

## **The Moral Foundations of Chinese Engineering Students: A Preliminary Investigation**

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## **Abstract**

Technology-related disasters and scandals have resulted in concerns regarding the safety and ethics of Chinese companies and practitioners. Although China now graduates and employs more science, technology, engineering, and mathematics (STEM) majors than any other country in the world, ethics is not yet a central component of engineering education. Simply importing foreign curricula, however, would be ineffective. Culture has been shown to affect ethical judgments, such that curricula based on the Western philosophical tradition are potentially problematic. More importantly, these curricula stress ethical understanding and the ability to reason ethically as educational outcomes, although these outcomes do not result in more ethical behaviors. To explain the causes of (un)ethical behaviors, numerous psycho-social models of ethical decision-making and judgments have been proposed, which can be used to improve engineering ethics education. To demonstrate this approach, a study was carried out with Chinese engineering students using two of these paradigms, Moral Foundations Theory (MFT) and elements of behavioral ethics. Similar to results from studies involving participants from Western cultures, Chinese engineering students were found to moralize behaviors associated with fairness to the greatest extent, closely followed by care, and then loyalty, authority, and sanctity. However, they moralized behaviors associated with fairness and care to a lesser extent, and those associated with loyalty, authority, and sanctity to a greater extent, than study participants from Western cultures. Chinese engineering students were only slightly likely to expect to face ethical issues in their working lives, but reported thinking it was important to be ethical. On this basis, recommendations are made for the improvement of engineering ethics education applicable both in China and in general, as well as proposals for future research.

## **Introduction**

The following paper describes the motivations for and nature of a study regarding the normative perspectives of Chinese engineering students. These motivations include high profile engineering- and technology-related disasters and scandals in China, the increased numbers of Chinese studying and working in science, technology, engineering, and mathematics (STEM) fields both in China and abroad, and challenges posed to engineering ethics by the cross-cultural and international educational and work environments of engineering. Additionally, findings about the failure of ethical understanding and reasoning to ensure ethical behaviors are considered as a more general challenge to applied ethics education. However, recent work related to ethical decision-making and behaviors can be used to address these challenges.

The study described in this paper uses two of these theoretical perspectives, Moral Foundations Theory (MFT) and elements of behavioral ethics, to better understand the normative perspectives of Chinese engineering students – what they think about right and wrong. On this basis, recommendations are made about how to improve engineering ethics education in general, and in cross-cultural and international contexts specifically, as well as noting shortcomings of this study and directions for further research.

*Engineering ethics in China, and the relation between ethical understanding, reasoning, and behaviors*

Both Chinese and international media have covered a number of high-profile incidents related to building, transportation, manufacturing, and bioethics scandals.[1]–[4] This has resulted in a perception that Chinese companies and industries are problematically unsafe and potentially unethical. Central to these concerns would be the education of engineers.<sup>1</sup>

In addition to the record number of Chinese students studying abroad [5], Chinese institutions of tertiary education now graduate more STEM majors than any other country in the world.[6], [7] China became a member of the Washington Accord in 2016 [8], requiring that engineering graduates achieve “Comprehension of the role of engineering in society and identif[y] issues in engineering practice in the discipline: ethics and the professional responsibility of an engineer to public safety; and the impacts of engineering activity – economic, social, cultural, environmental and sustainability.”[9] ABET student outcome f. requires accredited programs show their students have “an understanding of professional and ethical responsibility.”[10] With regard to ethics, however, this could be a challenge.

Because of its unique history and culture, some have argued China has evolved a distinctive normative perspective and framework, such that those arising out of different histories and cultures – such as the Western philosophical tradition – might be inappropriately applied in and to China.[11], [12] Empirically, past research among Chinese has found differences concerning not only the nature of ethical judgments and actions [13]–[17], but also other psychological traits and constructs potentially relevant to ethics [18]–[20] – such as thought styles [21], [22], causal attribution [23], and self-concepts and values.[24], [25] For these reasons, simply importing foreign ethics curricula into China might be inappropriate, resulting in not only a failure to cultivate ethical reasoning but also a strong backlash against a perceived cultural imperialism embedded in the theoretical perspectives of these curricula.[26]

Even if such curricula were successful in cultivating understandings of ethical and professional responsibility, it is not clear that these should be an ultimate goal of ethics education.[27] Presumably, the ultimate goal of engineering ethics education should be ethical behaviors, as emphasized in codes of ethics promulgated by professional engineering organizations as diverse as the AIAA, AIChE, ASCE, ASME, NSPE, and IEEE. Despite differences in the ethical codes of disciplines and across countries, all of them emphasize behaviors – for example, performing services, issuing statements, avoiding acts, and conducting themselves.[28] None of them states that engineers have a duty to *understand* anything or *reason* in a particular fashion.

The centrality of understanding and reasoning within engineering ethics education is probably based on the assumption that these precipitate and result in more ethical behaviors. This assumption is evident in ethical theories throughout the mainstream of the Western and – one could argue – Eastern philosophical traditions, as well as the work of early moral psychologists such as

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<sup>1</sup> This is not to claim that the education of engineers would be the most important factor involved in or main reason for such disasters. The decisions and actions of non-engineers also matter, as well as policies by governments and industries. This research and paper contribute to a better understanding of these as well, a point further explained below.

