of such standardized instruments may not align well with topics covered in particular courses they may not provide the most

were administered prior to and after student participation in both the stand-alone and embedded ethics module courses and to a control group of students not enrolled in either course. In addition to the quantitative assessment evidence of student learning from sample work collected by faculty was also evaluated.

Finally, to capture and document the teaching materials developed as part of the project, student assistants employed by University of Kansas Center for Teaching Excellence (CTE) worked with faculty to develop course portfolios and to post these portfolios online. In total, seventeen faculty members contributed at least some documentation of their courses. Eight of these produced completed online "posters" providing an in-depth description of ethics material covered including assignments and samples of student work illustrating the range of performance achieved.[5]

The remainder of this report describes in greater detail the different elements of the project. Chapter 2 provides a description of the faculty workshops and the stand-alone ethics course that was taught at the University of Kansas. Chapter 3 describes the formal, quantitative assessment elements of the project. Chapter 4 considers what can be learned from an evaluation of student work in selected courses, and how this can enrich our understanding of the quantitative results considered in Chapter 3. In Chapter 5 we offer some observations about lessons learned from the project and possible next steps.

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accurate measurement of the impact of specific courses. This topic is addressed further in the sections on assessment later in this report.

[5] A listing of the courses for which portfolios are available is provided as an appendix to chapter 4 of this report. Completed portfolios may be viewed at http://cte.ku.edu/gallery/.

Chapter 2

Faculty Workshops on Integrating Ethics into Courses and Stand-alone Instruction in Ethics in Science

One of the central objectives of the KU-EESE initiative was to expand the scope of instruction in ethics in science and engineering. To accomplish this the project supported a series of faculty workshops that provided training to faculty from KU, K-State and UMKC on fundamentals of ethical reasoning and on the principals of effective instructional design and implementation. It also facilitated the extension and elaboration of an existing stand-alone course to increase the amount of time spent on ethics. We describe each in turn here.

The Faculty Workshops

During the course of the grant, KU ran three faculty workshops for faculty members in the sciences and in engineering at KU, K-State and UMKC. In order to ensure individual attention to all participants, the workshops were limited to a maximum of 12, half from KU and the other half divided between K-State and UMKC. The purpose of making sure that there were a number of participants from each of the three institutions was that there would thereafter be a core of faculty at each institution familiar with methods of ethical reasoning and interested in applying these methods in their disciplines. Without such a core from which the participants can draw support and discuss their mutual interests, a faculty member would be isolated when it comes to discussing ethical issues or trying to influence

departmental policy about its inclusion in the curriculum. All sessions took place at KU, and the main instructors also came from KU.

Each workshop covered an initial three-day period of instruction, followed by two additional one-day sessions over the ensuing months.[6] The premise was that during the initial three days the participants would be introduced to the basic methods of ethical reasoning, and be provided with a variety of approaches to including ethics in their courses, as well as to a technique for developing courses and course components that make them available to others through the development of posters of each course, which would be accessible on the Internet.

During the afternoon of the third day the participants started on the project of integrating ethics into their course and joined with their colleagues in discussing how to develop and measure the ethical skills of graduate students in their programs. Part of the task was to also develop a rubric for grading students in their assigned task. Some chose the case-study approach, others tackled developing ethics throughout the course, some chose debates or role-playing, yet others proposed using videos or movies or other approaches.

After a break of a month or more during which participants had the opportunity to read, think about and develop their project further, they met for a fourth day. During this one-day follow-up session the participants reviewed what they had learned earlier, raised new question, discussed new cases, and presented their tentative plans for including ethics in their courses for comment and help from

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[6] A sample schedule for the initial three-day session is included as an appendix to this chapter. Copies of the PowerPoint slides that summarize the material presented in these sessions are available on the project website http://www.rgs.ku.edu/eese .

the other members of the workshop. After another break of several weeks, they met for the fifth day, during which the participants presenting the final details of how they would include ethics in their course, and received final comments for improvement from the instructors and the other participants.

The first workshop took place January 16-18, 2007, with follow-up sessions on April 26, and May 11. The second workshop took place August 13-15, 2007, with follow-up sessions on October 19, and December 12. The third took place August 18-20, 2008, with follow-up sessions on November 7 and December 12, 2008. The three workshops were basically the same, although there were improvements made as the workshops progressed. The three primary instructors remained the same for all three workshops but guest presenters varied from workshop to workshop.

Participants

Each of the three institutions chose it own participants from the pool of applicants—or if there were not enough applicants each recruited participants. As an inducement to applicants, each participant received a $750 stipend from the project for planning an ethics component and offering it within a graduate class.

In the first workshop there were six KU, three K-State, and three UMKC participants. In the second there were three KU participants, two from K-State and three from UMKC. In the third, four participants were from KU, two from K-State and two from UMKC. In all 28 faculty members completed the Workshop. Thus, while there was considerable interest in including ethics modules, the project could have included more faculty if it had been possible to recruit them.

Presenters

The workshops organizers and main presenters were: Professor Richard De George, University Distinguished Professor of Philosophy and Co-Director of the KU International Center for Ethics in Business; Douglas May, Professor of Management and Co-Director of the KU International Center for Ethics in Business; and Dan Bernstein, Professor of Psychology and Director of the KU Center for Teaching Excellence. Professors De George and May had offered a number of workshops for integrating ethics in the business curriculum for faculty members at business schools across the country. They used that experience in structuring the EESE workshops. Professor Bernstein has extensive experience and success in promoting excellence in teaching and in using the development of posters as a technique of making courses available on-line to colleagues.

Workshop Content

Prior to the start of the Workshop participants were sent three chapters dealing with the ethical theories that would be used in the Workshop. Upon arrival, participants were given a notebook which contained additional articles, readings and bibliographies—some to be read each evening before the next day's sessions and some to be used as reference and guides to additional material on a variety of pertinent topics that participants could pursue on their own after the Workshop.

Day One

The initial session set out the aims of the workshop and provided an overview of the five days. In the initial three days it would be impossible to teach the participants all that is covered in even an introductory course in ethics. But that was not the aim. The aim was to make the participants sufficiently familiar with what ethical theory means, what it does, and how it provides a variety of methods for identifying and thinking through ethical problems, cases and issues to a conclusion. A key part of such an approach was introducing them to the basic terms in which moral judgments are made—such as rights, duties, justice, consequences—and the logic appropriate to each mode of discourse. Lacking command of the vocabulary of moral and ethical discourse is a major impediment to most professors discussing ethical issues in their course. They usually lack confidence in leading such discussions and are conscious that such discussion is different from discussions in their discipline, in which they are trained. They may also worry that some students have had courses in ethics that they have not had and so know more than they do about techniques of ethical discourse.

The first task of the workshop therefore was to overcome the obstacles to integrating ethics into their courses, the first of which is lack of knowledge and confidence. There are other impediments as well. One is the often heard argument that there is already so much that their students have to learn in their own disciplines that there is neither room nor time in the curriculum to add either a course or modules in ethics. Another is that law provides all the guidance that scientists and engineers need. If they are taught the rules they must follow, there is

no need for ethics. Yet another is that ethics and morals are relative to each person and the faculty have no right to impose their own ethical views on their students. Each of these has to be discussed and answered in order to clear the way for the instruction that follows. This is the objective of the first morning. By having the participants discuss some relatively simple—or at least apparently simple—cases, the participants come to see that there are ethical issues about which they are concerned, that they have views about these issues, that not all the participants initially agree, and that in trying to defend their positions, they generally fall back on what they believe or feel, without being able to go further. By the end of the first morning they are ready to see what the workshop might offer them.

The first part of the afternoon deals with an intuitive approach to ethics in which actions are judged by their consequences. If an action produces more harm than good it is unethical; if more good than harm, it is ethical. Systematized into the ethical theory of utilitarianism, the ramifications and basics of such an approach are then developed. The participants are not taught the history of the theory or all of the esoteric debates about subtle differences of interpretation. That is neither necessary nor helpful for the participants to lead discussions. But they can get a good grasp of the basic method in the first half of the discussion and then take part in applying it to cases.

The second half of the afternoon is dedicated to a discussion of duty, rights and justice—again familiar notions that have given rise to discussion of their meaning, logic, justification and application.

Day Two

The second day starts with cases that raise the issues of duty justice and rights in the context of science and engineering. That discussion is followed by the introduction of virtue, its place in science and engineering, and a presentation of psychological and organizational influences on behavior. Tying the three approaches together and discussing cases in the light of them helps demonstrate their applicability as well the difficulties that one may encounter in their use. Not all cases, especially true dilemmas, have a ready or clear ethical answer or solution. The participants come to see that they often have to be satisfied with uncertainty and with settling for the best solution one can arrive at in the light of lack of complete information. They also see that cases are often complicated and cannot be settled simply by immediate, intuitive decisions.

Following lunch, the first part of the afternoon of the second day was dedicated to discussing psychological challenges, and to a variety of possible approaches to including ethics into a course. These approaches include modules dealing with ethical reasoning, case discussion, class debates, role playing, ethics games, movies and novels, and so on, including on-line courses.

The second half of the afternoon was dedicated to a discussion of professional codes in the sciences and engineering, the variety of government and university regulations governing various aspects of science and engineering research, and their relation of ethics. This was followed by a presentation and discussion of course applications and materials, and by the participants raising and

presenting their tentative ideas about how they expected to introduce ethics into their course or courses.

Day Three

The third day was dedicated to helping the participants develop their preliminary ideas into a concrete proposal and to introducing participants to the idea of preparing a poster for their projects. Working through the poster helps them add flesh to the bones of their proposal. Participants developed an assignment, then sketched out ways they would prepare students to perform an ethical analysis, and finally developed a rubric for grading the assignment. The day began with a discussion of "backward design" or deciding what one wants the students to learn and then working backwards to figure out the best way to achieve that goal. To facilitate this conversation participants were divided into small groups in which they could present their tentative projects and get feedback from other members of the group. They then began actually writing out their assignments.

After lunch they continued their writing, filling in their goals and the way the assignment achieved the goals. Then they filled out the assessment component. This again was discussed in small groups. To facilitate the whole process, participants were given examples of developed posters, and then given additional time to work further on their posters. This was followed by a final discussion with all three of the Workshop facilitators.

At the conclusion of the three days the participants typically had become confident in dealing with ethical issues and had gained some facility in using ethical

language and developing ethical analyses, which they were able to explain and defend. They had also worked out at least a tentative plan for including ethics into their courses.

Participants were aware that the workshop had not transformed them into experts in the new material, but they knew what they were doing and how to proceed in the six weeks until the Workshop reconvened.

Day Four

The first follow-up session began with a review of what was covered in the initial three days, and a discussion of questions that the participants wished to raise on the basis of their reading, reflection, and attempt to work out their projects. To reinforce the review process, the facilitators presented new cases or issues, working from relatively simple ones to more complicated cases. In two of the workshops a guest lecturer covered material pertinent to a specific discipline to illustrate greater depth in a given area.

The afternoon was dedicated to working with the participants on their projects. Each presented how far he or she had developed his or her project, what problems he or she may have encountered, and what he or she wanted help on. The discussion was both general, if someone raised an issue that was pertinent to all, and specific. Facilitators and participators joined in raising questions and making suggestions. Those participants having special difficulty had the opportunity to receive individual assistance in working through whatever problems they had. At

this stage most participants had gained confidence in their ability to handle a class discussion and to grade fairly whatever assignment they were developing.

Day Five

The last day of the Workshop was dedicated primarily to detailed presentations by the participants, followed by general discussion, questions, and constructive criticism by the facilitators and other participants. Each participant was allotted 30 minutes (more or less, depending on the number of participants) for the presentation, including discussion and questions from the group. The final hour of the day consisted of a summary, provision of additional sources for further study and resources for new courses, and final resolution of questions. The session concluded with the participants filling out an evaluation form to help the facilitators improve future Workshops.

Post-Workshop Activity and Dissemination

The Workshop was not the conclusion of the process, but the end of the introduction of the process. The next stage consisted of the participants actually implementing their projects in their classes. This was followed by completion of the poster for the course, which included samples of the work of the students in the class, as well as the rubric the instructor used for grading, and comments by the instructor about the class. This is posted for others to see on the Internet and is the primary way in which their experience and the experience of the Workshop are being disseminated. The final posters vary and not all have been posted. Some,

however, are excellent and serve as true models for how ethics can imaginatively and successfully be integrated into science and engineering classes both on the graduate and on the undergraduate level—even though the latter was not specifically included in the project.

Many of the participants borrowed freely—as they were encouraged to do—from the PowerPoint presentations of Professors De George and May to introduce the techniques of ethical analysis to their classes. This not only made it unnecessary for them to develop their own material, but it also added a certain consistency across courses as the students encountered similar material in different contexts.

Evaluation of Results:

Reports from the participants about their success vary. Some report great success and have gone on to integrate ethics into other courses, some have taken the initiative to push their departments to include ethics across the curriculum, some have had less success for a variety of reasons.

Two generalizations can be made at this point. The first is that ethics has been integrated more explicitly and formally in at least 28 courses (some participants include it in more than one course), and included more effectively, than had previously been the case. The course content and the techniques used have been documented in posters and the experience of these faculty members at three institutions is now available to help not only their colleagues at their own institutions but also those at institutions throughout the world through the global reach of the Internet.

The second is that at each of the three institutions there is now a core of faculty who have been through the Workshop. This core constitutes a critical mass. They now know each other and know they have colleagues in their own department as well as in other departments who have the same interest in including ethics in science and engineering as they do. This helps mitigate the feeling of isolation that they are alone in this commitment to ethics in education, and they have others with whom they can feel free to discuss ethical issues in their field. In this way they reinforce each other. In like manner, when students encounter ethical issues being discussed in several classes—and in a somewhat similar manner in each—they come to feel that such discussions are legitimate and that the issues are not simply to be treated as issues about which each person has his or her own feelings and which it is a waste of time to discuss. In both ways the workshops help legitimate the discussion of ethical issues in science and engineering faculties and departments. In a number of instances faculty members who have been through the Workshop have taken the lead in pushing their departments to take ethics seriously in their courses, and they have been identified as valuable members of college and university committees discussing, for instance, how the university should implement the recent NSF requirement that all students supported by NSF money be given appropriate instruction in ethics and compliance in their field.

The Stand-Alone Course

To talk about the stand-alone course is somewhat misleading, since several of the courses taught by participants in the Workshop were also stand-alone

courses, although they typically focused less on ethical theory than the course herein described. The course was taught twice. The account given here pertains to the first iteration. The second was somewhat different in that it met twice a week for fifty minutes each session, instead of for an hour and fifty minutes once a week.[7]

The course was taught jointly by Richard De George, University Distinguished Professor of Philosophy, and George Wilson, Higuchi Distinguished Professor of Chemistry and Pharmaceutical Chemistry and Associate Vice-Provost of Research and Graduate Studies. The instructors originally envisaged the course as a three credit course that met once a week for an hour and fifty minutes. It was originally offered as a Graduate School course. But in this configuration it enrolled only two students, both from engineering.

The problem, it turned out, was that the various science departments that were supporting tuition costs for their graduate students a either wanted their students to enroll in a course with their departmental designation or, for financial reasons, in a course that carried either onlt one or two credits. So the final course was offered under the title "Interdisciplinary Seminar on Ethics in Science and Engineering" with separate listings under Graduate Studies, Medicinal Chemistry, Neurosciences, Pharmacology and Toxicology, and Pharmaceutical Chemistry. Assignments were the same for all students, with the exception that those enrolled

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[7] A copy of the syllabus from the first iteration of the course is included as an Appendix to this chapter. Additional information about the course is also available in an online poster accessible at http://contentbuilder.merlot.org/toolkit/html/snapshot.php?id=12711848889209 . The poster provides links to PowerPoint presentations and reading assignments for the course as well as the assignments given to the students.

for three credits were required to write a term paper dealing with an ethical issue of their choice in their discipline in addition to the other requirements.

The course built on a previously existing one hour course offered by the Department of Pharmaceutical Chemistry. The intent was to cover many of the same topics as the previous course, but to add a large component of ethical theory and to include the moral or ethical dimensions of each of the topics previously covered. As with the previous course, the stand-alone course was structured to utilize a large number of faculty specialists each of whom spoke on a topic of their expertise. Some of the invited faculty had taken part in the Workshop on Integrating Ethics into Courses in Science and Engineering. Those who had not were invited to preliminary meetings in which the aims and techniques of the course were discussed. They were also given a copy of the text that would be used. Since there would be a number of guest lecturers, the course was given unity by weekly assignments from the text, and by assigning a short paper each week dealing with an ethical aspect of the topic for the week or with a case rlated to thee topic for the week. Professor De George prepared and graded the assignments, so as to provide continuity from week to week.

