

Global Engineering Ethics at the University of Michigan-Shanghai Jiao Tong University Joint Institute (China): Research and Teaching in Cross-cultural, International Contexts

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Abstract: Engineering is more cross-cultural and international than ever before, presenting challenges and opportunities in the way engineering ethics is conceived and delivered. To assist in providing more effective ethics education to increasingly diverse groups, this paper shares three related projects implemented at the University of Michigan-Shanghai Jiao Tong University Joint Institute (China). These projects are united in their attempts to address challenges arising from the increasingly global nature of engineering. The first is a course on global engineering ethics, developed for and attended by engineering students from diverse backgrounds. The second is a website hosting contents on global engineering ethics education and conducting research related to cross-cultural moral psychology. The third explores methods of assessing engineering ethics and moral development, using paradigms of ethical decision-making. Although these projects were developed in a Chinese-US collaboration with university students, these contexts could facilitate the adoption of similar programs elsewhere, with practicing engineers.

Key words: global engineering ethics, China, international education, moral psychology, cross-cultural

1. Introduction

Engineering is more cross-cultural and international than ever before, presenting both challenges and opportunities in the way instruction in engineering ethics is conceived and delivered. To assist instructors and administrators in providing

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more effective ethics education to increasingly diverse student bodies, this paper shares three related projects developed by and implemented at the University of Michigan-Shanghai Jiao Tong University Joint Institute (China) (UM-SJTU JI). These projects are united in their attempts to address in a comprehensive manner challenges related to the increasingly global nature of engineering. Although these projects were developed with Chinese-US university students, their multicultural nature would facilitate the adoption and implementation of similar programs elsewhere.

This paper is divided into four parts: First, it describes the UM-SJTU JI as an example of the increasingly global nature of contemporary engineering and outlines challenges to ethical engineering that arise from increasingly global engineering environments. Next, the paper explains how a course on global engineering ethics was developed to address these challenges. Third, to provide resources in engineering ethics education to underserved populations and improve this education, it discusses the development of a website hosting content on engineering ethics and conducting research on moral psychology. Finally, to gauge what it would mean to “improve” global engineering ethics education, this paper explores methods of assessing ethics education and moral development in global environments.

2. The UM-SJTU JI and Global Engineering Ethics

The UM-SJTU JI is based in Shanghai Jiao Tong University (SJTU) and was founded in 2006, an outgrowth of an agreement between the University of Michigan (UM) and SJTU. It has ABET-accredited undergraduate majors in mechanical engineering and electrical and computer engineering—two of only eight ABET-accredited programs in all of mainland China at the time of writing (ABET 2021)—based on those at UM. The majority of degree-seeking students are Chinese nationals, but the UM-SJTU JI has exchange programs with more than fifteen universities throughout Asia, North America, Europe, and Australia, with approximately 120 exchange students during the fall and summer semesters. As a result, this environment is highly diverse, with faculty and students of different nationalities and cultures, who often go on to work and study throughout the world. These circumstances in engineering education mirror those of broader engineering environments.

Engineering and technology are more cross-cultural and international than ever before, evident in the dominance of multinational corporations and in international technology and educational exchanges (Luegenbiehl and Clancy 2017; Luegenbiehl 2010; Zhu and Jesiek 2017). These circumstances present challenges

to ethical engineering. Since engineering and technology occur across multiple cultures and countries, 1) engineers and those working with technology are further removed in space and time from the effects of their work, making it difficult to determine who is being affected by it, and how (Martin, Zhu, and Schinzinger 2022) 2) conflicts can arise regarding how technologies should or should not be used, because of differences in cultural norms and values. To address these issues, engineering ethics education must become more global.

Engineering ethics education began and has evolved in the US (Davis 1995), generally taking the form of professional and/or applied ethics, where students learn about professional codes of ethics and/or (Western) philosophical ethical theories and then apply these to cases dealing with engineering and technology disasters (Harris 2008; Hess and Fore 2018). Given its origins, however, features of this education are somewhat unique to the US and not necessarily transferable across countries or cultures.

First, it is not clear that engineering is organized as a profession in all countries (Iseda 2008; Didier and Derouet 2013), or that the notion of professionalism would do the same ethical work in different countries as it does in the US (Luegenbiehl 2004). Next, insofar as professional codes or ethical theories are reflections of and further influence cultural values (AlZahir and Kombo 2014), they are potentially biased against those from non-Western cultures and countries (Luegenbiehl and Clancy 2017). Third, after thousands of years, philosophers still disagree about which ethical theories are correct. Finally, there is evidence to suggest that normative ethical theories are psychologically “irrealist,” meaning that the assumptions on which they are based about how people make judgments/ behave are incorrect (Bazerman and Tenbrunsel 2012; Haidt 2012; Greene 2014).

