Michigan Technological University

Responsible Conduct of Research in Science and Engineering Education: Moral Motivation and Ethical Sensitivity in Multi-National Graduate Students

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Project Description

Project rationale

Educating scientists and engineers in the responsible conduct of research (RCR), such as intellectual property, privacy, etc. is a daunting task, but progress has been made both in pedagogical theory as well as in teaching techniques (Huff & Fry, 2005). The majority of this work, however, has focused on undergraduate students, although some have been endeavoring to rectify this deficiency (Sprague, et al., 2001; Hart & Moore, 2007, Lucena, et al., 2007).

One of the challenges facing ethics education in science and engineering is motivating students to be committed to RCR and ethical scientific and engineering practice and, consequently, improving sensitivity to situations that require ethical deliberation. Sadly, research has shown that many RCR courses, while successfully imparting knowledge of RCR, fail to affect students' attitudes about it (Plemmons, et al., 2006). This is a pressing concern. As an example, one can consider intellectual property. Many (and perhaps most) current students have grown up in that intellectual free for all that we call the internet. In fact, for many students their primary research source is the internet - that relatively open, relatively authorless, relatively unchecked domain of freely available information. The internet tends to give the impression that it is by all and for all - one need only consider Wikipedia. Furthermore, until recently even copyrighted material such as music, movies, etc. became virtually transformed into the public domain and fair use by sites such as Napster. In sum, many students have become cultured into expecting that most of what is on the internet is freely appropriable by all or at least should be.

However, educating graduate students in RCR has its own unique challenges. Specifically, the science and engineering graduate student population in the U.S. includes a significantly higher percentage of international students than does the undergraduate student population. Our research will examine whether the graduate student population in science and engineering fields exhibit a wide variety of values, attitudes, commitments, and motivations both personal and professional due to its multi-national demographic. Recently, a number of authors have suggested that these variations may exist (Harris, 2004; Prince, 2006; Downey, et al., 2007; Iseda 2007). For example, international students are also susceptible to the influence of the internet, although perhaps less so since internet access in many countries is much less widespread and unrestricted than it is in the U.S. But, as Shamoo and Resnik (2003) have noted, intellectual property as we now know it is a particularly Anglo-American phenomenon, having been first explicitly articulated and legally offered in England in the 1400s and becoming part of the law of the land in the U.S. Constitution in 1789 (article 1, section 8). Not until relatively recently has there been a concerted effort to formulate an internationally recognized notion of intellectual property and rights, i.e., the World Intellectual Property Organization (WIPO). Moreover, the very notion of intellectual property evolved out of a specifically Roman understanding of property, an understanding that is absent from the traditions of many non-Western cultures. Thus, one cannot assume that students from non-Western countries even share a common notion of property and the importance of property rights per se. In essence, whereas one can assume that students from many Western countries come from a culture that is, at least traditionally, conscious of the importance of intellectual property in *definite* forms, one cannot say the same for students from countries outside of these.

These and similar differences complicate the effort to educate graduate science and engineering students in the *importance* of RCR and to motivate them to apply the principles of RCR. Furthermore, we cannot assume that all science and engineering graduate students are equally sensitive to those situations that call for RCR deliberations. This must be taken into account before attempting to import into graduate education pedagogical techniques that have proved effective on an undergraduate student population, e.g., Hart and Moore (2007). In essence, learning or education is just one determinant of behavior. An equally important determinant is motivation (both personal and professional). While learned behavior *can* occur in the absence of motivation, the probability of engaging in a learned behavior increases when an individual is also motivated to engage in the behavior. Thus, any attempt at teaching ethical behavior to science and engineering students must also determine ways of inducing the motivation to engage in the behavior**. Thus, the goal of the current project is to determine if a relationship exists between moral motivation and ethical sensitivity within science and engineering RCR, and whether nationality plays a moderating role in the relationship, so that differential value prioritizing can be considered when designing science and engineering RCR educational tools.**