The first four lectures—or four weeks—of the course were devoted to the topics that the Workshop had covered in three days. The topics were ethical relativism and the relation of ethics and law; followed by the techniques of moral argumentation: consequences (or utilitarianism), justice, rights, duties, and virtue. Typically one hour each week consisted of lecture, followed by a case discussion in which one of the techniques of moral argumentation was used. Each week the paper

assigned required the students to utilize a specified technique to analyze an assigned case. Professor Wilson always took part in the discussions and added the point of view of a practicing scientist, while Professor De George approached the cases from the point of view of an ethicist. After the first month, the rest of the course dealt with a wide variety of issues, including: the scientist as citizen; experimental techniques and the ethical handling of data; government regulations with respect to human subjects and the treatment of animals; the allocation of credit and ethical issue in authorship; plagiarism; ethics in grants and entrepreneurship; and ethics issues in the teacher-student and the employer-employee relationships. Fifteen papers were assigned and the best thirteen (in terms of grades) were averaged to determine the final grade for each student. For those who took the course for three credits and wrote a term paper, the paper counted as one-third of the final grade, the weekly papers for two-thirds.

In retrospect Professors De George and Wilson agreed that despite the overall success of the course, allowing the guest lecturers to lead the class for the entire hour and fifty minutes meant that in some cases the ethical issues were not adequately raised or sufficiently pursued in discussion. The second time the class was offered (by Professor Wilson and several guests from the Philosophy Department), the invited lecturers were given only one class session, and the second class session each week was devoted to discussing the ethical issues connected with the topic they had dealt with the preceding class session.

With the conclusion of the grant and the added challenges created by budget cuts related to the recession that began in 2008 it has not been feasible to continue

to offer the stand-alone course as a two or three hour course with two faculty members as instructors. Instead it has been scaled back to a one-hour course. Nonetheless, the idea of a stand-alone course, perhaps even one that is required of all students in a department, has gained some support among some faculty members. Not surprisingly, some of these supporters are those who have been through the Workshop.

Chapter 2
Appendix A:
Schedule for Faculty Workshops

EESE Faculty Development Workshop on Integrating Ethics into Science and Engineering Courses

(Draft Schedule August 12, 2008)

Monday, August 18 - Adams Alumni Center , Seymour/Brock Room (2nd floor)

8:30	Continental Breakfast
9:00	Introduction and Welcome Remarks - Richard De George and Douglas May
9:30	Overview and Plan for the Workshop - Richard De George and Douglas May
10:00	Break
10:15	Ethical Relativism, Law, Norms, and Compliance - Richard De George
11:15	Ethical Decision-making Framework - Richard De George and Douglas May
12:00	Lunch!
1:00	Utilitarianism - Richard De George
2:30	Utilitarianism and Case Applications - Richard De George and Douglas May
3:15	Break
3:30	Human Rights, Justice and Duties
5:00	END

Tuesday, August 19 – Adams Alumni Center , Seymour/Brock Room (2nd floor)

8:00	Continental Breakfast

9:00	Human Rights, Justice and Duties Case Applications - Richard De George and Douglas May
10:15	Break
10:30	Virtue Ethics and Application; Ethical Decision Making Process – Psychological and Organizational Influences - Douglas May
12:00	Lunch
1:00	Pedagogical Approaches and Challenges; Recommendations for Crafting an Ethics Module - Douglas May
2:30	Professional Codes and Ethical Issues in Science and Engineering – Richard De George and Douglas May
3:15	Break
3:30	Course Applications and Materials - Douglas May, Richard De George and Steve Starrett
5:00	END

Wednesday, August 20 – Center for Teaching Excellence, 135 Budig Hall

All participants should bring a laptop if available, or they are provided on site
CTE is a wireless zone, so you will be fully online as needed

Assignments: to be brought with you (on laptop or flash drive or on paper):

1) Create an assignment for your class that will include an ethical dimension in the students' performance. Try to take an existing assignment that you have already created and add details or complications that you believe raise ethical questions. If you need to invent a completely new assignment, that's fine. 2) Once you have the assignment sketched out, begin to write out the ways you will prepare students to perform this new ethical analysis. Be sure to include your plans for students to practice the analytical skills and receive feedback on their versions.

Look at two posters from first year of project for ideas:

Go to: http://www.cfkeep.org/static/index.html
Log in with your email address and the password "keeptoolkit"

You will find a gallery with two planning posters from last year; please read them with particular attention to the assignment used to measure ethical thinking, the

framework for evaluating levels of ethical thinking, and the plan for generating successful ethical thinking.

8:00 – 9:00	Breaking our fast
9:00 – 9:20	Discuss backward design and identifying priorities Qs: What are your primary intellectual goals for the entire class? How will ethical issues fit into this framework? How important are the ethical goals to the success of the entire class? How often will those goals be manifest in student work?
9:20 – 9:45	Discuss "thinking like an ethical scientist" Qs: What does it mean to think or practice ethically in your field? In what setting will you ask students to show you ethical thinking or planning? What will they do to demonstrate an understanding of the ethical content you have included? How often will they demonstrate ethical understanding? How does that fit with your analysis of the enduring issues in your course?
9:45 – 10:30	BREAK and go into group conversations around what opportunities you will build into your class for students to demonstrate ethical understanding. You should share what assignment you might use that would prompt ethical work, and you should also articulate what practice in that thinking you will promote during and outside class meeting time.
10:30 – 11:00	First writing time: Revisit and revise your assignments based on discussions
11:00 – 12:00	Discussion of criteria used to evaluate assignments on ethical thinking. Present examples of assignments and criteria. What does it mean to have a deep understanding of ethical guidelines, protocols, and procedures? What characteristics of ethical thinking would you value and look for?
Noon – 1:00	Lunch
1:00 – 1:30	Second writing time: Write out the characteristics of ethical thinking that you want to generate in your students. Decide the number of categories you want or need to frame. Identify several key component skills or aspects of ethical thinking in your field that you feel you want to recognize and teach. Fill in for each combination of component and level the kind of performance you would expect. Combine this with the initial assignment you have

drawn up into a coherent statement of your plans for having students demonstrate their ethical analysis.

1:30 - 2:30 Presentation and discussion of examples with complete plan

2:30 – 3:15 BREAK and REFORM into working groups with similar interests. Groups work on refining guidelines for recognizing varying levels of ethical thinking. Discuss how students would acquire the skills you identify.

3:15 – 4:00 Third writing time: Continue to refine your plan for the ethics portion of your course. Based on the assignment and criteria, what teaching plan will help students show that skill? How will you collect an archive of work?

4:00 - 4:30 BREAK followed by demonstration and discussion of portfolios and uses of portfolios: Identification of key indicators or student learning, development of an archive, obtaining student cooperation and consent. Teaching as inquiry into successful understanding. Focus on what you will do next year and how we can make your students' learning visible, to you, to each other, and to our teaching colleagues.

4:30 – 5:00 Final discussion and questions with Profs. May and De George Wrap up and evaluation of the time

Readings in notebook, for your future reference:

- 1: First chapter from Wiggins and McTighe, Understanding by Design.
    - A book that outlines the benefits of backward design. Excellent starter for alignment of goals, practices, and assessment. Very readable without jargon
- 2: Walvoord and Anderson, Chap 5 on specifying performance
    - Effective Grading. A book that is very helpful in guiding conversations about what are the characteristics of deep understanding, whether skills or cognition and language. Faculty members like the many examples and the straightforward language of the book. Walvoord is an English professor and Anderson teaches Biology.
- 3: Halonen and others on describing excellent understanding
    - A good example of the development of criteria for identifying varying levels of understanding; a useful prototype of the framing of your own judgments about ethical reasoning and analysis.

Chapter 2
Appendix B
Syllabus for Stand-alone Course

INTERDISCIPLINARY SEMINAR ON ETHICS IN SCIENCE AND ENGINEERING
GS 804; MDCM 804; NURO 804; P&TX 804; and PHCH 804

Fall 2007
Tuesdays, 12:00-1:45 Room 100C MRB

Instructors:

Richard T. De George
3065 Wescoe
Office Hours
M & W 11:00 – 12:00
and by appointment
Tel. 864-2324
Email: degeorge@ku.edu

George S. Wilson
203 Youngberg
E-mail: gwilson@ku.edu
For meeting by appointment
contact Linda Crawford:
Tel. 864-7298 or
Email: lcrawfor@ku.edu

Course Description: The course will cover basic techniques of moral reasoning, especially as applied to ethical issues in the natural sciences and engineering. Topics covered will include the ethical conduct of research, the federal and professional guidelines for different kinds of research, and the ethical dimensions of publication and professional life. While principles and codes will be discussed, emphasis will be on practical applications, cases and student involvement. A variety of formats will be used to stimulate discussion and reflection.

Texts: ORI: *Introduction to the Responsible Conduct of Research* (accessible online at http://ori.dhhs.gov/publications/ori_intro_text.shtml [may be downloaded in PDF format] -- referred to below as ORI

Francis L. Macrina, *Scientific Integrity*, 3rd ed., Washington, DC: ASM Press, 2005 – referred to below as Macrina [available in the Union Bookstore]

SCHEDULE AND READING ASSIGNMENTS

T Aug 21 Introduction. (George Wilson [CHEM/PHCH], Richard De George [PHIL])
The nature of ethics
Ethical Relativism, Law, Norms, and Compliance

28 Ethical decision-making Framework (De George)
Utilitarianism
Read ORI: pp. xi-xiii, 1 – 29; Macrina, pp. xx, 1 - 18

T Sep 4 Human Rights, Justice and Duties (De George)
Read Macrina, pp. 19-40

11 Virtue Ethics and Application (De George)
Ethical Decision Making Process

18 The scientist as citizen (Mabel Rice [SP/LANG/HEAR])
Scientist in society
Gender Issues

25 The scientist in the laboratory (1): (Jane Aldrich [MDCM])
Experimental techniques and treatment of data
Error and negligence
Misconduct
Read ORI: pp. 82 – 101; Macrina, pp. 269 – 296

T Oct 2 Professional Codes in Science and Engineering (Richard Hale [AE], Richard Schowen [CHEM/MOBI/PHCH])
Read Macrina, pp. 333 – 341

9 The scientist in the laboratory (2): (Craig Lunte [CHEM])
Government regulations
Welfare of Laboratory Animals
Read ORI: pp. 50 -65; Macrina, pp. 127 - 157

16 The scientist in the laboratory (3): (Bill Sharp [KUCR])
Institutional policies
IRBs and Protection of human subjects
Read ORI: pp. 30 – 49; Macrina, pp.91 - 126

23 The scientist as author (1): (Russell Middaugh PHCH)
Allocation of credit
Read Macrina, pp.61 – 73; Macrina, pp. 187 - 209

30 The scientist as author (2): (Wilson)

Authorship practices -- Plagiarism

T Nov 6 The scientist as author and reviewer (3): (Ron Borchardt [PHCH])
Publication and openness
Peer review
Read ORI: pp. 128- 164; Macrina, pp. 73 - 80

13 The scientist as grantee (Kristin Bowman-James [CHEM])
Read Macrina, pp. 211 - 245

20 The scientist as entrepreneur (Elizabeth Friis [ME], Valentino Stella [PHCH)
Read ORI: pp. 66 – 81; Macrina, pp. 159 - 185

T Nov 21 Thanksgiving Break

27 The scientist as employer/employee and
teacher/student (Howard Rytting [PHCH], Bala Subramaniam [C&PE])
Mentor/trainee
Read ORI: pp. 102 – 127; Macrina, pp. 39 - 60

T Dec 4 Conclusion (Wilson, De George)

REQUIREMENTS:

Regular attendance is expected. You are to read the assigned texts prior to the class. There will be a short paper assigned for each week on the assigned reading or on a topic appropriate to it. The topic for the paper will be distributed during the class prior to when it is due.

The papers will be graded each week and returned the following week. Of the fifteen short assignments, the best thirteen (handed in in class and not sent electronically) will be counted toward the final grade.

Since the class will be conducted by a large number of faculty members, we hope that the texts and papers will provide continuity that might otherwise be lacking. The individual faculty member lecturing for a given class period may supplement the readings assigned.

Those students enrolled in for three credits will do a research paper on some ethical issue in their field of study. The topic will be determined in consultation with Professors De George, Wilson, and possibly a faculty member from the student's department.

Chapter 3
Assessment of the Effectiveness of Alternative Approaches to Ethics Education in Science and Engineering

Recent research has attempted to understand the effectiveness of ethics education in science and engineering through a variety of approaches. For example, Thomsen (2007) essentially did an in-depth case analysis of one course in ethical issues in physics that he had taught for the last 15 years. He examined how the content had changed over time to include topics on the responsible conduct of research and physicists' interactions with society at large. Thomsen noted that instructors should tailor assignments to the career needs of students and attempt to help the students understand what ethical standards exist in the field, why they exist, and how to apply them to situations they are likely to face in their careers. Other work by Plemmons, Brody, and Kalichman (2006) surveyed participants (e.g., undergraduate, graduate, post-doctoral students) at the end of eleven different courses on responsible conduct of research (RCR) at ten different institutions. Qualitative and quantitative findings confirmed that the participants felt that their knowledge of such issues was enhanced, but that their skills and attitudes about responsible conduct of research were not necessarily influenced. Thus, additional research is needed that focuses on ways to develop specific ethical reasoning skills and attitudes concerning research conduct.

Powell, Allison, and Kalichman (2007) reported on the effectiveness of a responsible conduct of research course with pre/post data to try to get at some of these research needs. Specifically, Powell and his colleagues examined such

outcomes as knowledge, ethical decision-making skills, attitudes about responsible conduct of research, and the frequency of discussions students had regarding RCR topics outside of class. Disappointingly, the only statistically significant improvement they found was in students' knowledge of RCR practices, but there was a positive trend toward an improvement in reasoning skills and RCR attitudes. Other research on the enhancement of moral reasoning skills with RCR courses in science and engineering has demonstrated similar mixed results (e.g., Bebeau, Pimple, Muskavitch, & Smith, 1995; Heitman, Salis, & Bulger, 2000).

Most recently, Antes, Murphy, Waples, Mumford, Brown, Connelly, and Devenport (2009) addressed this issue by conducting a meta-analysis of extant empirical studies that examined the effects of ethics education for scientists in the fields of medicine, health, and psychology. These researchers defined ethics education as "any instructional program or course, including single courses in ethics, multiple courses in a sequence covering ethics, or an entire curriculum, spread over time, that addressed scientific, research or medical ethics" (p. 385). Overall, these researchers found that ethics education did influence both students' moral development and "ethical analysis" (i.e., ethical decision-making and ethical sensitivity). Furthermore, when examining potential moderators in their research, Antes et al. (2009) found that courses held in a stand-alone fashion had greater overall effectiveness than those embedded in an existing course/curriculum. Also of interest is the fact that these scholars found that more rigorous research designs tended to find lower overall effects for ethics education efforts.

The purpose of the research discussed here was to build on this past research by examining the relative effectiveness of ethics education courses created as a result of the KU-EESE project. As described in the previous chapter, this initiative involved several approaches to increase exposure to ethical reasoning at three different institutions. To assess the impacts of these approaches we used a rigorous pre/post-test control group research design to determine the efficacy of both stand-alone ethics courses and the faculty development program that resulted in a number of embedded ethics modules. Our research extended previous work in this area by (a) examining the effects of ethics education within the context of a long-term faculty development program, (b) inclusion of psychological variables previously unexplored in the responsible conduct of research literature, and (c) inclusion of engineering and science disciplines not previously studied.

Ethics Education Outcomes

Our hypothesis is that instruction in ethics will positively affect student moral judgment and reasoning ability, their knowledge of responsible conduct of research and produce a range of positive psychological outcomes that would enhance ethical behavior. In this section we discuss the empirical constructs we use to test these conjectures.

Moral Judgment/Reasoning**.** Consistent with previous research, we sought to examine the effects of ethics education on students' level of moral reasoning. One of our goals in the faculty development workshops was to train faculty in the ability to teach students one or more of the ethical foundations for how to examine ethical issues. Thus, consistent with authors (Antes et al., 2009; Kraiger & Jung, 1996) who

advocate that the criterion measure selected to assess instruction should reflect the intended outcome, we used one of the most widely adopted measures of moral reasoning or moral development, Rest and colleagues' (Rest 1976; Rest, Narvaez, Thoma, & Bebeau, 1999) Defining Issues Test (DIT-2). Rest's instrument is based on the work that Kohlberg (1969) and Rest (1986) have done in the area of cognitive moral development.