In recent years, attempts have been made to address difficulties arising from the increasingly global natures of engineering. Most of these attempts have involved adding and/or swapping educational materials, for instance, including additional discussions of issues engineers are likely to encounter in cross-cultural and international work environments, non-Western ethical theories, and the localization of educational contents (Hess 2013; Harris et al. 2018; Van de Poel, Zandvoort, and Brumsen 2001). As an educational institution based in China, the UM-SJTU JI could well consider the Chinese philosophical tradition, seeking inspiration there.

China has a long tradition of moral education, stretching back to the origins of Chinese philosophy and extending up to the present day. This has generally taken the form of character education, aiming at the cultivation of virtues (Clancy

2020a). Within the Confucian tradition, one aims at becoming a “gentleman” (君子), a person who possesses ethical dispositions and the practical wisdom to mediate competing obligations, which requires a long period of education and training (Flanagan 2017; Ivanhoe and Van Norden 2005). This tradition was institutionalized in the Confucian examination system, from the Han until the fall of the Qing dynasty (Spence 2012). This education was largely conservative and removed from practical affairs, however, creating impediments to reform (Fairbank 1987). As a result, Confucianism and traditional Chinese philosophy were attacked and marginalized from the founding of the People’s Republic of China throughout the Mao years, when Marxism became state ideology (MacFarquhar and Schoenhals 2008).

Since then, “ethics education” (道德教育) has become largely synonymous with ideological/political education—what it means and how to be a good citizen/communist party member in China—which begins in primary school, extends throughout tertiary education, and continues in the form of public education campaigns (Zhao 2005; Meyer 1990). With reform and opening up in the late 1970’s and early 1980’s, there was a move away from ideology and towards practical, technical fields of study and education (Andreas 2009), although party building has become more important again in recent years under the Xi Jinping administration. This philosophical heritage and nationalist tradition have affected the development of engineering ethics education in China (Zhu 2010; Zhu, Jesiek, and Gong 2015).

In terms of philosophical heritage, engineering ethics in China has been in part an outgrowth of philosophy of technology (Wang 2020). Centers for research on philosophy of technology in China, such as the Dalian University of Technology and Northeastern University, Shenyang, are also hubs for research on engineering ethics. Different, nonetheless significant, work on engineering ethics is also taking place at Tsinghua University, Beijing Institute of Technology, and Zhejiang University (Tang, Zhang, and Yang 2017). In terms of China’s nationalist tradition, codes of Chinese engineering organizations have tended to emphasize the obligations of engineers to the country (Cao and Su 2008). The technology and work of engineers has been central to China’s unprecedented development in the last forty years.

This development has had positive consequences—for instance, raising hundreds of millions of people from poverty and forging new economic and political relations and opportunities—but has also had negative ones—for example, pollution and concern about personal and professional ethics stemming from

high-profile scandals related to building disasters, tainted food, and widespread corruption. The latter have led to renewed public interest in and discussions about ethics and values in China (Hu et al. 2018), and these calls have been met with the development and/or strengthening of institutions and policies related to ethics in spheres of engineering, technology, research, and medicine (Tsai 2005, 2001; Koerber et al. 2005). Those working on engineering ethics with a focus on China have increasingly drawn on the Chinese philosophical tradition to thematize and address issues within engineering and technology (Jing and Doorn 2020; Zhu 2018; Wang 2020).

Since the UM-SJTU JI is located in China, and most of its degree-seeking students are Chinese, it would make sense that ethics education should be geared towards China. However, Chinese students are not the only national or cultural group studying engineering and engineering ethics at the UM-SJTU JI. The UM-SJTU JI enrolls degree-seeking and exchange students from over 30 countries throughout Asia, North and South America, Europe, and Oceania. Further, most of its Chinese students go on to work and study abroad. As a result, all students must be familiar with and able to act in accordance with ethical norms governing engineering outside of China. Engineering ethics education at the UM-SJTU JI cannot be specific to any one ethical, legal, or professional tradition, since cultural values, legal practices, and professional conduct vary between and even within countries (AlZahir and Kombo 2014). These circumstances motivated the way engineering ethics education at the UM-SJTU JI was conceived and taught. This work began with a course on global engineering ethics.