Newberry (2004), refining the work of Harris, et al. (1996), has argued that ethics education in engineering has three primary objectives, namely, *emotional engagement*, *intellectual engagement*, and *particular knowledge*. He respectively summarizes these as follows: “to help students i) want to make ethical decisions, ii) know how to make ethical decisions, and iii) be aware of the currently accepted guidelines for ethical practice.” (pg. 344) He also notes that the ease of accomplishing these objectives is in the reverse order, viz., imparting particular knowledge is the easiest, followed by intellectual engagement, and emotional engagement being the “least tractable” to teach even though it is the most important (pg. 344). In other words, imparting particular knowledge simply requires informing the student of the guidelines governing ethical practice, e.g., professional codes of conduct. Secondly, intellectually engaging science and engineering students is *relatively* straightforward since, as Newberry argues, they are "typically adept at manipulating facts, rules, and logic" (pg. 347). However, there seems little prima facie evidence to believe that science and engineering students are any more adept at emotional engagement than anyone else. In fact, Newberry points to a trend toward the "engineer-ization of ethics," i.e., the tendency "to force square pegs of non-technical knowledge into round holes of technical learning, in order to accommodate the thinking preferences of engineering faculty and students" (pg. 350). One would expect that such a trend would have the inadvertent and unfortunate consequence of engendering an emotionally detached and non-committed attitude toward the material.

Furthermore, whereas one would expect little inherent variation in the ability of graduate science and engineering students from different countries and cultures to engage intellectually with and acquire particular knowledge of RCR issues, one would expect that particular hurdles would need to be overcome in order to emotionally engage students from countries and cultures in which those values essential to RCR, e.g., the value of intellectual property, have traditionally no explicit and well-formulated meaning and where they are given differential priorities or not considered very important. Moreover, it has been demonstrated that there is reason to believe that a correlation exists between one's values, both personal and professional, and one's sensitivity to ethical aspects of a given situation (Myyry & Helkama, 2002). Consequently, it may be the case that although engineers are "typically adept at manipulating facts, rules, and logic" they must have the requisite and necessary values, i.e., they must be emotionally engaged, in order to recognize what the appropriate facts are upon which they are to apply rules and logic (Cf. Huff & Fry, 2005 and McGinn, 2003).

We believe an appropriate model for researching this issue is the neo-Kohlbergian approach to moral functioning. In 1982, James Rest argued through a thorough review of the literature that moral functioning is comprised of four components: (1) "interpreting the situation," (2) "formulating the morally ideal course of action," (3) "deciding what one actually intends to do," and (4) "executing and implementing what one intends to do" (Rest, 1982; Cf. Rest, 1986, 1994a). This has come to be known as the Four Component Model (FCM) and the components have been labeled, respectively, *ethical sensitivity*, *moral reasoning and judgment*, *moral motivation and identity formation*, and *ethical implementation* (Bebeau, 2002, Institute of Medicine, 2002). Rest, Bebeau, et al., have done much to apply this model to professional ethics education in Medicine, Dentistry, Law, and Nursing, including the assessment and testing of each component. Newberry's categories of practical knowledge and intellectual engagement fall primarily within the single FCM component of moral reasoning and judgment. It is Newberry's broad category of emotional engagement that receives a more refined and adequate model in the FCM's ethical sensitivity and moral motivation and identity formation.

As Bebeau (2002) notes, "the major focus of research on ethical development in the professions has been on moral judgment" (pg. 283), and Huff and Frey (2005) concur, remarking that "there are precious little data on the three processes other than judgment" (pg. 391). In all likelihood this is due partly to the reasons that Newberry gives, viz., that it is more straightforward and easier to teach moral reasoning and judgment and it is more straightforward to assess and test. On the other hand, progress has been made on the other components of FCM. A number of assessment strategies have been suggested. One is the Schwartz Value Inventory (SVI)

(Schwartz, 1992) which assesses personal values. The SVI was developed using over 60,000 subjects from 20 different countries, validating the cross-cultural presence and reliability of 10 grouped personal values (Power, Achievement, Hedonism, Stimulation, Self-Direction, Universalism, Benevolence, Tradition, Conformity and Security) which can be combined into 4 interrelated and interacting super groups (Openness to Change, Conservation, Self-Transcendence, Self-Enhancement). One of the main findings of Schwartz's work is that while a nearly universal pattern of *value structures* exists, the *relative importance* (priorities) of these universal values changes across cultures. The one possible exception to the universality of value structures was found in Schwartz's Chinese samples. According to Schwartz, these samples, who demonstrated the universal structure on 7 of the 10 grouped values, may additionally have 3 Chinese-specific value types. Schwartz found support for this culture-specific value structure in other non-Western samples of his study. This Western vs. Non-Western variable will be examined in the proposed study.