Knowledge of Responsible Conduct in Research. Another goal of ethics education efforts in science and engineering is to develop the students' knowledge of responsible conduct of research (RCR) practice. As noted above, Powell et al.'s (2007) examination of a short-term course in RCR showed that increased knowledge of RCR practices was the only statistically significant outcome of the course. Plemmons et al. (2006) similarly found that the impact of research ethics courses on knowledge outcomes was greater than changes in skills or attitudes in their multi-institution study. Other researchers have sought to develop an assessment tool of the core concepts and standards of RCR by doing a content analysis of 20 published RCR texts (Heitman, Olsen, Anestidou, & Bulger, 2007). These authors showed from baseline studies that the mean scores of new graduate students range around 60% correct of 30 questions that address such topics as falsification and fabrication of data, recording of data, plagiarism, responsibilities of authors, conflict of interests, coercion in human research, reviewer's responsibilities, informed consent, institutional review boards, submission of manuscripts, animal research policies, disclosure of conflicts of interest, and retention of data. We chose to use this measure due to the breadth of RCR topics

covered since the faculty selected to participate in the project were from a diverse set of departments (e.g., engineering, chemistry, physics, pharmacy, political science, psychology).

Positive Psychological Outcomes. One major purpose of this research was to expand the focus of typical ethics-related outcomes by incorporating ideas on positive ethics from the positive psychology movement (e.g., Handelsmann, Knapp, & Gottlieb, 2002). Specifically, recent work by May, Luth, and Schwoerer (2009, 2010) in business ethics education suggests that future ethics education would benefit from examining such positive variables as *moral efficacy, moral courage, and moral meaningfulness*. Furthermore, we considered the effects of ethics education on individuals' abilities to take the perspective of others when considering their actions. Each of these is briefly reviewed below.

Perspective-taking. Ethics education often aims at enhancing the ability of students to understand the consequences of their actions on others. Specifically, students learn how to empathize with others. Empathy has two fundamental components – cognitive and affective. We focus here on the cognitive component because it seems to play a more significant role in the ethical decision-making process (Mencl & May, 2009). Cognitive empathy entails thoughts about the potential negative or positive effects that an action has on others; that is, attempting to take their perspective. Such perspective-taking has been shown to result in better cooperation among team members in an organization (Parker & Axtell, 2001). Within the ethics literature, cognitive empathy has been found to be more

closely related to moral judgment than the emotional or affective dimension of empathy (Kalliopuska, 1983; Leith & Baumeister, 1998).

Moral Efficacy. Moral efficacy is derived from the psychological literature by Bandura (1997) on self-efficacy which is the belief that one can carry out a task successfully. Believing that you can do something plays a powerful positive force in one's life (Maddux, 2002). Indeed, self-efficacy has been linked to a variety of behaviors, learning outcomes, and performance in a variety of environments (e.g., Judge & Bono, 2001). Extending these ideas to the ethics field, May et al. (2009) defined moral efficacy as "an individual's confidence in one's ability to actively and positively deal with ethical issues that arise in the workplace and to overcome obstacles to developing and implementing ethical solutions to ethical dilemmas" (p. 7). These authors found that a course dedicated to business ethics education was successful in developing individuals' moral efficacy beliefs. Furthermore, subsequent work by these researchers found that moral efficacy influenced individuals' independently-rated moral behaviors in the workplace (e.g., raising ethical issues to management, making suggestions for solutions to ethical problems) through their own moral courage (May et al., 2010).

Moral courage. Courage is a concept from positive psychology (Hannah, Sweeney & Lester, 2007) and one dimension, moral courage, has been argued to be fundamental to positive human mental health (Lopez, O'Byrne, & Petersen, 2003). May, Chan, Hodges, and Avolio (2003) maintain that moral courage is "the fortitude to convert moral intentions into actions despite pressures from either inside or outside of the organization to do otherwise (p. 255)." Thus, individuals often face

aversive consequences if they choose to act in a positive moral manner to correct an injustice or an unethical action. As noted above, moral courage explains how individuals translate their morally efficacious beliefs into actual actions or behaviors.

Moral meaningfulness. As human beings, we all strive to achieve meaning in our lives and it is generally accepted that individuals need values that lead to a sense of goodness to their lives and themselves as human beings (Baumeister & Vohs, 2002). Indeed, Blasi (1999) has argued that morality is critical to one's understanding of him/herself and other authors maintain that acting consistently with ones values brings meaning to individuals (Bergman, 2004). Thus, *moral meaningfulness* represents the extent to which one gains meaning from behaving ethically (May et al., 2009).

Research Hypotheses

Based on the above literature review, we expected that ethics education in science and engineering courses would positively influence students' knowledge of responsible conduct in research practices as well as their level of moral reasoning (i.e., moral judgment). Drawing from recent research in the business ethics education domain, we also expected that ethics education initiatives would positively influence the ethically-relevant psychological variables of perspective-taking, moral efficacy, moral courage, and moral meaningfulness.

In the current study, we were particularly interested in a comparative analysis of the relative effectiveness of stand-alone vs. embedded approaches to teaching ethics to scientists and engineers. Given the recent research review by Antes et al. (2009),

we expected that the stand-alone ethics courses would result in more effective outcomes than the embedded ethics module courses. We contributed to their research by examining the specific ethics-based criterion measures of knowledge of RCR practices and moral judgment since they were only able to provide an overall estimate for this comparison. Furthermore, our research extends the research in this area by examining the four positive psychological outcomes of perspective-taking, moral efficacy, courage, and meaningfulness.

Specifically, we maintain that in a stand-alone ethics course much more time and interaction is spent with the students on the ethical issues in their profession. This additional "time on task" is likely to enhance students' knowledge of proper research practice. Furthermore, students in stand alone courses are able to repeatedly practice how they would handle different ethical issues which should both build their perspective-taking and moral judgment abilities as well as their confidence in such abilities (i.e., moral efficacy). As noted by previous authors (May et al., 2009), such confidence should be the basis for the willingness to engage in future morally courageous actions to report unethical actions in the research context. Finally, students in stand-alone courses have more time to integrate the importance of ethical actions into their identities as scientists and engineers. The study's specific hypotheses are listed below:

> ***Hypothesis #1****: Individuals who receive ethics education in a science or engineering course should experience more improvement in their (a) knowledge of RCR practices and moral judgment and (b) positive psychological outcomes (i.e., perspective-taking, moral efficacy, moral courage, and moral*

meaningfulness) than those who do not receive such ethics education (i.e., the control group).

***Hypothesis #2**: Individuals who participate in a stand-alone ethics course should experience greater improvement in these effectiveness measures than those who receive ethics education in an embedded module condition.*

Methods

Participants and Setting

Participants were 422 students enrolled in undergraduate and graduate science and engineering courses at the University of Kansas, the University of Missouri-Kansas City and Kansas State University. Three treatment conditions were selected for this study: a control group, an embedded ethics module group, and a stand-alone ethics course group. The control group consisted of participants who were not enrolled in any ethics-based coursed during the current semester. The embedded group consisted of participants who were enrolled in a course where ethics was not the primary topic, but instead ethics was embedded in the curriculum. The stand-alone group consisted of participants who were enrolled in a stand-alone ethics course, where ethics content was the primary material for the course. All groups consisted of participants enrolled in programs in science, engineering, and technology.

One of the members of our research team distributed the survey instruments to the participants in the respective classes. Participants were invited to participate in a research project concerning education curricula, but were unaware that the

research questions specifically focused on ethics education and were blind to the research hypotheses. In order to match pretest and posttest survey instruments, participants were asked to generate a unique identification number based on family information. All participants were assured of strict confidentiality and that only the research assistant would have access to individual-level data.

This study employed a quasi-experimental pretest-posttest with nonequivalent control group design. Dependent measures were collected at two points in time for the two treatment groups and the control group. Pretest measurement occurred during the first week of classes, before any course material was covered. Posttest measurement typically occurred the second to last week of the semester, after all the course materials were covered. For the treatment groups, this represents collecting the dependent measures before and after exposure to the ethics education content. By also collecting pretest and posttest measure for the control group at equal time intervals, we were able to control for the effects of repeated testing, history, and maturation in the sample (Cook, Campbell, & Peracchio, 1990).

As is common with pretest-posttest designs, some participants did not complete all the measures at both points in time. In addition the survey materials took over one hour to complete, and although participants were given ample time to complete the survey, some participants did not complete all the measures.[8] Of the 422 potential participants in this study, 150 (36%) completed at least one of the

[8] There are, of course, many reasons for non-completion of both instruments. In some classes there were a high number of international students for whom English is not their first language. These students may have become frustrated by the length of the survey instruments.

measures for both pretest and posttest conditions. Eighty-nine of the participants completed more than two-thirds of the dependent measures (21%), while only sixty-nine (16%) of the participants completed all of the dependent measures at both pretest and posttest conditions. Participants who did not complete any of the measures for either pretest or posttest were removed from the data analyses. These lower response rates were somewhat expected given the pretest-posttest design, the use of a time-intensive survey, and the volunteer nature of the survey at both the beginning and end of the semester.

To test whether the included respondents systematically differed from those excluded, we conducted a multivariate analysis of variance (MANOVA) using the socio-demographic variables collected in the study (gender, age, and education level). This omnibus test revealed that these socio-demographic variable varied somewhat as a function of inclusion / exclusion in the analyses, $F(3,334) = 3.44$, Wilks' Lambda = .97, $p<.05$. Follow-up tests revealed that there were no significant differences in age nor education level, but there were significant differences in gender, $F(1,334) = 8.83$, $p < .01$. In this sample, females were more likely than males to complete the survey instrument at both pretest and posttest conditions.

Of the total sample size of 150, 58.7% of the participants listed their current program as engineering, 20.0% were physical science (e.g., chemistry, physics, mathematics), 11.3% were natural sciences (e.g. biology, biochemistry, ecology), and the remaining 10% listed "other" as their current program. Participants' ages ranged from 18 to 43 years (M = 25.1 years, SD = 4.4 years). Slightly more than half (54%) of the participants were male. 50.7% of the sample was White/Caucasian,

16% of the participants were Asian, and 25.3% did not report their ethnicity. The percentage of undergraduates, masters / professional school, and doctoral students were 32.7%, 26.7%, and 40.7% respectively.

Measures

Moral Judgment. Moral judgment was measured using the Defining Issues Test, Version 2 (DIT-2; Rest, Narvaez, Thoma, & Bebeau, 1999). The measure entails a set of five stories about social problems. After each story participants are asked to answer a series of questions regarding the ethical issues raised by that story. First participants are asked to take the position of the protagonist and select an action from the three proposed alternatives. After selecting the action for each story, participants are then asked to rate 12 items in terms of importance for their choice. Completed surveys were sent to the Center for the Study of Ethical Development at the University of Minnesota for the initial statistical analysis and scoring of the N2 Index.

The N2 Index provides an indication of the extent to which an individual is acquiring more sophisticated moral thinking and gaining clarity about ideas that should be rejected for their simplistic or biased solutions (Rest et al., 1999). The N2 score has two components: the degree to which post-conventional reasoning items are prioritized plus the degree to which the personal interest items (i.e., lower stage items) receive lower ratings than the ratings given to post-conventional items (i.e., higher stage items). *Personal interest* items focus on items that appeal to Stage 2 reasoning (i.e., focus on the direct advantages to the actor and on the fairness of simple exchanges of favor for favor) and Stage 3 reasoning (i.e., focus on the good or

evil intentions of the parties, on the party's concern for maintaining friendships and good relationships, and maintaining approval) considerations. On the other hand, *post-conventional* items represent items selected that appeal to Stage 5 reasoning (i.e., focus on organizing a society by appealing to consensus-producing procedures, insisting on due process, and safeguarding minimal basic rights) and Stage 6 reasoning (i.e., focus on organizing social arrangements and relationships in terms of intuitively appealing ideal considerations).

The N2 score of moral judgment is based on the choice of action and the ratings of the 12 subsequent items. Cronbach alpha reliability scores for the N2 score for the pretest and posttest were 0.73 and 0.75 respectively.

Knowledge of Responsible Conduct of Research. Baseline knowledge of the responsible conduct of research was measured using a 30-question multiple-choice assessment of the core concepts and standards in responsible conduct of research developed by Heitman, Olsen, Anestidou, and Bulger (2007) after extensive review of the RCR literature. The total number of correct answers was used as the participant's knowledge of responsible conduct of research.

Perspective-Taking. We measured perspective taking using a six-item measure developed for this study based on Davis (1980). Participants were asked to select the best response to a series of statements using a 7-point Likert scale from 1 *(strongly disagree)* to 7 *(strongly agree)*. Sample items include: "I try to look at everybody's side of an argument before I make a decision." and "I sometimes find it difficult to see things from the 'other person's' point of view (reverse-scored)." The

Cronbach alpha for this measure of perspective-taking was 0.68 for the pretest and 0.61 for the posttest.

Moral Efficacy. Moral efficacy was measured using fourteen items based on Parker's self-efficacy scale (1998). Participants were asked to indicate their confidence level in addressing each of fourteen tasks using a 5-point Likert scale from 1 *(not confident at all)* to 5 *(very confident*) including such tasks such as "making suggestions to management for an ethical problem" and "writing a proposal to resolve an ethical problem in your work unit." Scores from the fourteen items were averaged to form a single scale. The Cronbach alpha was 0.89 for the pretest measure and 0.87 for the posttest.

Moral Courage. Moral courage was measured using six items based on the work by Gibbs and colleagues (1986) and used by May et al. (2009). Participants were asked to select the best response to a series of statements using a 7-point Likert scale from 1 *(strongly disagree)* to 7 *(strongly agree)*. Sample items include: "I would stand up for my position even if it meant negative consequences." and "I would prefer to remain in the background even if a friend is being taunted or talked about unfairly (reverse coded)." The Cronbach alphas for the pretest and posttest measures of moral courage were 0.68 and 0.70, respectively.

Moral Meaningfulness. We measured moral meaningfulness using four items (May et al., 2009). Participants were asked to read a series of statements and select the best response on a 7-point Likert scale from 1 *(strongly disagree)* to 7 *(strongly agree)*. These items were "Maintaining high morals/ethics brings me meaning at work; find that doing the right thing at work is personally meaningful for me; Doing

the ethical thing gives me purpose at work; and Behaving consistently with my morals is quite important to me." Cronbach alphas for the items were 0.82 for the pretest and 0.90 for the posttest.

Control Variables. We controlled for three additional variables that could influence the effects of ethics education. First, we controlled for the potential effect of gender because of our initial finding discussed above that females were more likely to fill out both pretest and posttest surveys. Second, we controlled for education level because our sample came from a wide variety of educational experiences (i.e., undergraduate, masters/professional school, and doctoral level). Given the positive nature of the perceptual survey items (i.e., perspective-taking, moral efficacy, moral courage, and moral meaningfulness), we also controlled for impression management by using 10 items from the Balanced Inventory of Desirable Responding (BIDR; Paulhus, 1991). Impression management is the deliberate and conscious self-presentation intended to present a more positive social image. Since we were interested in how impression management might influence our dependent variables at the end of the semester, we controlled for the posttest measure (Chronbach alpha=.67).

Results

Table 1 summarizes the internal consistency measures and bivariate correlations among the study variables.

Tests for Selection Effects

Prior to evaluating our research questions, we conducted a MANOVA to test for systematic pre-existing differences on our six dependent measures between the three experimental conditions. Results of this omnibus test revealed no significant differences between the three conditions (Wilks' Lambda = .728, $p > .05$), reducing the possibility that systematic pre-existing group differences could confound our data analysis.

Analytic Procedures

In order to address our research hypotheses, we utilized a one-way analysis of covariance (ANCOVA) with our three experimental conditions as the independent variable as omnibus tests of overall group mean differences between our three experimental conditions. We conducted separate ANCOVAs for each of our six dependent measures. Gender, education level and the pretest score on the corresponding measure were included as covariates in each of the analyses, with posttest impression management added as a covariate to the models for perspective taking, moral efficacy, moral courage, and moral meaningfulness. As a test of group mean differences between our three experimental conditions on the outcome measures, we conducted pair-wise comparisons of means using Tukey's Honestly Significant Difference (HSD) tests.

Manipulation Check

We used two questions to verify the inclusion of ethics education in the courses across the different conditions. Specifically, participants were asked to indicate their agreement with the following items on a 7-point Likert scale ranging from 1 *(strongly disagree)* to 7 *(strongly agree)*: "to what extent has ethical decision-making been incorporated into your current coursework" and "to what extent has knowledge of responsible conduct of research been incorporated into your current coursework".