3. “Global Engineering Ethics”—A Course in China But for the World

The UM-SJTU JI has adopted an approach to engineering ethics developed by Heinz Luegenbiehl and Rockwell Clancy, which consists in rethinking engineering ethics at a fundamental level, making it more appropriate to the increasingly global environments of contemporary engineering (Luegenbiehl and Clancy 2017; Clancy 2021a; Luegenbiehl 2010). This approach is based on over thirty years of experience teaching engineering and technology ethics at universities throughout the world. The resulting course is entitled “Global Engineering Ethics” (GEE) and has been taught and revised the last seven years.

Rather than a “top-down” approach—beginning with codes of ethics and/or maximally broad ethical theories and/or laws that are then applied to cases, which are problematic for the reasons mentioned above—GEE takes a bottom-up approach, beginning with different kinds of cases and then reasoning to more

general principles on this basis (Luegenbiehl and Clancy 2017; Clancy 2021a). This process is guided by an understanding of the nature of engineering and the social roles of engineers, and by a case-study procedure—similar in nature to wide reflective equilibrium and its use in engineering ethics education (Van de Poel and Royakkers 2011). The course uses both complex, real, and largescale cases involving many actors and stakeholders (“macro” cases/ethics), and simpler, hypothetical, and small-scale cases involving fewer actors and stakeholders (“micro” cases/ethics) (Herkert 2001).

Case Studies Used

Überlingen midair collision (real) | Building collapse (hypothetical) | McDonnell and Miller, and the ASME (real) | Development and its Broader Contexts (real) | Deepwater Horizon oil rig explosion and BP oil spill (real) | Heating Unit (hypothetical) | John’s friendship (hypothetical) | Nosedive (hypothetical, an episode of the popular science fiction series *Black Mirror*) | Sexual harassment in the workplace (hypothetical)

This approach has several advantages: First, it avoids the use of ethical theories arising from specific cultural contexts or ethical codes belonging to particular professional organizations. This is important to global engineering, since educators can no longer assume that students share specific cultural information or professional ambitions (Luegenbiehl and Clancy 2017; Downey, Lucena, and Mitcham 2007). Engineers come from and go to all parts of the world. Second, it allows students to see the large-scale significance of their work within engineering, connecting these outcomes to simpler decisions they might make in their working lives (Bebeau 2002). Again, this is especially important to global engineering, as engineers are often separated in time and space from the consequences of their work, making reflection on these consequences all the more necessary (Luegenbiehl and Clancy 2017; Martin, Zhu, and Schinzinger 2022). Third, students can practice the case-study procedure on relatively simpler cases, building up competencies in close reading and critical thinking—the ability to identify and question assumptions—and then applying them to more complex problems, skills that are as central to engineering as ethical reasoning (Whitbeck 2012). Fourth, the detailed, step-by-step nature of the case-study procedure allows for the possibility of identifying sources of disagreements—for instance, whether they stem from

disagreements about facts or values—which is especially important to ethical reasoning across cultures. Case studies used and topics discussed change year to year, but they include a mixture of contents typical of courses in engineering ethics, as well as ones specific to global engineering ethics education.

GEE is organized as a two-credit-hour course, which results in a total of 28 contact hours. Individual reading, reflection, and case-study assignments are geared towards student groups researching, writing, and presenting an original case study on their past experiences or future aspirations, issues they have encountered in engineering work, or questions they can foresee arising when working with technology. This project is completed in groups, to mirror the contexts of and practice skills necessary to engineering.

The ultimate goal of the course is to foster more long-term ethical behaviors. Although it would be difficult—if not impossible—to determine whether the course succeeds in this objective, moral awareness and ethical reasoning can be assessed using various activities—a point further discussed below. For example, steps one and two of the case-study procedure consist in identifying ethical issues and stakeholders—in other words, questions about what should or should not be done and those affected (fostering moral awareness)—and steps three through ten consist in resolving these issues—in other words, answering the questions posed and identifying what might have been done to avoid such problems in the first place (fostering ethical reasoning) (Luegenbiehl and Clancy 2017; Clancy 2021a).