A second assessment strategy is the Professional Role Orientation Inventory (PROI; Bebeau, et al., 1993) which was created to examine the relationship between professional and personal values within Dentistry. According to Bebeau, the PROI examines the notion of "role concept", which influences one's prioritization of professional and personal values, and serves as a measure of motivation and commitment. In addition, a method for assessing the effects of values on ethical sensitivity has been conducted on professional students of social work (Myyry & Helkama, 2002). However, to our knowledge, no studies have examined the components of moral motivation and commitment or ethical sensitivity among graduate science and engineering students. As we have argued, there is a pressing need for this basic and fundamental research.

Several current NSF-supported projects are concerned in one way or another with the ethics education of graduate students in science and engineering. (They include award numbers 0530028, 0530217, 0628814, 0629294, 0629344, 0629377, 0629443, 0629520, 0734887, 0734919.) However, only some of those projects focus primarily on RCR (0530217, 0628814, 0629377, 0629443, and 0734919), and fewer still concentrate on intercultural/multicultural aspects (0629344, 0734887, and 0734919). The uniqueness of our project lies in the fact that it seeks to examine the values of graduate students representing a broad diversity of world cultures and the impact of these values on ethical sensitivities with an emphasis on RCR.

Michigan Tech is an ideal site for conducting the research we propose. By bringing together faculty from engineering (Holles), psychology (Amato), statistics (Drummer) and humanities (Bowler, Lockhart, and Ren), as well as the support of the graduate school (Charlesworth) we have the necessary resources to conduct this research. We will utilize the support and expertise of Michigan Tech's Center for Educational Technology, Research, and Assessment (CETRA) in the project assessment. Additionally, Michigan Tech is an ideal site for such research since not only does it have an internationally diverse graduate student population, but the university's culture is dominated by science and engineering.

Moreover, from data provided by the National Science Foundation (NSF, 2007), it is evident that in the last decade or so the percentage of foreign graduate students in science and engineering in the U.S. has trended upward. Since 1996, the number of first-time, full-time graduate students in science and engineering who were not citizens or permanent residents of the U.S. has gone from

98,106 in 1996 (23.6% of all S&E first-time, full-time graduate students) to 142,684 in 2006 (29.3%). The number reached its peak in 2003 with 147,464 (31%). Consequently, there is a pressing need for this research.

We believe that this project represents some of the fundamental and basic research necessary for advancing our understanding of the challenges facing ethics education of multi-national graduate students in science and engineering. With a play on the words of Newberry (2004) characterizing the engineer-ization of ethics, it is our belief that current engineering ethics education may be trying to force the square pegs of Westernized, undergraduate pedagogy into the round holes of varied personal and profession values, motivations and sensitivity represented within the multi-national population of graduate students. We argue that this “one size fits all” approach in engineering ethics education will present significant obstacles to educators attempting to import traditional approaches towards educating undergraduate science and engineering students to the more culturally diverse, international and variously motivated and emotionally engaged populations of students one finds in graduate programs in science and engineering. Our research will help other educators by exposing them to the values and ethical sensitivities that science and engineering graduate students bring to the table, thus helping them to identify gaps or modify their own methods accordingly. Furthermore, the results of the proposed project will spur research into creative, innovative and more effective approaches to educating multi-national science and engineering graduate students in ethics.

By disseminating our findings broadly through publication in academic journals and presentations at conferences, we shall be providing the EESE community with the information they need in order to tailor their RCR education to a diverse graduate student population. That is, we shall provide them with the knowledge they need to begin to educate and socialize both domestic and international students in RCR.

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