As expected, the extent to which ethical decision-making was incorporated into participants' current coursework did vary significantly as a function of the experimental condition, $F(2, 96) = 9.92$, $p < .001$, $\eta_p^2 = 17$. Post hoc tests revealed that both the stand-alone ($M = 5.56$, $SD = 1.33$, $p < .001$) and embedded ($M = 5.03$, $SD = 1.35$, $p < .001$) conditions rated the extent to which ethical decision-making was incorporated into the current coursework higher than participants in the control ($M = 3.88$, $SD = 1.90$) condition. Although the difference in means between the stand-alone and embedded conditions was in the correct direction, we did not find evidence for group mean differences ($p > .10$).

The extent to which knowledge of responsible conduct of research was incorporated into participants' current coursework marginally varied as a function of experimental condition, $F(2, 96) = 2.76$, $p < .10$, $\eta_p^2 = 05$. Post hoc tests revealed that participants in the stand-alone ($M = 4.93$, $SD = 1.79$, $p < .05$) rated the extent to which knowledge of responsible conduct of research was included into the current coursework higher than participants in the control condition ($M = 3.92$, $SD = 1.85$).

However we found no differences between the embedded (M = 4.68, SD = 1.51, p > .10) condition and either the stand-alone condition or the control condition.

Moral Judgment

In our sample, moral judgment did not vary significantly as a function of treatment condition, $F(2, 123) = 0.35$, $p > .10$, $\eta_p^2 = .01$. Post hoc tests corroborated the omnibus tests and indicated that none of the treatment condition means were significantly different from one another (Control: M = 42.51, SD = 12.19; Embedded: M = 42.94, SD = 11.86; Stand-alone: M = 40.84, SD = 12.19). Thus, contrary to our predictions, moral judgment did not increase as a function of the ethics education conditions and, hence, moral judgment did not increase more for the stand-alone condition than for the embedded condition.

Knowledge of Responsible Conduct of Research

Analyses revealed that knowledge of responsible conduct of research varied only marginally as a function of treatment condition, $F(2, 83) = 2.88$, $p < .10$, $\eta_p^2 = .07$. However, post hoc tests detected no statistically significant differences between any of the three experimental conditions (Control: M = 15.55, SD = 3.62; Embedded: M = 14.47, SD = 3.31, Stand-alone: M = 16.36, SD = 3.30). Again, contrary to our expectations, knowledge of responsible conduct of research did not increase as a function of the ethics education treatment conditions (H#1) and it did not improve more for the stand alone courses vs. embedded module courses (H#2).

Perspective-Taking

Our analyses did demonstrate that perspective-taking varied significantly as a result of treatment condition, $F(2, 83) = 3.85$, $p < .05$, $\eta_p^2 = .09$). Consistent with Hypothesis #1, planned comparisons indicated that participants in the stand-alone ($M = 5.30$, $SD = 0.50$, $p < .05$) and embedded ($M = 5.34$, $SD = 0.51$, $p < .05$) conditions rated their posttest perspective-taking ability higher than participants in the control condition ($M = 4.96$, $SD = 0.52$). However, contrary to Hypothesis #2, we found no differences between the stand-alone and embedded ethics education conditions.

Moral Efficacy

Moral efficacy also varied significantly as a result of treatment condition ($F(2, 74) = 3.79$, $p < .05$, $\eta_p^2 = .09$) with planned comparisons for Hypothesis #1 indicating that participants in the stand-alone ($M = 3.90$, $SD = 0.46$, $p < .05$) and embedded ($M = 3.90$, $SD = 0.46$, $p < .05$) conditions again rated their posttest moral efficacy higher than participants in the control condition ($M = 3.56$, $SD = 0.48$). However, contrary to Hypothesis #2 expectations, we found no difference between the stand-alone and embedded module conditions.

Moral Courage

Consistent with our expectations (H#1), findings also revealed that moral courage varied significantly across treatment conditions ($F(2, 83) = 3.81$, $p < .05$, $\eta_p^2 = .08$) with planned comparisons indicating that participants in the stand-alone ($M = 5.46$, $SD = .54$, $p < .05$) and embedded ($M = 5.58$, $SD = .55$, $p < .05$) rated their

posttest moral courage higher than participants in the control condition (M = 5.13, SD = .57). Hypothesis #2 was not supported, however, as there was not a statistically significant difference between the stand-alone and embedded conditions.

Moral Meaningfulness

Finally, our initial overall analysis did not reveal that moral meaningfulness varied as a result of treatment condition, $F(2, 71) = 3.81$, $p > .10$, $\eta_p^2 = .05$. Although the omnibus test did not produce significant results, we decided to conduct a priori planned tests to further evaluate the data. While these results should be interpreted as somewhat tentative, our planned comparisons indicated that participants in the embedded (M = 6.13, SD = .87, $p < .10$), but not the stand-alone (M = 5.83, SD = 0.87, $p > .10$) condition rated their posttest moral meaningfulness *marginally* higher than participants in the control (M = 5.62, SD = 0.90) condition. However, we found no differences between the stand-alone and embedded conditions.

Finally, a summary of the mean differences by experimental groups discussed in the above sections is shown in Table 2. The covariate-adjusted group means for the significant findings for perspective-taking, moral efficacy, and moral courage are illustrated in Figure 1.

Discussion

Summary of Results

Overall, we found partial support for Hypothesis #1, which predicted that any form of ethics education (i.e., embedded or stand alone courses) would result in positive ethics-related outcomes. Specifically, perspective-taking, moral efficacy, and moral courage increased more for participants in the ethics education conditions (embedded and stand-alone) than for participants in the control condition. Second, we found marginal evidence that moral meaningfulness increased more for participants in the *embedded* condition when compared to the control group. However, we found no evidence in our research that either moral judgment or knowledge of responsible conduct of research increased in the expected direction for the ethics education conditions. Finally, we found no support for Hypothesis #2 which argued that stand-alone ethics education courses would provide better outcomes than embedded ethics module courses. The implications of these findings for future research and practice as well as the research study's strengths and limitations are discussed below.

Implications for Theory and Practice

First, our research findings reinforce recent calls in positive organizational psychology for more work that takes a positive approach to ethics (Handelsmann et al., 2002). Combined with emerging research (May et al., 2009), our results demonstrate that ethics education can have positive effects on individuals' moral efficacy, moral courage, and moral meaningfulness across different disciplines (e.g.,

science, engineering, and business). As noted above, such effects are important because moral efficacy and courage have been linked to independently-rated moral behaviors in the workplace such as raising ethical problems to management and suggesting solutions even if such actions may have aversive consequences for their own careers (i.e., moral courage) (May et al., 2010). Such behaviors are critical to enhance the integrity and reputation of innovative R&D labs, scientific organizations seeking to advance knowledge, or engineering firms building new products that must meet stringent safety guidelines. Individuals must be willing and able to discuss potential ethical problems before they occur and help solve them in order to build a strong ethical culture in their organizations.

Second, we also extend previous research in this area by demonstrating that ethics education can improve individuals' perspective-taking abilities which have been shown to be important for moral judgment (Kalliopuskia, 1983; Leith & Baumeister, 1998) and for cooperation in teams in organization (Parker & Axtell, 2001). Our finding suggests that science and engineering programs would be well served to implement ethics education in their curricula in order to produce students who can work well together in organizations of the future. Since much of the work in organizations is project team-based, these skills are vital for successful careers. Future research may wish to explore the connections of perspective-taking to other positive employee attitudes and behaviors in the workplace. For example, perspective-taking may lead to higher levels of creativity or innovation as individuals are able to look at problems from multiple perspectives. Thus, perhaps such skills may generalize from the interpersonal domain to other areas.

Third, the findings for moral meaningfulness tentatively suggest that embedded ethics modules in the regular curriculum may provide better opportunities for students to integrate ethics into their professional identities than stand alone ethics courses. Such courses likely provide the appropriate professional context for discussions about relevant ethical issues. Students may be more engaged in such discussions given the meaningfulness they inherently possess because of their professional content. Future research may wish to explore which type of instructional method for ethics education leads to the most meaning individuals experience in the educational setting. Initial assessments of the successfulness of ethics education by Antes et al. (2009) suggests that interactive, case-based ethics instruction may hold the key to developing the meaningfulness individuals experience as they are able to more actively consider the importance of ethics to their professional identity.

Fourth, the lack of a significant effect for ethics education on students' general knowledge of the responsible conduct of research was likely due to the diversity of the educational objectives that individual instructors used in their ethics education initiatives as well as the nature of the assessment of RCR knowledge. As noted above, the faculty development workshops gave the faculty participants much discretion how they chose to implement ethics into their curricula. Indeed, the results of the manipulation check for RCR knowledge integration suggested that only the stand alone courses appeared to address RCR knowledge in any systematic fashion, however these courses may not have adequately addressed the type of knowledge assessed by Heitman et al. (2007) which tends to lean toward research

conduct in the biomedical sciences. Given that Heitman and colleagues have developed one of the only scales in this area, future research should seek to develop another assessment instrument for RCR practices that addresses both general and discipline-specific research practices.

Finally, the ethics education initiatives in our study did not influence the moral reasoning level of students. Such a finding is consistent with previous research by Powell et al. (2007) and Plemmons et al. (2006) for responsible conduct of research coursework. Indeed, Antes et al. (2009) found that such ethics education efforts are more effective at enhancing "ethical analysis" skills than moral development or abstract philosophical reasoning outcomes. Ethical analysis skills are those which focus on the cognitive nature of the ethical decision-making process and often acknowledge the individual, situational, and organizational influences on these processes (e.g., Trevino, Weaver, & Reynolds, 2006). Sensitivity to ethical issues and ethical problem-solving steps are likely to be emphasized in this form of ethics education.

The faculty development workshop that served as the initial context for this research project exposed instructors to both pedagogical approaches (philosophical and psychological), but the faculty workshop participants tended to adopt a cognitive-based, ethical decision-making skill development focus for their ethics education initiatives based on anecdotal evidence from their presentations and course portfolios. The ethics-related psychological outcome results discussed above are consistent with such an approach. Further research needs to be done on the viability of enhancing students' moral development with embedded ethics modules

in courses. It may be that a more discipline-focused assessment instrument is necessary to adequately engage students in the assessment process. Recent work in the business field has attempted to move away from the abstract scenarios in the Defining Issues Test (Rest et al., 1999) to ones more suited to the managerial context (Loviscky, Trevinio, & Jacobs, 2007; Weber & McGivern, 2010).

Finally, this research found no evidence that ethics education delivered in a stand alone course was more effective than modules embedded in science and engineering curricula. Much of this was likely due to the short-term nature or pedagogical approach used in such courses. Indeed, departments were reluctant to allocate more than 1-2 credit hours for students taking a research ethics course. Anecdotal evidence from the instructors suggests that the pedagogical approaches varied widely with some instructors using regular case instruction with weekly write-ups while others had relatively few written assignments and used guest speakers extensively. Still other courses were taught on-line over the internet. Thus, critical instructional methods such as time on task, level of participant interaction, and the use of cases varied considerably across the stand alone courses. Unfortunately, the relatively small sample size in this condition prevented us from teasing apart the effects of these differences from one another. Future research should more systematically try to decouple the impact of specific instructional methods versus the type of instructional program (stand alone or embedded) on the specific psychological, knowledge and moral reasoning outcomes examined here. Future research should also consider investigating the efficacy of different models for integrating the current topics of sustainability and social responsibility into the

engineering and science curricula (e.g., Lucena & Schneider, 2008; Conlon, 2008). While philosophical-based moral development may be best taught in stand-alone course, sustainability and social responsibility may be topics that are particularly well-suited to being embedded in a context throughout the curriculum, particularly in the engineering field.

Future research may also wish to examine the relative influence of instructional objectives on specific ethics-related outcomes. That is, it may be that compliance-driven education with a goal of minimizing deviations from professional codes of conduct may have positive effects on knowledge of appropriate RCR practices, but may have negative effects on levels of moral development. Emphasis on virtue ethics among engineers (Harris, 2008) may also be most appropriate for the expression of positive professionalism in the engineering field.

Finally, future research should continue to examine the effectiveness of ethics education across different disciplines. Antes and colleagues (2009) examined primarily the medicine, health, and psychology fields, while we focused on predominantly on the engineering, science, and technology fields. It may be that students in these different fields vary in their receptiveness to ethics-related concepts provided in ethics courses. Numerous anecdotal comments from faculty workshop participants suggested that students have a difficult time "switching gears" from quantitative material to the more abstract qualitative material involved in ethics education.

Strengths and Limitations

Each research project has its strengths and limitations. First, this research project was part of an extensive three-year, multi-institutional faculty development project in ethics education. Second, the research employed a rigorous, pre/posttest research design with a control group. Third, a number of traditional and emerging ethics-relevant criteria were used (knowledge, moral judgment, and positive psychological outcomes) to assess the effectiveness of the ethics education initiatives. Fourth, a diverse set of courses and pedagogical approaches were represented in the sample.

The diversity of disciplines, participants, and teaching methods used also served as a limitation in the research study. Such diversity in field research creates natural error in the data and prevents researchers from finding hypothesized effects. Second, the relatively small sample size in the stand alone course condition may have limited our power in detecting differences between the ethics education treatment conditions. Third, as discussed above, the measures of RCR knowledge (and even moral reasoning) could have been better tailored to discipline-related knowledge and ethical issues. Finally, the multiple effectiveness measures created a lengthy survey for research participants. The research team felts that a significant amount of attrition from pre to posttest occurred in the project because of the time needed to complete the assessment instruments. The length of the survey may have also influenced participants' focused attention to questions and impacted some of the scales' reliabilities. Future research would do well to focus on just a few critical

outcome variables for investigation in order to minimize the effects of such lengthy assessment instruments.

Conclusion

In closing, we believe that the research reported here on ethics education in science and engineering courses demonstrates that ethics initiatives in these disciplines can have positive effects on students' ethics-related psychological outcomes. Specifically, the findings of this long-term study suggest that faculty can train students to (a) envision multiple perspectives of ethical issues, (b) develop their confidence in their abilities to handle ethical issues in their respective field of study, (c) be willing to raise the issue to management even if entails aversive consequences for themselves, and, (d) to foster professional integrity in their work places by developing a professional identity that incorporates the importance of acting ethically. The scientific and engineering world can be a better place with greater attention to ethics education in their college programs!

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Table 1 – Correlations and Internal Consistency Measures

		Correlations [a]																														
	Variables	**1**		**2**		**3**		**4**		**5**		**6**		**7**		**8**		**9**		**10**		**11**		**12**		**13**		**14**		**15**
	Covariates																															
1.	Gender	--																														
2.	Education Level	.21	**	--																												
3.	Impression Management	.07		.08		(.67)																										
	Pretest																															
4.	Moral Judgment (N2)	.13		.06		-.07		(.73)																								
5.	Research Knowledge	.13		-.01		.03		.21		--																						
6.	Moral Efficacy	-.01		.07		.27	*	-.08		.13		(.89)																				
7.	Perspective Taking	.06		-.07		.27	**	.17		.18		.40	**	(.68)																		
8.	Moral Courage	.11		-.11		.21	*	.13		.31	**	.28	**	.50	**	(.68)																
9.	Moral Meaningfulness	.01		-.21		.18		-.14		.10		.37	**	.41	**	.38	**	(.82)														
	Posttest																															
10.	Moral Judgment (N2)	.21	*	.13		-.11		.57	**	.22		-.01		.23	*	.18		-.01		(.75)												
11.	Research Knowledge	.11		.06		-.10		.44	**	.60	**	.16		.19		.24	*	.05		.40	**	--										
12.	Moral Efficacy	.00		-.17		.03		.02		.45	**	.34	**	.26	*	.25	*	.34	**	.02		.38	**	(.87)								
13.	Perspective Taking	.15		.08		.38	**	.02		.24	*	.34	**	.67	**	.34	**	.29	*	-.01		.08		.15		(.61)						
14.	Moral Courage	.19		-.10		.25	*	-.01		.45	**	.34	**	.44	**	.67	**	.25	*	-.01		.32	**	.41	**	.46	**	(.70)				
15.	Moral Meaningfulness	.03		-.08		.08		-.22	*	.26	*	.29	**	.38	**	.30	**	.51	**	-.12		.18		.45	**	.30	**	.45	**	(.90)		

Table 2 – Mean Differences by Experimental Group

Dependent Variable		ANCOVA F		R^2	ΔR^2	Parial Eta Squared	Mean [b]		SD [b]	N
1.	Moral Judgment	.35		.35	.00	.06				
	Control						42.51	a	12.19	43
	Embedded						42.94	a	11.86	43
	Stand-alone						40.84	a	12.19	43
2.	Research Knowledge	2.88	*	.40	.04	.07				
	Control						15.55	a	3.62	20
	Embedded						14.47	a	3.31	31
	Stand-alone						16.36	a	3.30	38
3.	Moral Efficacy	3.79	**	.25	.08	.09				
	Control						3.56		.48	22
	Embedded						3.90	a	.46	32
	Stand-alone						3.90	a	.46	27
4.	Perspective Taking	3.85	**	.58	.04	.09				
	Control						4.96		.52	22
	Embedded						5.34	a	.51	29
	Stand-alone						5.30	a	.50	39
5.	Moral Courage	3.81	**	.53	.04	.08				
	Control						5.13		.57	22
	Embedded						5.58	a	.55	29
	Stand-alone						5.46	a	.54	39
6.	Moral Meaningfulness	2.02		.31	.04	.05				
	Control						5.62	a,†	.90	22
	Embedded						6.13	a,†	.87	29
	Stand-alone						5.83	a	.87	27

[a] Means that do not share any subscript "a" are significantly different at p < .05, one-tailed test. Means that share a dagger (†) are significantly different at p < .10, one-tailed.