Topics Discussed

Nature of ethics, ethical issues, and in engineering | Importance of ethics in engineering, moral awareness, ethical reasoning, and case-study analysis | Professions, role responsibilities, ethics, and engineering | Social experimentation, safety objective and subjective, and risk | Business, engineering, and ethics | Personal and professional autonomy, and its significance across cultures | Loyalty, conflicting interests, and dissent/whistleblowing | Engineering and the public—science and the humanities | Rights, employee rights, and the rights of engineers

To make these decisions, the case-study process encourages attention to detail, identifying facts most important to one's decision-making, and/or making explicit

assumptions about missing facts. Missing facts are often a feature of real life, again, relevant to not only ethical but also engineering reasoning.

After seven years teaching the course, students seem to like the approach, welcoming the opportunity to think beyond technical know-how alone. Further, although previous research has found that non-US students make insignificant gains in ethical reasoning after ethics education (Borenstein et al. 2010; Canary et al. 2012), a study found that students at the UM-SJTU JI scored considerably higher on measures of ethical reasoning after completing GEE—this study is further discussed below—providing evidence that GEE outperforms other kinds of engineering ethics education (Clancy 2020b, 2021b).

Plans are underway to specialize the GEE curriculum to different fields of engineering. Different fields of engineering present unique ethical issues. Using the GEE approach, for example, electrical engineering ethics curricula could use case studies specific to this field, while maintaining the basic conceptual and skills-based framework described above. This framework would allow for the possibility of specifying the nature of “safety” with regard to electrical engineering, for instance, using examples that would be different from those of “safety” within mechanical engineering. However, the specialization of global engineering ethics curricula presents challenges, for example, in reaching large numbers of engineering students, and in developing and sharing unique contents. These issues have motivated the development of a website.

4. A Website for Global Engineering Ethics and Research on Cross-cultural Moral Psychology

GEE has begun using the website Global Applied Ethics, which hosts course readings and exercises, and can be used to conduct research on cross-cultural moral psychology. Rather than using a textbook in GEE, the site includes readings based on *Global Engineering Ethics*, used with permission of the authors and publisher (Luegenbiehl and Clancy 2017). Chapters of that book were abridged and their language simplified, in consultation with course participants, to make the readings more accessible to non-native English speakers (Clancy, Charlemagne, and Ge 2019). Reflection questions are interspersed throughout the readings—for example, “Give an example of an unethical behavior”—prompting students to reflect on their own knowledge/experience and connecting it to course contents.

Global Applied Ethics has two ultimate goals: 1) Facilitating access to global engineering ethics education by hosting content, and 2) Improving this education by conducting cross-cultural research in moral psychology. When registering

for the site, participants complete demographic information and have the option of making their responses available for research purposes. Global Applied Ethics also includes ethical assessment instruments, such as the Moral Foundations Questionnaire, further discussed below. As with the course, this website and these objectives address trends within contemporary engineering and technology.

Engineering and technology are developing ever more quickly, far outstripping the abilities of regulatory bodies and national governments to develop and enforce regulations and laws. Therefore, ethics and ethics training are increasingly important. Ethics training could be provided by educational institutions, although many would have difficulties addressing this need at present.

As science, technology, engineering, and mathematics (STEM) curricula require evermore technical courses, room for liberal arts courses—the traditional mainstay of ethics education—becomes smaller. Within STEM fields, engineering faculty have reported feeling unprepared/uncomfortable addressing ethical issues (Barry and Herkert 2015). In countries such as China, there are not enough philosophical ethicists (faculty members with a PhD in philosophy and a research/teaching focus on ethics) to meet the demand for ethics courses (Murphy 2016), and even fewer faculty with expertise in engineering ethics specifically. This expertise is important, since previous work has found that general courses in philosophy and/or technology and values do not necessarily improve ethical reasoning to the same extent as courses in engineering ethics specifically (Borenstein et al. 2010; Hess et al. 2019). Although not a replacement for either in-person courses or qualified faculty, a website hosting educational materials would make it easier for faculty to teach and students to learn about global engineering ethics (Clancy, Charlemagne, and Ge 2019). In addition to improving access to global engineering ethics education, the website can contribute to the improvement of the quality of engineering ethics education.

Considerable disagreement exists concerning the form engineering ethics education should take—what should be taught and how (Hess and Fore 2018)—and this disagreement becomes greater with regard to global engineering ethics education (Zhu and Jesiek 2017; Hess 2013). These disagreements can be mediated empirically, by conducting studies and collecting information currently lacking, for example, the extent to which either culture or education influence ethical judgments, judgments concerning technology, how these change over time, and so on. Such questions have been the topic of greater research by psychologists and anthropologists in recent years (Haidt 2012; Greene 2014; Henrich 2015; Flanagan 2017; Nisbett 2010; M. J. Gelfand 2018), although much of this work remains

disconnected from engineering and technology ethics. Global Applied Ethics can help to address these questions, collecting information related to background knowledge, ethical judgments, and judgments about engineering and technology, for example, through reflection questions and assessment instruments included on the site, and treating nationality and culture, gender, previous education, and so on as input variables. In addition to quantitative research using assessment instruments, the website can assist in conducting qualitative research, using methods associated with the digital humanities.

These methods have been used to explore values/virtues in obituaries (Alfano, Higgins, and Levernier 2018), the authorship and organization of ancient texts (Slingerland et al. 2017), and the moral foundations and emotions of Tweets (Hoover et al. 2020), for instance, but not the ethical perspectives of university students. This approach would be well suited to cross-cultural research, since it does not impose any one theoretical paradigm that might be inappropriately applied to the populations studied because of cultural differences (Kulich and Zhang 2012).

In a pilot study of 70 participants, network analysis and semantic maps were used to explore understandings of unethical behaviors among engineering students in China (Clancy et al. 2020). As part of a reflective exercise, students were asked to 1) give an example of an unethical behavior, and 2) explain what it is about this behavior that makes it unethical. Initial results indicate that engineering students in China think 1) that behaviors by companies that harm people through their products are prototypically unethical, and 2) it is the harmful, other-regarding nature of these behaviors—in other words, behaviors that negatively affect others—that make them unethical. Participant responses referred to/clustered around a few salient categories: the 2008 tainted milk/baby formula scandal in China; the 1984 Chernobyl nuclear powerplant explosion in the Ukraine; environmental denigration because of the activities of companies (Clancy et al. 2020).

These findings touch on questions surrounding the form global engineering ethics education should take, mentioned above. Would engineering students outside of China give similar responses? What about non-engineering students? Although non-Chinese students are unlikely to refer to the tainted milk scandal, what kinds of events would they mention instead? Chernobyl was likely mentioned because HBO's popular miniseries was on at the time the study was conducted, but what other tv shows, movies, or forms of popular media are likely to impress aspiring engineers? Answering such questions is essential to improving global engineering ethics and specializing curricula to national, cultural, and professional groups. However, this raises the question of what it would mean to "improve"

global engineering ethics in order to identify criteria for and methods of assessing education.

5. Assessing Global Engineering Ethics Education and Moral Development

The final project developed at the UM-SJTU JI consists in identifying/developing measures of progress in ethics education, based on desired educational outcomes. Much has been written on outcomes from and assessments of engineering ethics education, from content and knowledge to skills and awareness (Hess et al. 2019; Downey, Lucena, and Mitcham 2007; Hess and Fore 2018; Antes et al. 2009; Shuman, Besterfield-Sacre, and McGourty 2005; Bernstein et al. 2017). The matter is complicated by the global environments of engineering, since culture affects understandings of ethics (Haidt 2012; M. J. Gelfand 2018; Nisbett 2010), and different countries have different accreditation and professional guidelines (Cao and Su 2008; AlZahir and Kombo 2014; Zhu, Jesiek, and Yuan 2014). Satisfaction has been considered when assessing student outcomes in higher education but, disturbingly, research has found an inverse relation between student satisfaction with ethics education and ethical reasoning abilities (Holsapple et al. 2011).

As was mentioned above, at the UM-SJTU JI, the ultimate goal of engineering ethics education is more long-term ethical behaviors. This goal is somewhat controversial, since the adoption of behaviors as an educational outcome has been explicitly discouraged (Baum 1980; Van de Poel, Zandvoort, and Brumsen 2001), and educational bodies such as ABET and the Washington Accord have stressed ethical knowledge and understanding as student outcomes (ABET 2016; “Washington Accord: 25 Years 1989-2014” 2014). This is understandable, since accurately assessing whether and the extent to which education affects behaviors is difficult and costly: There is disagreement about which behaviors are (un)ethical, and assessing the effects of education on long-term ethical behaviors would require the creation of control and experimental groups—(not) providing (different kinds of) ethics education—and then monitoring participants throughout their careers.

Although a full treatment of this issue would lead beyond the scope of the present article—but is considered elsewhere (Clancy and Gammon 2021)—the following consideration is relevant: While controlling for the effects of education and monitoring long-term behaviors would be difficult, proxies for behaviors could be identified and assessed, for example, conditions that would be necessary to long-term ethical behaviors (Clancy and Gammon 2021). Ethical reasoning and

moral foundations are two such proxies for ethical behaviors used by the UM-SJTU JI to assess ethics education.