[b] Means and standard deviations are adjusted for covariates.

* $p < .10$.

** $p < .05$.

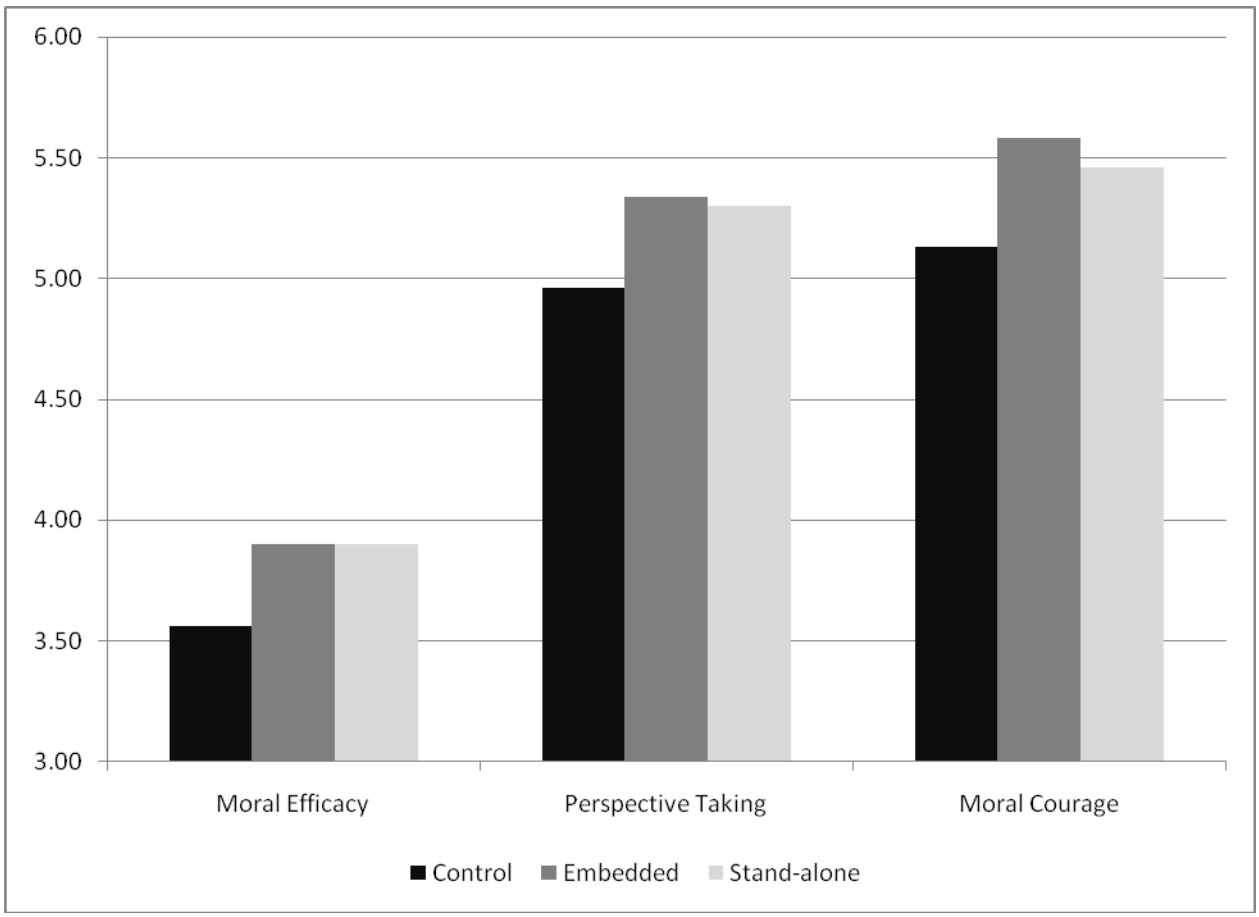


Figure 1 – Posttest Group Means Adjusted for Covariates

Chapter 4

Evaluating Student Work and its Implications For the Effectiveness of Alternative Approaches to Ethics Education in Science and Engineering

Our intervention plan (as described in Chapter 2) was pretty straightforward. Volunteer instructors would participate in a three-day workshop, during which they learned about ethical reasoning and the teaching of ethical reasoning. As part of the workshop they were guided through steps in planning both their instruction and the evaluation of their students' understanding through the use of rubrics. Each person completed the workshop with a written plan for a small project: embedding some ethics instruction into a course, creating assignments to measure the level of ethical reasoning, and representing the results of that instruction for colleagues in the EESE project. We offered the workshop three times, as described elsewhere, and this account describes the third day, when the focus shifted to engaged teaching and measuring learning.

In the first two days of the EESE workshop, faculty members had substantial exposure to the vocabulary and theories of ethical reasoning, and they had also practiced using a pluralistic ethical decision-making process to make ethical decisions about case studies. On the third morning, the agenda turned specifically to how faculty members could incorporate ethics into their courses. To begin, Professor Dan Bernstein presented the concept of Backward Design, a process of designing a unit or course by first describing the end goal that course hopes to achieve. Course work and assignments are built from that "back end," aligning goals

and measures with content (e.g., reading, lecture) and practice opportunities to achieve those goals. The course is built to achieve a known objective, rather than starting with a set of readings and presentations, leaving design of measures of success to a later point. The seminar divided into small groups, and faculty members discussed their courses using the following prompts: What do you hope to accomplish by incorporating ethics into your course? What is your motivation for adding ethics into your course? What does it mean to think ethically in your field? What does an ethical person in your field look like? How does an ethical decision maker proceed with analysis and come to a conclusion?

Articulation of answers to those questions leads naturally to examples of what should students be able to do when they leave the course. Through the discussions participants formed clear ideas of what skills their students needed. In the same way that the faculty members themselves did not require a complete theoretical understanding of ethical philosophy in order to conduct these units, the instructors defined a bounded set of skills and knowledge their students needed to act ethically as professionals or academics in their chosen field. Specification of explicit performance goals is important because it is challenging to create an assignment that assesses high-level thinking. While it is easier to create an assignment that tests basic recognition of ethical terms or identification of rules, it requires more thought to develop assignments in which students demonstrate more complex ethical decision-making.

Deeply considering what it means to think ethically in their fields also prepared faculty members to develop assessment criteria for their assignments. At

this point in the workshop, the participants were asked to construct an example of an opportunity for their students to demonstrate the skills that they described. While creating that assignment, they also specified what they would look for in their students' work to know whether the students were achieving the desired goals. In small groups the participants discussed their ideas for assignments and for quality work on those assignments, and they refined their examples through that interaction. At this point, the faculty members were encouraged to develop a rubric, or a set of evaluative criteria, to describe what their expectations were for the assignment. Articulating levels of achievement in this way gives both the professor and the student a clear understanding of what they hope to accomplish, in part by describing both novice and mature work. There is ample evidence from a wide range of studies that having well articulated learning goals results in higher levels of student achievement.

Rubrics were a very hard sell for the faculty members to incorporate or adopt, especially in the first year of the EESE workshops. Some of the faculty had used rubrics to delineate points values for different portions of an assignment, but very few had used a rubric to describe different qualitative performances. Many of the faculty had not used a rubric at all in their prior teaching, preferring ad hoc grading and feedback. One first-year participant, engineering professor Lisa Friis, developed an excellent model of an ethical thinking rubric, so it was easier in the second and third years of the project to encourage participants to use rubrics for their assignments. We first asked participants to develop their assignment along with a corresponding rubric, then Dan Bernstein shared Lisa Friis' rubric that

described levels of achievement for each step in the pluralistic decision-making process. Since many of the faculty participants developed case study assignments asking students to utilize this same decision-making process, Professor Friis' rubric was directly relevant. In some cases faculty members developed a variation of Friis' rubric, but many instructors simply used her rubric exactly as she wrote it.

Only after the faculty members had specified what they wanted their students to be able to do, through creating assignments and rubrics, did they begin to frame how they might spend time in and out of class and what materials, readings, and resources they would use to prepare students for the assignments. Participants read examples of other faculty members' approached to teaching and they met again in small groups to discuss alternative approaches. While an occasional participant came up with a novel form of teaching, for the most part they simply used their own customary forms of teaching (largely lecturing) to prepare students for the ethics assignments. At the conclusion of the third day of the workshop, the participants spent time drafting a public statement of what they planned to do in their course. These statements were developed as online posters that could be shared easily with the group and with others. Faculty participants in the second and third year were given examples of exemplary work from previous workshops in the form of these public planning posters.

Over the next two meetings, held as single afternoon sessions, the faculty participants further developed and refined their public posters, presenting their plans and any offering questions or concerns they had about their plans to the group. Each faculty member was paired with a graduate student writing-partner to

develop and implement the plan within a course. Though each of these partnerships was individualized to the preferences of the faculty members, the graduate students were available to assist the faculty members in creating their public statements, developing their course plans and rubrics, and assisting in creating a reflections sections of their findings. The graduate student writing partner also requested a sampling of student work from the ethical judgment assignment the faculty member developed. This sampling of student work was not a comprehensive selection of all of the student work, but was expected to include a cross section of the variety of performance levels demonstrated by the students.

Documenting and learning from teaching ethical reasoning

As the courses were offered, the faculty members developed their original planning posters into more descriptive course portfolios, housed publicly on the Internet. Each of these portfolios included background information about the course and the students it enrolled, the faculty member's considerations and thoughts for developing the course structure, a full implementation section describing ethics-relevant in-class and out-of-class activities and assignments, along with the rubrics used to assess these assignments. These portfolios also included the selected samples of student work and an evaluation by the faculty member of students' performance, including how it compared with their expectations. The portfolio concludes with faculty reflections addressing what they learned from teaching the course, what they would do differently if they taught an explicit ethical component again, and how they might apply a similar assignment to another course.

Appendix 4-A is a full description of the faculty members who participated in the EESE workshops, a brief description of their course project, an inventory of the student work they contributed to the project, and a link to their intermediate poster document and final course portfolio (as available). This repository of faculty work represents a rich resource of the intentions, experiences, and conclusions of the participants in the project; consideration of their work at such a first person level would be a valuable use of time by anyone who is considering adding explicit ethics education into an existing course or curriculum. The repository provides excellent examples of assignments, rubrics, and class activities that provide an excellent starting point for instructors. The narratives also provide insights into the process of developing these courses, and careful reading will help instructors introduce ethics into their own courses with fewer missteps or false starts.

Among the many observations made by the faculty participants, some emerging themes are worth mentioning as a summary of their experiences. Many faculty participants felt they spent too much lecture time on introductory descriptions of ethical theories and decision-making, preferring instead to focus more on modeling case analyses and performing them as a class. When professors taught more than one semester, they often reduced the amount of introductory lecture, moving more quickly into case studies. After making this shift in emphasis of class time, they typically found that the students were well prepared for their take-home assignments.

Many professors also decided not to introduce the full range of ethical frameworks presented during the project workshop but instead used a pluralistic

approach that was one of the frameworks offered. Even when faculty members did explicitly introduce multiple frameworks, students rarely discussed them by name, had difficulty determining which approach was best, and were unable to describe how to compare alternative frameworks. Similarly, when students worked in groups to approach a single case using multiple approaches, the students did not effectively compare the approaches. In short, it was very difficult to generate a broad or deep understanding of comparative ethics, even though students became reasonably adept at using an individual framework to analyze ethical situations.

Assessment of the quality of ethical reasoning

The overall plan for evaluation of effective teaching included converging measures, rather than relying on only one perspective on learning. The Center for Teaching Excellence contributed one approach, a careful analysis of student written projects to see what levels of skill and understanding were manifest in their performance on ethics-related assignments. Such an approach is based on widespread practice in assessment and the notion that the deepest understanding is found within topics relevant to the experiences of learners. This measurement is a complement to the students' own perceptions in course evaluation documents and to their responses to the standardized tests used to measure both procedural knowledge and ability to analyze vignettes situated in contexts outside their course-based learning.

The analysis was based on the samples of student work provided to the project leadership by the faculty participants. This sample was neither complete

nor random, but it could be described as a representative sample from the instructors who completed their participation in the project, sometimes referred to as a convenience sample in the evaluation arena. Two graduate students who work at the Center for Teaching Excellence assessed the collection of student work to see if any trends and patterns could be found in the student performances and if any conclusions could be reached concerning which assignments best exhibited student understanding and ethical decision-making. These students have extensive experience in working with faculty members in evaluation of course goals, and they are familiar with both conceptual bases of rubrics and the use of specific rubrics across many fields. The graduate students created a rubric for this project by collecting all of the rubrics for the contributed student assignments and combining the key components from each into a single framework. Since the great majority of faculty used Lisa Friis' rubric as a model, or had simply adopted it unchanged, the collective rubric emerged through adaptations and modifications of Professor Friis' rubric.

The intellectual content of the summary rubric (shown below) was derived very closely from the ideas presented by Professors De George and May during the first two days of each workshop. Their presentations included many key elements of the process of making an ethical decision, and nine components or elements of that process emerged from the process. These included items such as gathering facts, defining the issues, identifying the stakeholders and affected parties, considering obligations and duties, considering character and integrity, and deciding upon an action. For each component, the rubrics typically used in courses

described low, average, and high levels of student performance; accordingly the summary rubric followed that convention. The graduate students included two additional columns in the summary rubric: Not Present, and No Opportunity to Demonstrate. These allowed them to identify students whose performance did not at all demonstrate a particular quality and to identify assignments that did not provide students with an opportunity to demonstrate the component. Along with the input from Professor Dan Bernstein, the graduate students also provided fuller descriptions for some of the categories. Finally, they practiced using the rubric extensively, discussed how they interpreted each of the qualities, and adopted procedures for reconsideration so that their uses of the rubric matched as closely as possible.

After establishing reliability of judgment using the rubric categories, the graduate students scored all of the student assignments included in the course portfolios with this generalized rubric. All of the student names and faculty information was removed from the assignment sheets and student work. Since the sample of student work analyzed was taken from the course portfolios, the work that was analyzed was a sample of convenience and not a representative sampling of student work, and each assignment had a different number of samples available to code. There were many samples from both dedicated ethics courses and from regular courses with embedded ethics assignments, but the there was not random assignment to conditions. The results are accordingly limited and comparisons may not represent the totality of work.

To generate rater agreement the graduate students assessed six separate pieces of student work and discussed how they had coded each assignment, uncovering some issues with the definitions. In some categories one rubric step encompassed a large jump in performance, so some samples of student work with very different levels of performance received the same score. In particular, scores in the Obligations and Duties component were highly dependent on the level of specificity required by each scorers, so some categories required a more detailed description of the implications of that duty. After refining their coding, the two graduate students categorized each piece of student work along every component of ethical decision making in the rubric. Once all of the samples were coded, the two sets of scores were compared and scores that had discrepancies of more than one category of difference were reconsidered to ensure that none had been inadvertently improperly scored.