5.1 Ethical Reasoning, Stages, Schema, and the ESIT

Philosophers have long supposed that ethical behaviors are based on ethical reasoning, and that this is part of the value of doing ethics (Tiberius 2015). One of the first psychologists to study ethics empirically was Lawrence Kohlberg. Kohlberg believed people develop through three different levels of ethical reasoning, from less to more advanced, based on the kinds of principles they use to resolve ethical dilemmas (Kohlberg 1984). He identified three levels of development: the pre-conventional, conventional, and postconventional. Preconventional reasoning is based on narrow self-interest, for example, not taking a cookie because one would be punished for taking a cookie; conventional reasoning is based on rules and convention, for example, not taking a cookie because taking a cookie is against the rules; and postconventional reasoning is based on justice, for example, not taking a cookie because taking cookies is unfair. To assess this development, Kohlberg and colleagues conducted in-depth interviews, presenting participants with ethical dilemmas and noting how they responded (Kohlberg 1984). This approach, however, has both theoretical and practical problems.

Practically, the procedure is time consuming, and difficult to administer and score, given its interview format and the subjective judgments of interviewers/scorers. Theoretically, it is based on only one conception of ethics, that of “justice as fairness,” a form of deontological ethics conceived by 20th century legal philosopher John Rawls, potentially biased against women, conservatives, and those from non-Western cultures and countries. To address these issues, James Rest and colleagues developed the Defining Issues Test (DIT).

Unlike Kohlberg’s procedure, the DIT and revised DIT2 are multiple-choice measures that can be scored easily. Like Kohlberg’s approach, participants read and decide on ethical dilemmas but, unlike Kohlberg’s, they are presented with numerous considerations that could affect their decisions (Rest et al. 2000). Participants then score each consideration on a scale of 1–5, based on how important each consideration is to the decision made. For example, participants could be presented with the following question: “Should Heinz steal bread to feed his starving family?” then answering, “Yes, No, I can’t decide,” and ranking how relevant various considerations would be to this decision, for instance, “1. Heinz will likely be caught and punished for his crime (preconventional). 2. The law is unclear regarding what constitutes stealing in situations of duress (conventional). 3. Heinz’

stealing the bread is unfair to the baker who made it (postconventional).” It also contains nonsense items, to ensure participants are paying attention. They are then asked to rank the top four most important considerations. Each consideration falls within one of Kohlberg’s three levels: the preconventional, conventional, and postconventional.

Following work by Eliot Turiel (Turiel 1983), Rest and colleagues conceive of Kohlberg’s levels as contemporaneous “schemas”: ways of thinking about ethics and behaving, rather than stages one moves through, into or out of (Rest et al. 1999). In this account, the postconventional schema concerns “principled” reasoning in general, accommodating different normative ethical theories concerned with less local, more “macro” ethical issues, such as global justice and human rights. By contrast, the conventional schema concerns less global, more “micro” ethical issues, such as family obligations and customs (Narvaez and Bock 2002; Rest et al. 1999). The preconventional schema consists in a narrow focus on one’s self-interest. Depending on how participants rank different considerations, they can be given various scores indicative of their ethical orientations (Bebeau 2002; Dong 2011). The most widely used have been P and N2 scores. P scores indicate the amount of postconventional reasoning present in decision-making, and N2 scores—introduced in the DIT2—measure the amount of postconventional reasoning *relative* to preconventional reasoning.

Based on extensive use of the DIT and DIT2, an important finding is that ethical reasoning is specific to professional fields/disciplines (Bebeau 2002). This means that ethics education in a professional field, such as engineering, will not necessarily result in greater postconventional reasoning in general (Hess et al. 2019). For that reason, discipline-specific versions of the DIT have and should be used to assess ethics education. One such instrument is the Engineering and Science Issues Test (ESIT).

The ESIT was developed by Jason Borenstein and colleagues at Georgia Tech and has been used to assess different kinds of ethics education (Borenstein et al. 2010; Kerr, Brummel, and Daily 2016; Canary et al. 2012; Clancy 2020b, 2021b). The kind of ethics education one receives affects performance on the ESIT: Those who took courses on engineering ethics, specifically, performed better than those enrolled in courses about philosophical ethics or society and technology (Borenstein et al. 2010). Additionally, non-US, non-native English speaking students performed worse on the ESIT than their US, native-speaking counterparts, although it remains unclear whether this is a result of culture or language (Borenstein et al. 2010; Canary et al. 2012; Clancy 2020b).

5.2 Moral Intuitions, Dispositions, Pluralism, and the MFQ

Although the DIT, DIT2, and discipline-specific variants have been used extensively, a growing body of work has called into doubt the extent to which 1) ethical judgments and/or behaviors are primarily/exclusively the result of ethical reasoning (Haidt 2012; Greene 2014) and 2) the normative taxonomy on which Kohlbergian and neo-Kohlbergian schemas are based is correct (Haidt 2012; Graham et al. 2011; Curry, Jones Chesters, and Van Lissa 2019; Sinnott-Armstrong and Wheatley 2014; Schein and Gray 2018; Shweder et al. 1997; Dranseika, Berniūnas, and Silius 2018; Heath 2017; Stich 2017; Piazza et al. 2019). Moral Foundations Theory (MFT) addresses both concerns.

According to MFT, ethical judgments result from intuitions, closer in nature to feelings than rational thought (Haidt and Joseph 2007). On this view, ethics is about many things rather than only one, at least, care: fairness, loyalty, authority, and sanctity. These correspond to different “moral foundations” (Graham et al. 2018). Moral foundations, like neo-Kohlbergian schemas, are ways of thinking about right and wrong. Each foundation deals with different concerns and emotions corresponding to challenges humans have faced throughout their evolutionary heritage (Haidt and Joseph 2007). Individuals and groups differ in the extent to which they endorse different foundations, corresponding to factors such as political affiliation/orientation, nationality, field of study, and so on (Graham et al. 2011; Graham, Haidt, and Nosek 2009; Kim, Kang, and Yun 2012; Zhang and Li 2015; Nilsson and Erlandsson 2015; Yilmaz et al. 2016; Beever and Pinkert 2019).

Various instruments have been developed in conjunction with MFT, but the most widely used and validated is the Moral Foundations Questionnaire (MFQ) (Graham et al. 2011). The MFQ has two parts: The first part asks participants to rank the extent to which various behaviors are important in their considerations of right and wrong, and the second part directs readers to score their agreement with different statements. Each item corresponds to a different moral foundation, so the MFQ assesses the relative importance attached to different understandings of ethics.

Although MFT is a descriptive ethical theory—simply describing how people reason ethically rather than telling them how they should reason and behave, and why—one of its creators, Jonathan Haidt, endorses virtue ethics as the most plausible/psychologically realist normative ethical theory, because different moral foundations could be likened to/associated with different ethical dispositions, virtues (Haidt 2012). Virtue ethics has received more attention in recent years among

those working in engineering and technology ethics (Harris 2008; Han 2014), in part a response to the growing recognition that the ability to reason ethically does not necessarily result in more ethical behaviors (Schwitzgebel and Rust 2014; Bay and Greenberg 2001; Ponemon 1993).

Finally, insofar as MFT is a pluralist theory of ethical reasoning, it would be well-suited for research on and the teaching of global engineering ethics. Since ethics is about many concerns rather than only one, MFT can help to explain ethical conflicts and conflicting interests, when different, competing goods cannot all be fulfilled at the same time. Such conflicts are central to (global) engineering ethics and can be explained by MFT. Jonathan Beever and Laurie Pinkert have used the MFQ to examine the moral foundations of different kinds of engineering majors and faculty (Beever and Pinkert 2019).

5.3 Ethical Reasoning and Moral Intuitions in Global Engineering

Similar work has been taking place at the UM-SJTU JI, assessing the moral foundations of engineering students in China, and their relations to previous education, demographic information, and ethical reasoning, as measured by the ESIT.

After taking GEE, students scored higher in ethical reasoning and attached greater importance to care and loyalty, although ethical reasoning was negatively related to loyalty and positively related to care (Clancy 2021b, 2020b). No significant differences were found with regard to gender, major, or previous ethics education. This preliminary work is being extended.