Figure 1: Rubric used by coders:

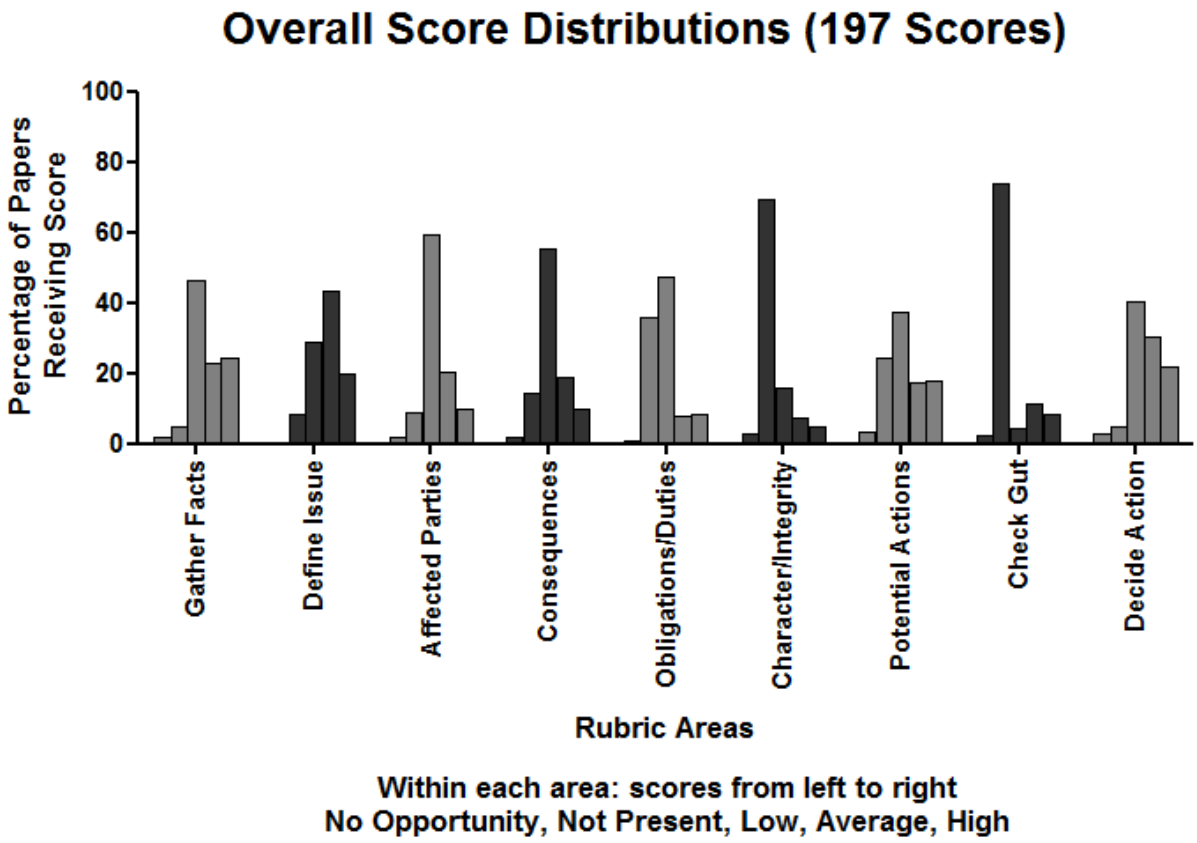
	No Opportunity To Observe	Not Present	Low	Average	High
Gather the facts (who, what, where, when, how and why)	Assignment did not give students opportunity to identify the facts.	No relevant facts identified. Or All facts identified either irrelevant or incorrect.	Some relevant facts not identified. Facts are incorrect.	Facts identified, but some may not be relevant to case or may be slightly misinterpreted.	All relevant facts identified appropriately. Who, what, where, when, how and why were all addressed, as appropriate. Unavailable facts that were relative to the ethical outcome were also identified. Acknowledges where assumptions were made. Facts were assembled as preliminary work to analysis.
Define the ethical issues	Assignment did not give students opportunity to define the ethical issues.	No ethical issues defined. Or Total misunderstanding of the issues related to the case.	Central ethical issues not defined appropriately or completely. Some misunderstanding of the issues related to the case.	Central issues are identified, but not clearly explained. Peripheral issues not identified.	Central issues are all identified, clearly explained, and used as basis for ethical evaluation; other issues are identified
Identify the affected parties (stake-holders)	Assignment did not give students opportunity to identify the affected parties.	No affected parties identified.	Affected parties are not identified completely. Major players critical to analysis are not identified. Perspectives of players are missing.	Major players are identified, but some minor players may be missing. Perspectives are not complete.	Critical affected parties (both direct and indirect) are identified. Perspectives of all critical stakeholders are identified.
Identify the conse-quences of each possible action	Assignment did not give students opportunity to identify the consequences of each possible action.	No consequences identified. Or Actions are not connected with consequences, but are instead random and illogical.	Critical consequences of actions are missing. Relative weights of actions and consequences are not identified.	All critical consequences are identified, but some minor consequences are missed. Consequences are related to actions, but relative weights are not clearly articulated or are inappropriate.	All critical consequences are identified and connected with actions. More minor consequences are also considered. Relative weights of the various consequences explicitly articulated with rational thought.
Identify the obligations or duties	Assignment did not give students opportunity to identify obligations or duties.	No obligations or duties identified. No codes, laws, or rights addressed.	Not all relative codes and laws have been identified, or the relationship of those laws are not clear to the issues. The obligations and rights of all players have not been addressed fully.	All major codes and laws have been identified that influence the ethical analysis, but some other relative duties have been missed. The importance of the duties has not been fully articulated.	All relative codes and laws that influence the ethical analysis have been identified. Other duties relative to the analysis that are not necessarily dictated by laws are recognized. The relative importance of this aspect explicitly articulated with rational thought.

Categories	No Opportunity To Observe	Not Present	Low	Average	High
Consider your character and integrity	Assignment did not give students opportunity to consider character and integrity.	Character and integrity are not addressed.	Major aspects of the character of the players have been missed. The importance of the integrity of the players has been grossly underestimated or overlooked.	Some aspects of the character and integrity of the players with respect to the ethical issues have not been fully addressed or explored. An analysis of the importance of this aspect has been done, but is incomplete.	The role of character of the players in the ethical analysis have been addressed and explored in detail. The relative importance of this aspect explicitly articulated with rational thought.
Think creatively about potential actions	Assignment did not give students opportunity to think creatively about potential actions.	Potential actions not stated.	An incomplete analysis is presented and acceptable potential actions have not been explored fully.	An ethical analysis has been made, but is incomplete. Acceptable actions have been stated, but may not be clear or complete.	The influence of the ethical analysis has been explored fully and articulated clearly. Possible actions that stay within acceptable ethical boundaries have been presented in detail. Develops competing viewpoints or arguments supporting each solution. Tests potential solutions.
Check your gut	Assignment did not give students opportunity to submit an answer that could be checked against basic societal values, or conventional morality.	Student submits an answer that violates basic moral societal values, yet student does not recognize this problem. Or Student does not address conventional morality.	A fundamental flaw in the ethical analysis exists that leads to a conclusion that violates basic moral societal values, yet student does not recognize this problem. Student simply acknowledges conventional morality.	Student has done comparison of the outcome of the ethical assessment with conventional morality, but does not articulate comparisons fully. The outcome is in line with conventional morality.	Student has done comparison of the outcome of ethical assessment with conventional morality and has clearly articulated the comparisons. The outcome is in line with conventional morality, or if the outcome is not in line with conventional morality, student acknowledges this and soundly defends outcome using ethical reasoning.
Decide on the proper ethical action and be prepared to deal with opposing arguments	Assignment did not give students opportunity to decide on the proper ethical action or present ethical analysis.	No solution or ethical analysis present.	Analysis was not carried out sufficiently and is fundamentally flawed. Solution may be trivial or illogical.	Solution and ethical analysis are logical and clear, but does not show great reflection or insight. The analysis may be superficial at some level.	Solution and ethical analysis are logical and clearly presented at a level that reflects extensive reflection and insight.

Descriptions of the ethical reasoning observed in student work

The first analysis of the data simply looked at the total distribution of categories of understanding achieved across all components of reasoning by all the students involved in the program. This data set was then divided into subsets to see if any variations in practice were associated with variations in levels of student understanding. The graph below represents the overall distribution of scores across all assignments on each area of the rubric.

Figure 2:



In general, students were more successful in identifying facts and issues and making decisions about actions, and they were less successful at explaining or explicitly describing the processes and reasoning used to reach a decision. Students were typically competent to list elements of a case, such as the consequences or the affected parties, but they did not often describe how they balanced the weights of the consequences, evaluated potential actions, or ultimately came to their decision. One example of this was the "Check your gut" step, a process more valued by faculty than by ethical experts. This step asks students to compare their decision with conventional morality. Students often did not describe or demonstrate what

happened in this step in their write-ups. Even when given a chart with a space to fill in their work for this step, students often simply wrote, "Check!" in the area asking them to check their guts. This initial finding is a common feature of self-report data across many fields of survey research. In general people answer specific questions about the contents of consciousness or prior actions better than those same people can identify the nature of their thought processes through introspection. Failure to report on the process of decisions is common, and not unique to teaching.

The data also indicated that students performed better on assignments that provided specific, discipline-oriented case studies and in courses in which they had multiple opportunities to use the decision-making process. One example is found in Steve Starrett's assignments, which asked students to complete multiple case analyses based in their own field. Another effective version of multiple opportunities was an in-class analysis modeled by the professor, followed with a similarly designed take-home assignment. Terry Slocum used this method, introducing one case analysis in lecture, having students work through three more in groups in class, and then assigning an individual take-home case analysis paper. The two graphs below illustrate this finding. In all nine categories of observation, the assignments with multiple opportunities set in a familiar context were done more successfully. The number of students reaching the top two levels of quality was consistently higher in all cases, and in some features the differences were large.

Figure 3:

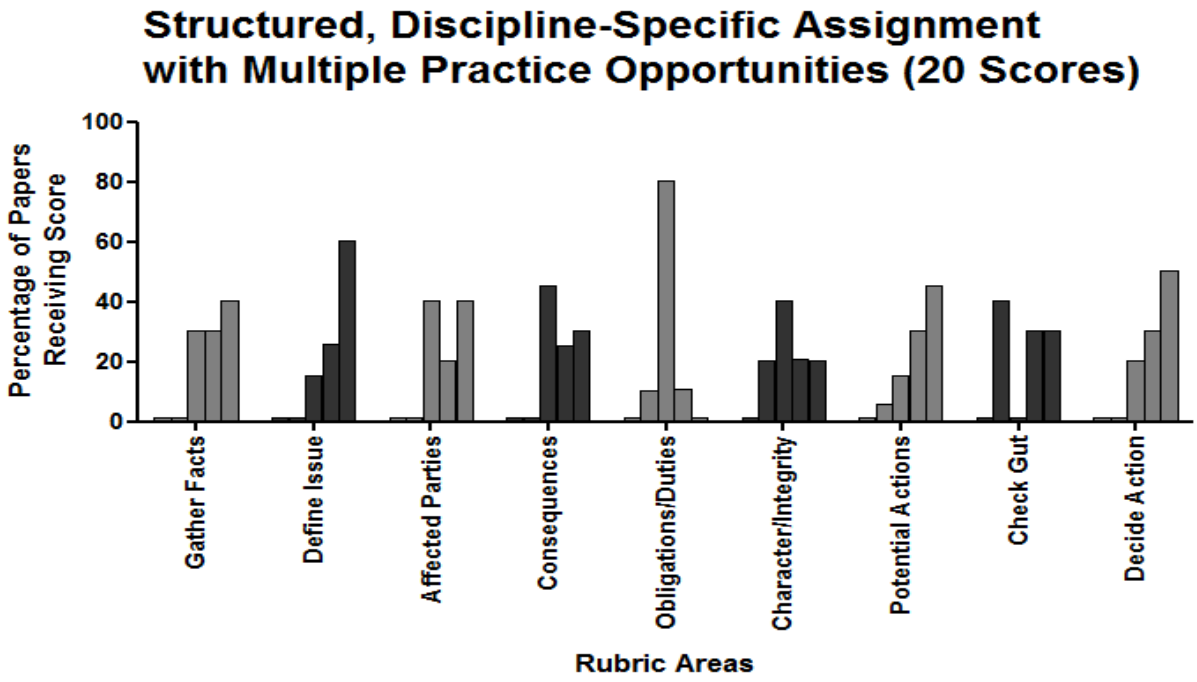
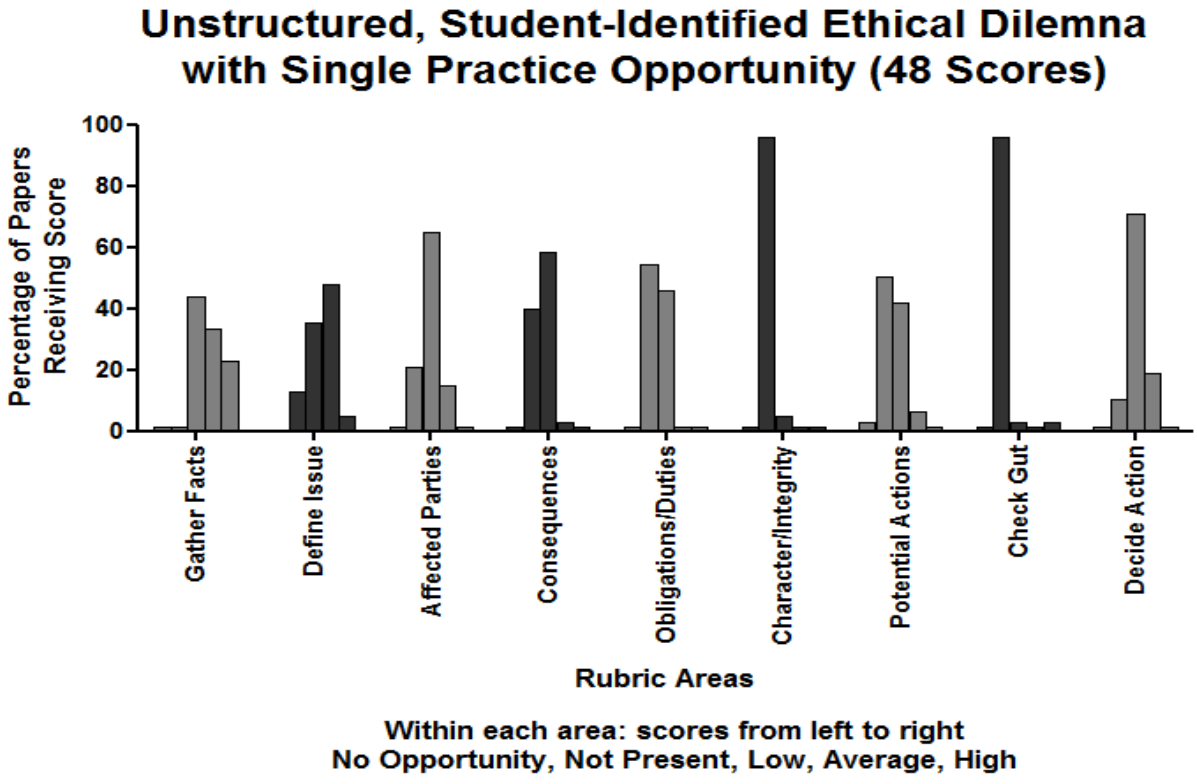


Figure 4:



To further illustrate this point we looked at two kinds of assignment even within the same course. The two figures below indicate that students working on well-structured examples based in the discipline of the course consistently performed much better than those same students did when asked to recall simple factual recall details of case studies. This result implies that instructors should give close attention to the constructor of the assignments students are given to demonstrate their understanding.