Using the same design, larger, more diverse samples are currently being collected. With partners in North America and Europe, there are plans to survey students and practitioners in STEM and non-STEM fields from the US and the Netherlands, exploring the strength of the effects of culture and education on ethical judgments and judgments concerning technology (Zhu et al. 2022; Clancy et al. 2022). Previous research has found that health concepts are more strongly related to culture than profession—for example, French and American doctors have ideas about health that are more similar to those of their fellow citizens than each other (Leeman, Fischler, and Rozin 2011)—although one's education and profession have been found to influence ethical judgments: Hospital administrators are more likely to make sacrificial decisions than doctors or the lay public (Ransohoff 2011), business majors are more likely to report having cheated than engineering majors, and engineering majors are more likely to report having cheated than humanities majors. These differences could not be explained through self-selection:

Dishonest students were not more likely to study business than engineering, or more likely to study engineering than the humanities (Carpenter et al. 2007).

To date, no work has explored if or how the ethical judgments of students and practitioners in STEM fields are distinctive. However, knowing this would be crucial to developing more effective ethics education (Zhu and Jesiek 2017; Clancy and Zhu 2021). Additionally, it would shed light on the nature of culture, for example, the extent to which culture is primarily a local or national phenomenon (Henrich 2015). To do so, Chinese- and Dutch-language versions of the ESIT are being developed—this work will also add to a growing understanding of the effects of language on ethical reasoning (Costa et al. 2014; Clancy et al. 2022). Additionally, efforts are underway to explore if and how moral foundations/dispositions change over time. Previous research has explored how and why ethical reasoning changes (McCabe, Treviño, and Butterfield 2001), although almost no work has examined if and how moral dispositions change. Of the work that does exist, the methods used and conclusions drawn are contested (K. B. Smith et al. 2017; Haidt 2017).

6. Conclusion

Engineering and technology are more cross-cultural and international than ever before. These circumstances present challenges to ethical engineering. Ethics training must adapt to meet these challenges. The UM-SJTU JI has experienced these challenges firsthand, as a US-Chinese educational institute with an international faculty and student body. These circumstances have provided opportunities to reconceive engineering ethics education and research, pushing them in a more cross-cultural and international direction. The forgoing has described three related projects: a course on global engineering ethics, a website to host educational contents and conduct research, and measures of ethical reasoning and moral development. Although only a start has been made, these projects have the potential to yield longer-term, larger-scale insights about the effects of culture and education on ethical reasoning and moral dispositions, as well as what can be done to ensure more ethical behaviors among engineers and those working with technology.

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Notes

1. The inspiration for and form of this article comes from a paper by Christelle Didier, “Engineering ethics at the Catholic University of Lille (France): Research and teaching in a European context” (Didier 2000).

2. Unless otherwise noted, “China” is used to refer to the mainland of the People’s Republic of China. China shares a cultural heritage with Taiwan, Hong Kong, and the Chinese diaspora in Singapore, North America, and elsewhere, although economic and political circumstances in these areas/among these people are different. This economic and political diversity likely explains largescale, substantial value differences among Chinese populations (P. B. Smith 2010), as well as highlight the importance of using a fine-grained approach when considering the nature and effects of culture.

3. Although this description broadly characterizes the field, in recent years, there has been a proliferation of research on different approaches, for instance, the cultivation of empathy/perspective-taking (Hess, Strobel, and Brightman 2017) and a focus on extracurricular factors (Burt et al. 2013).

4. By contrast, Michael Davis has dismissed calls to develop global engineering ethics education, claiming engineering is a profession and, therefore, already global in nature (Davis 2015).

5. “Ethics,” “morality,” and their variants are used interchangeably throughout this article. For a different account, see (Van de Poel and Royakkers 2011).

6. The extent to which differences in engineering ethics education across cultures might be captured in the psychological literature on culture and ethics—discussed in section five—is an interesting question but, unfortunately, one that falls outside the scope of this paper. For a discussion of the ways that moral and cultural psychology could be used by engineering ethics, see (S. D. Gelfand 2016; Han 2014) and (Clancy and Gammon 2021). I am grateful to an anonymous reviewer for raising this possibility.

7. Updated figures can be found here: <https://www.ji.sjtu.edu.cn/about/facts-figures/>.

8. A fuller description of this process can be found in (Luegenbiehl and Clancy 2017). A fuller description of the course can be found in (Clancy 2021a).

9. But see (Beever and Pinkert 2019; Clancy 2020a; S. D. Gelfand 2016), for instance, for recent exceptions.

10. Although the use of postconventional reasoning is more prevalent among those with higher levels of education, it is unclear if and why Rest and colleagues believe the postconventional schema is “better” in any significant normative sense.

11. There are theoretical and empirical reasons for doubting the veracity of this distinction, but a full consideration of this issue here would lead too far afield.

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