Figure 5:

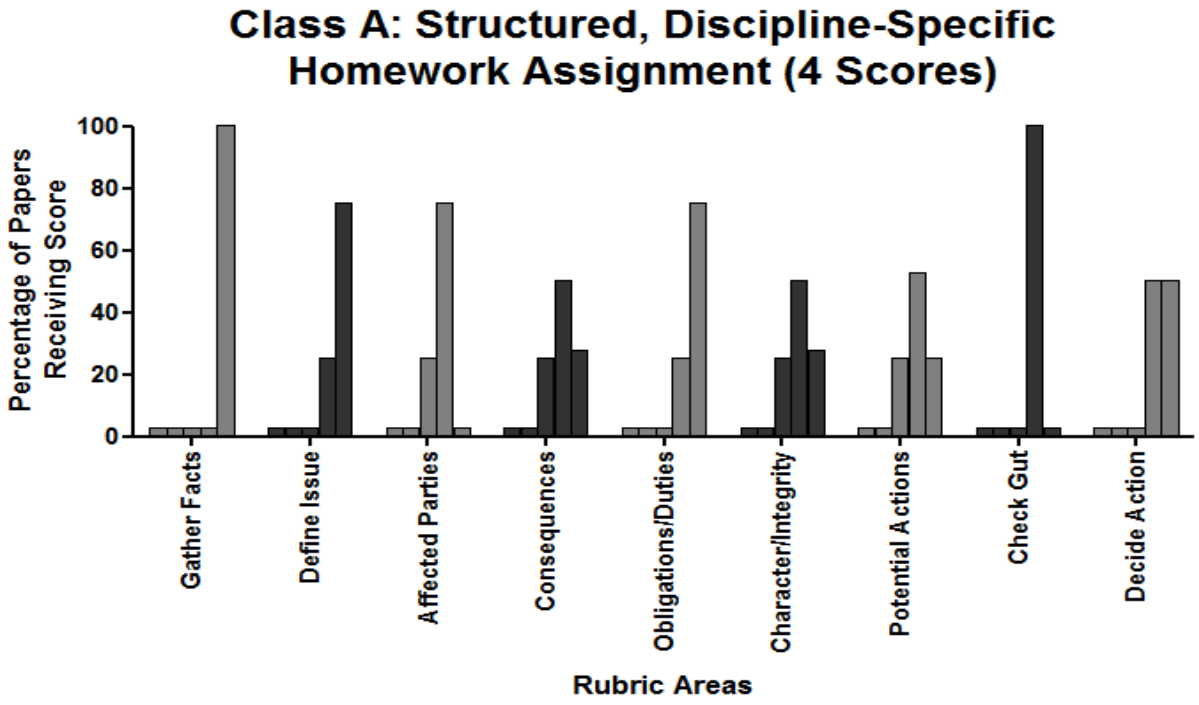
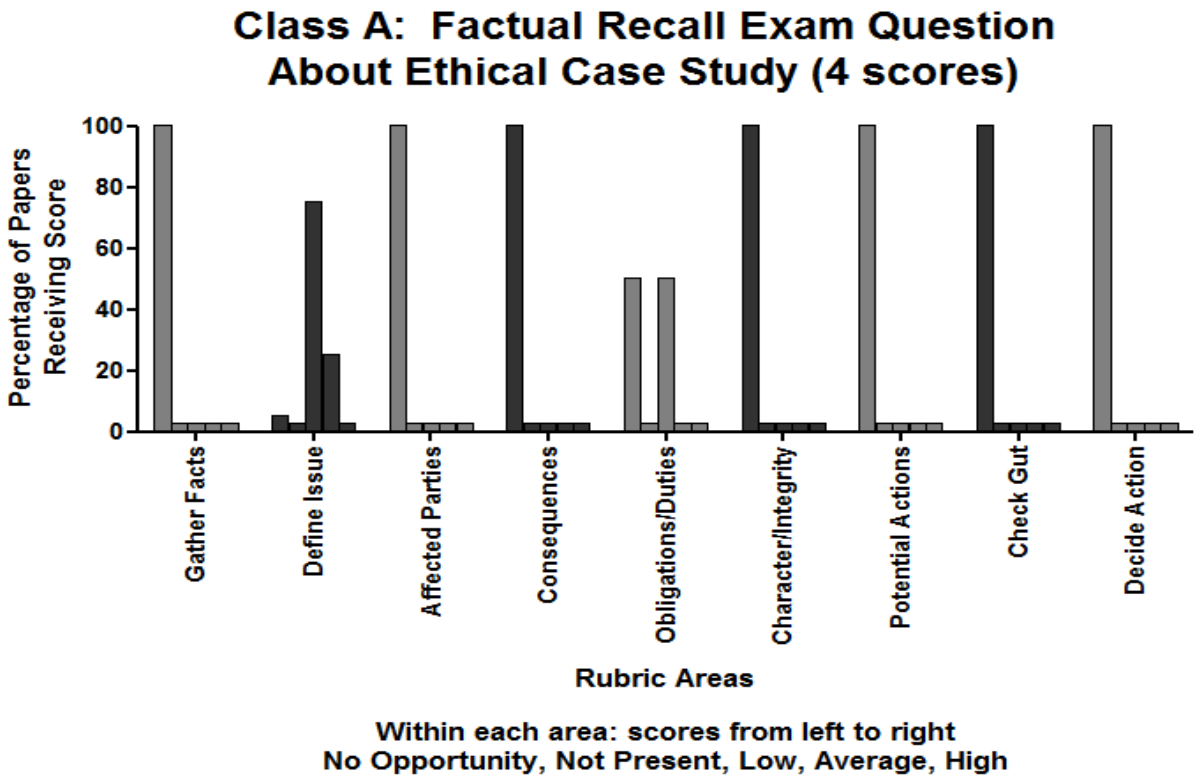


Figure 6:



Geography students provide an example of better performance on specific, discipline-oriented case studies; they were asked to determine the most ethical scale model to use when mapping a particular data set. The students engaged the ethical considerations and consequences of the presentation of the data with specificity and insight, methodically and effectively applying the decision-making process to the dilemma. This type of assignment may be more effective because it provides the students with the culture, pressures, and other characteristics of the organization involved, one of the influences that can complicate a decision-making process. It may also seem more relevant to their own expectations for future experience, and might be easier to evaluate since they have a greater sense of

authority in the subject area. Students who were asked to create their own ethical dilemma or recall a past dilemma had greater difficulty considering the multiple affected parties and considering a variety of potential options.

One important finding from analyzing the students' work replicates a result from the self-report data on students' answers to ethical vignettes, as reported by Prof. May. We found that in general students performed more successfully on assignments from ethics units incorporated into discipline-specific courses than on assignments from stand-alone ethics courses. The two graphs immediately below represent overall distributions for assignments from both types of courses. Once again in all nine components that were analyzed, more students' work from the embedded courses was categorized in the top two categories than was work from the sample we had from dedicated ethics courses. Since we did not assign students to conditions, there are confounds in the separation of the two types of courses that make a simple explanation impossible. For example a large majority of the student work from stand-alone courses was based on cases in a general ethical context, not specific to the students' own areas of study, while the embedded assignments were closely related to the students' professional interests and experience. One possible implication of these data is that stand alone courses should be taught within familiar contexts, taking maximum advantage of both focused attention and personally relevant and meaningful examples. To consider that possibility, the student work from stand-alone ethics courses was divided into those with a general conceptual frame and those embedded in a familiar disciplinary context. The resulting samples

were of distinctly different sizes, but our analysis is presented in graphs that follow after the comparison of embedded and stand alone courses.

Figure 7:

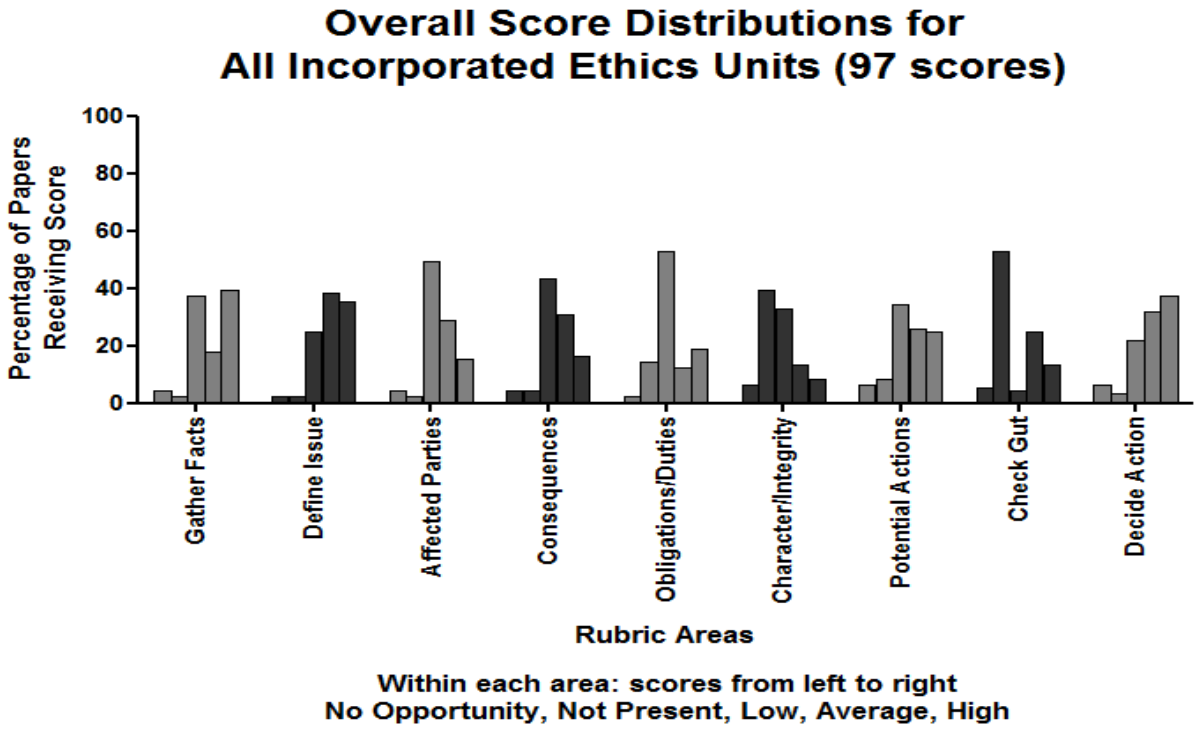
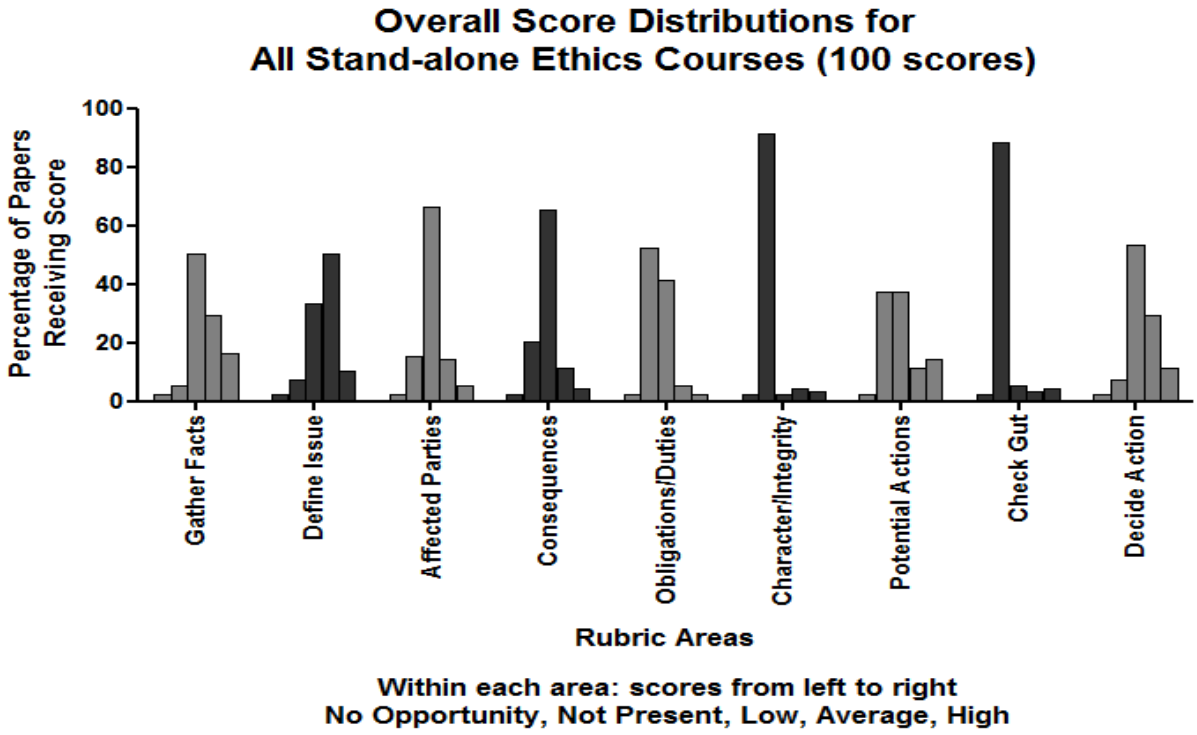


Figure 8:



It is reasonable to question how it is possible that a stand-alone course, entirely dedicated to teaching ethics did not deliver better results and increased understanding than a course dedicated to other aspects of its field, with just a small portion of content that concerned ethics. It violates the reasonable assumption that the amount time spent on an area of study, especially time spent in focused study, should correlate with gains in understanding in that area. However, the stand-alone courses were not structured identically, and the performances across all stand-alone ethics courses were not uniform. By dividing the stand-alone courses into two categories, discipline-specific and non-discipline-specific, differences in performance emerged. Students in a discipline-specific, stand-alone course showed

the highest level of performance in two difficult areas: addressing character and integrity, and comparing their decision against conventional morality (checking their gut). In contrast, those students in non-discipline specific stand-alone courses scored lower in every category, lower even than the cumulative average of all courses, embedded and non-embedded.

Figure 9:

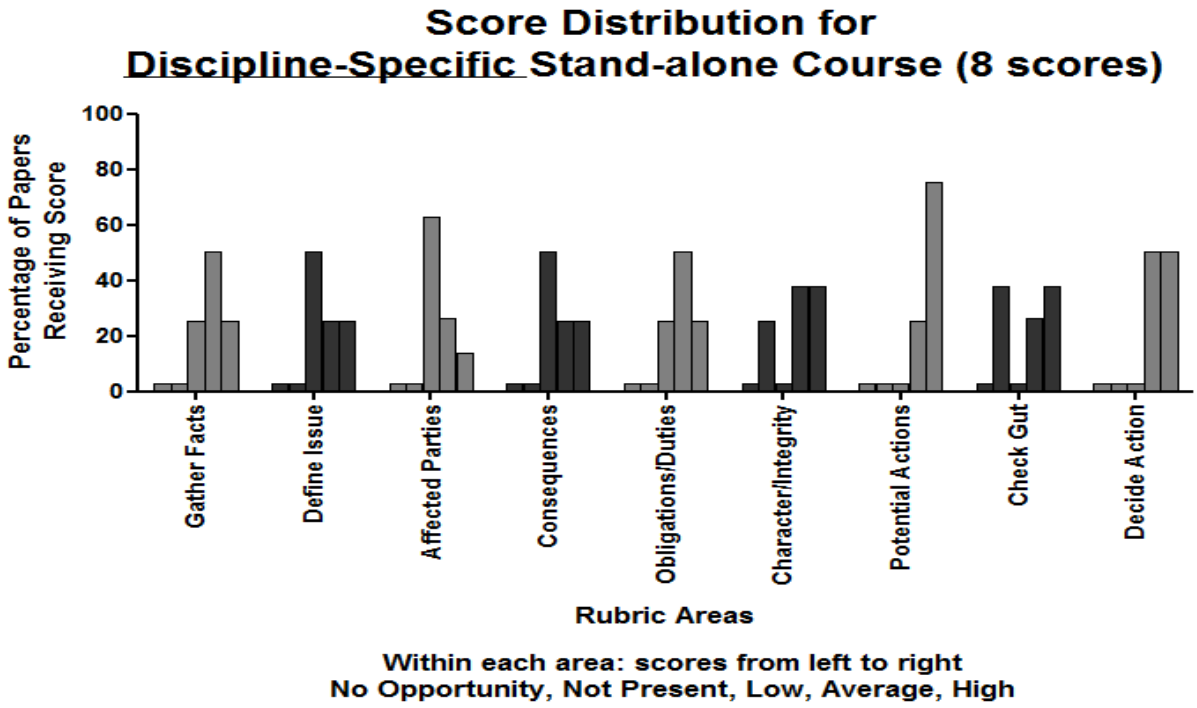


Figure 10:

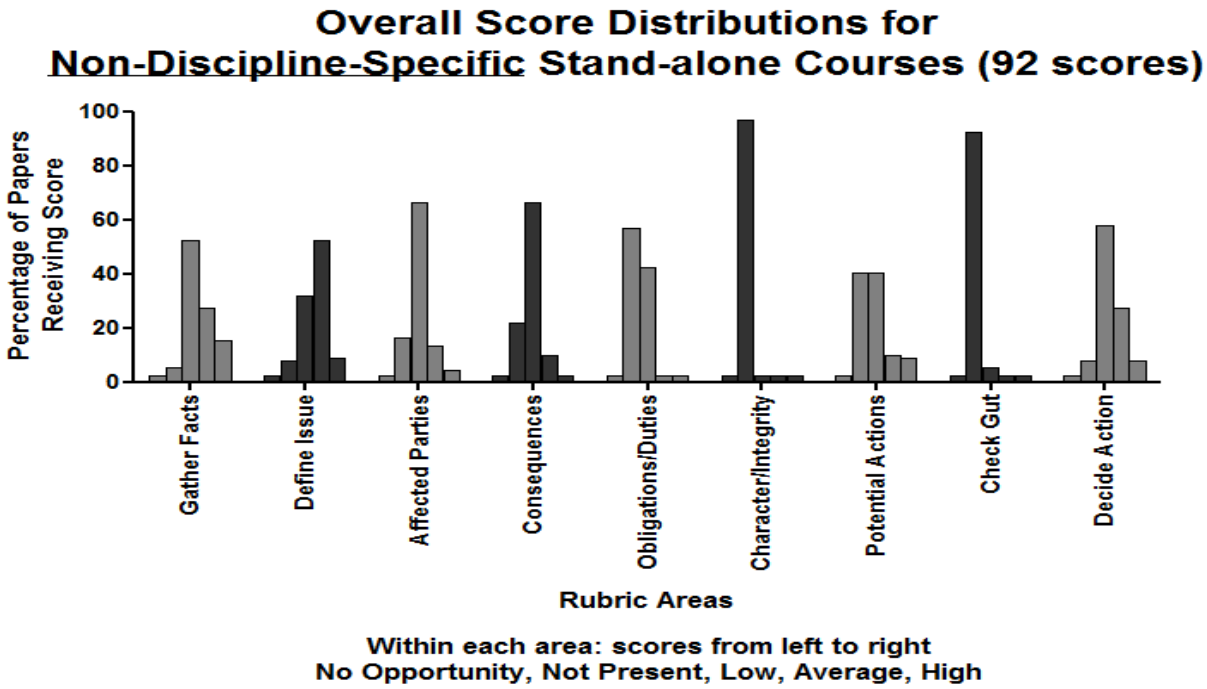
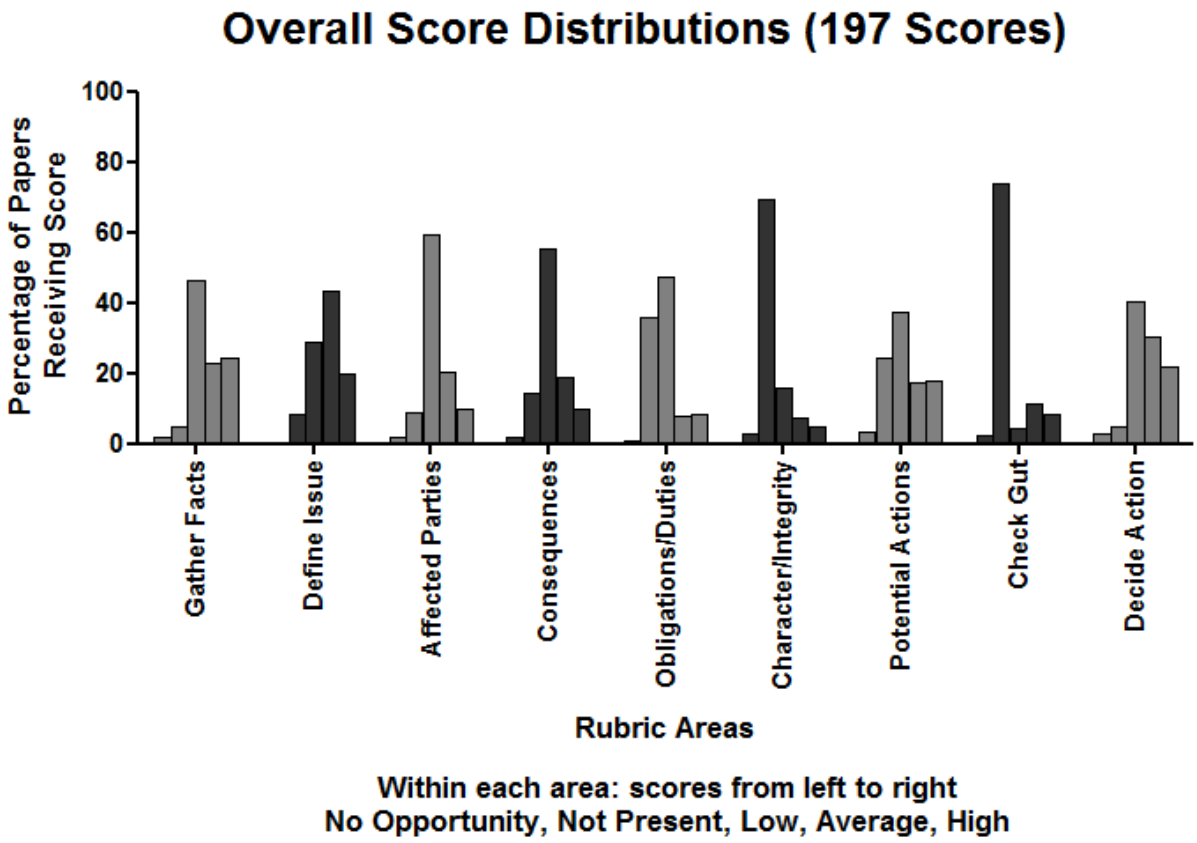

Overall Score Distributions for
Non-Discipline-Specific Stand-alone Courses (92 scores)
Percentage of Papers Receiving Score
100
80
60
40
20
0
Gather Facts
Define Issue
Affected Parties
Consequences
Obligations/Duties
Character/Integrity
Potential Actions
Check Gut
Decide Action
Rubric Areas
Within each area: scores from left to right
No Opportunity, Not Present, Low, Average, High

Figure 11:



Additionally, the two courses had other distinguishing characteristics beyond their discipline-specific or general nature. These confounding variables were not just incidental items such as department or time of day. In the discipline-specific course, students were assigned to complete multiple case-study analyses using the pluralistic ethical decision-making process. These students were given a well developed rubric and individual feedback on their work after each case study. In the course that was not discipline-specific, students were introduced to ethical concepts through lectures, and then asked to describe ethical situations from self-selected examples.

In most cases, the embedded work on ethics was framed well inside the rich, personal, and professional interests of students; while limited in scope, it was engaging and may have involved some interaction with peers and some problem solving. By contrast, the large majority of the work done in the stand-alone courses (at least the work we analyzed) came from a course with students from many disciplines and not as centrally aligned with students' current interests. While there were guest speakers from specific fields, we don't know what those speakers did and whether they included engaging, hands-on problems that matched the intellectual and professional interests of the students in the class. It is possible that they took the opportunity to describe their own field and its issues rather than dive in with a group of unknown students and work in-depth problems. So what seems implausible at first glance could instead reflect that engaged learning can be more powerful than learning acquired by listening to the refined understandings of an expert. It is at least possible that such a difference could account for our observation rather than the difference between embedded and stand alone courses per se.

Possible implications of the findings

Based on the various analyses presented, we offer the possibility that the embedded courses fared as well as the stand-alone courses at improving students' understanding and execution of ethical processes due to the level of engagement of students with relevant and meaningful contexts. Perhaps the amount of class time spent on ethics is less critical than the level of student engagement with that

material. This is congruent with what we know in general about student engagement, and it is reasonable to assume graduate students learn in ways similar to students in general. Students learn best when they are introduced to a concept through inductive, engaged teaching, while first exposure to high-level, abstract, and theoretical concepts through lecturing only works well for those who already have a highly developed understanding in the area, such as advanced learners and faculty peers.

These findings are also congruent with what we know about meta-cognition. The ability to summarize habits of mind or patterns of thinking comes best from experience with doing that thinking. Attempts to teach students directly how to think about learning are rarely effective. Meta-cognition is a "top-down" process (known ideas or principles influence perception and processing of new material), but it is best developed through "bottom-up" experience with specific cases. In general understanding that is actively constructed through experience and examples is more flexible and longer-lasting than is understanding stated as conclusions of experts' analysis.

These results are congruent with the concepts and principles behind backward design. Courses that promoted practicing the reasoning process that students were ultimately asked to perform were more effective in increasing student performances on those tasks. Courses that first presented a theoretical posture, often informing students through lecture, were less effective in this particular sample of courses in generating high levels of student performance. We need to repeat that the samples used in this analysis were highly limited; they are

convenience samples and do not represent an optimal attempt to answer the question of the most effective methodology for teaching ethics. More general research results would require far greater cooperation and collaboration from teaching colleagues and academic leaders. Without that further research, it is not possible to untangle the many possibilities we have mentioned with any confidence. The results are consistent with general educational research, however, so it is reasonable to speculate that those findings may also apply to the teaching of ethical reasoning.

Chapter 4
Appendix A
Inventory of Ethics Incorporation in Individual Courses and Student Work Contributed

Below is an inventory of the ways in which individual faculty members incorporated ethics into their courses. A more detailed description of each course and the instructor's reflections on it are available in their individual course portfolio. Most of the professors introduced their students to the pluralistic decision-making process and practiced the process in class discussion using a case study, then assigned a case analysis for the students to complete as homework. Some, however, had students write group papers or included an ethics component in test questions.

Lisa Friis
Mechanical Engineering, KU

Complete Portfolio:
http://cte.ku.edu/gallery/EESE/friis/index.shtml
Intermediate Poster:
http://www.cfkeep.org/html/snapshot.php?id=96883524951417

Courses:
Mechanical Engineering 346/ 306: Selecting and Processing of Engineering Materials
Mechanical Engineering 765: Biomaterials
Mechanical Engineering 760: Biomedical Product Development

Assignments:
ME760 Team Homework #2 (2 examples: 1 high, 1 average)
ME765 Test Question (7 examples: 2 high, 2 average, 3 low)
ME346 Team Homework #1 (3 examples: 1 high, 1 average, 1 low)
ME346 Midterm Question (2 examples: 1 high, 1 low)

Dan Higgins
Chemistry, KSU

Complete Portfolio:
http://cte.ku.edu/gallery/EESE/higgins/index.shtml
Intermediate Poster:
http://www.cfkeep.org/html/snapshot.php?id=29836839744669

Course:
Chemistry 315: Environmental Science: A Chemistry Perspective

Assignment:

Take Home Test Question (10 examples: 8 high, 2 average)

Julia Keen
Architectural Engineering & Construction Sci., KSU

Complete Portfolio:
http://cte.ku.edu/gallery/EESE/keen/index.shtml
Intermediate Poster:
http://www.cfkeep.org/html/snapshot.php?id=94405643171077

Course:
Architectural Engineering 720: Topics in Architectural Engineering:
Building Energy Codes & Standards

Assignment:
Case Study Paper (4 examples: 2 high, 1 average, 1 low)

Jenny Lundgren
Psychology, UMKC

Complete Portfolio:
http://cte.ku.edu/gallery/EESE/lundgren/index.shtml
Intermediate Poster:
http://contentbuilder.merlot.org/toolkit/html/snapshot.php?id=881037455
87267

Course:
Psychology 5580A: Special Topics: Evidence Based Psychotherapy

Assignments:
Midterm Test Question (1 example)
Final Exam Test Question (1 example)

Ruth Douglas Miller
Electrical & Computer Engineering, KSU

Complete Portfolio:
http://cte.ku.edu/gallery/EESE/miller/index.shtml

Courses:
Electrical & Computer Engineering 590: Senior Seminar

Assignments:
Individual Paper (3 examples: 2 high, 1 low)
Group Paper (2 examples: 1 high, 1 average)

Terry Slocum
Geography, KU

Complete Portfolio:
http://cte.ku.edu/gallery/EESE/slocum/index.shtml
Intermediate Poster:
http://contentbuilder.merlot.org/toolkit/html/snapshot.php?id=40618958920817

Courses:
Geography 806: Approaches to Geographic Problems, Special Topics, and Research Proposals

Assignment:
Case Analysis Paper (10 examples: 4 high, 4 average, 2 low)

Steve Starrett
Civil Engineering, KSU

Complete Portfolio:
http://cte.ku.edu/gallery/EESE/starrett/index.shtml
Intermediate Poster:
http://contentbuilder.merlot.org/toolkit/html/snapshot.php?id=86419766197372

Courses:
Civil Engineering 790: Engineering Ethics

Assignment:
Case Analysis Paper (4 examples: 2 high, 1 average, 1 low)

Jim Steichen
Biological and Agricultural Engineering, KSU

Complete Portfolio:
http://cte.ku.edu/gallery/EESE/steichen/index.shtml
Intermediate Poster:
http://contentbuilder.merlot.org/toolkit/html/snapshot.php?id=56201108131745

Courses:
Biological and Agricultural Engineering 815: Graduate Seminar in Agricultural Engineering

Assignment:

Research Ethics Assignment (3 examples)

Richard De George and George Wilson
Philosophy, KU and Chemistry and Pharmaceutical Chemistry, KU

Intermediate Poster:
http://contentbuilder.merlot.org/toolkit/html/snapshot.php?id=12711848889209

Course: Graduate Studies 804: Interdisciplinary Seminar on Ethics in Science and Engineering

Assignments:
Weekly Ethical Paper 1 (24 examples)
Weekly Ethical Paper 6 (21 examples)

The following work does not have complete portfolios available, but has some developmental or intermediate documentation.

Jane Aldrich
Medicinal Chemistry, KU

Intermediate Poster:
http://www.cfkeep.org/html/snapshot.php?id=50414307834966

Courses:
Pharmaceutical Chemistry 801: Issues in Scientific Integrity
MCDCM 721: Introduction to Medicinal Chemistry

Heather Desaire
Chemistry, KU

Intermediate Poster:
http://www.cfkeep.org/html/snapshot.php?id=57192918618389

Alesha Doan
Political Science, KU

Intermediate Poster:
http://contentbuilder.merlot.org/toolkit/html/snapshot.php?id=81630690099328

Course: Political Science 705: Introduction to Research Design

Sara Dallas

Dentistry, UMKC

Intermediate Poster:
http://www.cfkeep.org/html/snapshot.php?id=35801668312216

Course: Oral Microbiology

Saeed Farokhi
Aerospace Engineering, KU

Intermediate Poster:
http://www.cfkeep.org/html/snapshot.php?id=92035503584925

Sarah Kieweg
Mechanical Engineering, KU

Intermediate Poster:
http://contentbuilder.merlot.org/toolkit/html/snapshot.php?id=6362659005786

Course: Mechanical Engineering 756: Dynamics of Complex Fluids

Lorin Maletsky
Mechanical Engineering, KU

Intermediate Poster:
http://contentbuilder.merlot.org/toolkit/html/snapshot.php?id=60304459706232

Course:
Mechanical Engineering 228: Computer Graphics

Sara Wilson
Mechanical Engineering, KU

Intermediate Poster:
http://www.cte.ku.edu/teachingInnovations/ethicsInst/wilson.shtml

Course: Engineering 801: Issues in Scientific Integrity

Chapter 5
Lessons Learned and Next Steps

The focus of the preceding chapters has been on assessing the effectiveness of different approaches to introducing ethical thinking into graduate education in the STEM disciplines. As this discussion makes clear, designing and implementing clear assessment strategies in a diverse set of courses spread across a wide array of disciplines and three different universities is both conceptually and logistically challenging. Despite these challenges, assessments based on both the systematic, quantitative instruments and the more qualitative assessments based on samples of student work confirm that the instructional strategies adopted in both stand-alone ethics courses and in ethics modules embedded in subject-specific courses appear to have enhanced students ability to apply techniques of ethical reasoning. Although our expectation was that a stand-alone course might be more effective than a shorter ethics module, the empirical results suggest that we cannot distinguish the effects of these two different approaches based on the available evidence. Further study of these alternative approaches is, thus, warranted.

Although our formal assessment efforts fell short of the power and precision that had originally been anticipated, in many other respects the project was highly successful. An important goal of the project was to enhance instruction in ethics at the University of Kansas, Kansas State University and the University of Missouri-Kansas City. Through the efforts of the participants in the three faculty workshops this goal has clearly been met.

The faculty workshops attracted a cadre of enthusiastic, creative, and committed scholars and provided them with a strong foundation in ethical reasoning techniques that they were able to employ in developing an array of ethics modules. The majority of the faculty participants favorably evaluated the training and assistance they received in the workshops and the assistance provided by the graduate assistants deployed by the Center for Teaching Excellence. The impact of this intervention is clear in the course portfolios created and made public as a result of this project. Faculty who participated in the workshops will continue to be advocates for incorporating increased instruction in research ethics in their departments and schools, and the ethics modules they developed will provide useful examples for colleagues both at their institution and elsewhere.

Looking beyond the specific objectives of this project, our experiences over the past 4 years offer a broader, cautionary lesson. For all of the enthusiasm and effort invested by the investigators, and by the faculty who participated in the project, it is clear that implementing substantive changes in the educational culture of a large research university is extremely difficult. This project had the endorsement of officials at the highest level at the participating universities, and deans and department chairs were frequently supportive of the goals of the project. Yet, when push came to shove, administrators and faculty were reluctant to sacrifice technical subject time in their curriculum for ethics instruction. This problem is exemplified in the difficulties encountered in getting students enrolled in the stand-alone ethics course described in Chapter 2. In a similar way, despite their enthusiasm for the project, faculty who were teaching courses with embedded

ethics modules were reluctant to sacrifice class time to allow for administering the assessment instruments used to gauge the impact of the different modes of instruction.

As these examples suggest, while there are few faculty and administrators who would question the value of increased ethics instruction in the abstract, their behavior suggests that they place a relatively low value on this instruction when it comes at the cost of reducing instructional time elsewhere in the curriculum. Instructional time is a scarce good in most STEM graduate programs and those seeking to increase student exposure to issues related to the responsible conduct of research and ethical reasoning need to recognize that competition for this time is intense. If RCR training is truly going to become an integral part of graduate education it will be necessary to either make a more effective case for the value of this instruction, or alter the incentive system that drives curriculum choices at the department and college level.