Laurence Kohlberg, as well as more recent neo-Kohlbergians such as James Rest and colleagues.[29]–[32] Although recent work in engineering ethics has identified problems with an exclusive focus on ethical reasoning – pulling on insights from theories of “planned behavior” [33] and positive psychology [34] – the most influential empirical studies within engineering ethics to date have used almost exclusively neo-Kohlbergian theories and instruments.[35]–[38] However, there are reasons to doubt the assumptions on which these theories and instruments are based is true, that ethical understanding and reasoning result in more ethical behaviors.

If understandings of ethics and ethical reasoning were sufficient to produce ethical behaviors, then professional philosophers – arguably the most knowledgeable and skilled in matters of ethics and ethical reasoning – should behave more ethically than others. However, a number of studies examining behaviors commonly associated with ethics have not found evidence to support this conclusion.[39]–[44] Further, research within social and moral psychology has called into question a direct and unproblematic relationship between ethical knowledge and understanding and behaviors, highlighting the extent to which actions are affected by situational factors [45], knowledge of and expectations about the behaviors of other [46], and biases.[44]

To explain the fact that neither ethical knowledge nor reasoning adequately explains (un)ethical behaviors, a number of psycho-social models of moral decision-making and judgments have been proposed. [44], [46]–[51] Unlike many of their more traditional philosophical and psychological counterparts, most of these models are “pluralist” in nature, meaning that morality and the contents of moral judgments are multi-faceted, not only about any one thing – for example, fairness or helping/non-harming. That makes these models indispensable to the fields of not only engineering and technology ethics but also applied ethics in general, where conflicting interests and principles occupy a central place – for example, a duty to public safety or health versus an obligation to an employer.

### **Current study**

A greater understanding of ethical judgments and the effects of culture, education, and other factors on these judgements is necessary to improve engineering ethics education, foster more ethical behaviors, and ultimately ensure public safety both in China and abroad. The current study has sought to better understand the normative perspectives of Chinese engineering students, using theoretical perspectives and methodologies associated with psycho-social models of moral decision-making and behaviors.

### *Moral foundations theory*

Moral Foundation Theory (MFT) is a social intuitionist model of ethical decision-making conceived by social psychologist Jonathan Haidt and colleagues.[51] According to MFT, moral judgments result from “intuitions,” closer in nature to feelings than rational thoughts. Rational thoughts play a secondary role, justifying judgments to oneself and others once they have been made. Intuitions result from different moral foundations, which have been likened to mental “modules,” suites of fast acting, informationally isolated cognitive mechanisms, which have evolved to deal with different kinds of ancestral challenges and respond to specific contents.[52] This is the intuitionist component of MFT, highlighting the role feelings, rather than understanding or reason, play in normative judgements.

Evidence has been given for the existence of five moral foundations, although additional foundations have been proposed. Each foundation deals with a specific set of normative concerns, corresponding to and elicited by different contents. These include care, fairness, loyalty, authority, and sanctity: caring for others is good and harming others is bad; being fair/just is good and being unfair/unjust is bad; being loyal to one's ingroup members is good and betraying them is bad; following sanctioned authority is good and undermining authority is bad; and remaining pure/sanctified – or engaging in purifying/sanctifying behaviors – is good, and the alternatives are bad.

The first two have been labelled the “individuating” foundations, primarily concerned with protecting the individual, and the latter three have been called the “binding” foundations, primarily concerned with protecting groups. Given their evolutionary origins, these foundations would be universal, although culture affects the relative priority given to and contents associated with the different foundations. Those who identify as socially liberal, for example, tend to emphasize the individuating foundations, judging a concern for the wellbeing (care) and equal treatment (fairness) of others as paramount in assessments of right and wrong, whereas those who identify as socially conservative emphasize all five.[53], [54] This is the social component of MFT, highlighting the role culture plays in normative judgments. Since intuitions are better predictors of moral judgments and behaviors than understanding and reasoning alone, and engineering practice and education is increasingly cross cultural and international, this study adopted MFT as one of its theoretical perspectives.

Various instruments have been developed in association with MFT, and one of the most widely used is the Moral Foundations Questionnaire (MFQ).<sup>2</sup> Divided into two parts, part one directs participants to read statements and then rank how relevant they consider the contents of these statements in their assessments of right or wrong (the “relevance” items/subscale) – for example, “Whether or not someone suffered emotionally,” associated with the care foundation, from “[0] = not at all relevant (This consideration has nothing to do with my judgments of right and wrong)” to “[5] = extremely relevant (This is one of the most important factors when I judge right and wrong).” Part two directs participants to read statements and then rank their agreement with these statements (the “judgment” items/subscale) – for example, “When the government makes laws, the number one principle should be ensuring that everyone is treated fairly,” associated with the fairness foundation, from “[0] = Strongly disagree” to “[5] = Strongly agree.”

Scores for all items associated with each of the foundations are averaged. The higher the scores, the more participants are interpreted as “moralizing” contents associated with the foundations – these behaviors are taken to be more central to respondents’ conceptions of morality. Two additional “catch” items are included, to ensure participants are adequately engaged while completing the MFQ, which are not scored. The full MFQ and additional items can be found in the appendix.

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<sup>2</sup> There are two forms of the MFQ, a shorter, twenty-item version and a longer, thirty-item version, which contain four and six statements about behaviors related to each of the moral foundations, respectively. The study described here used the longer version, for reasons explained below.

The MFQ was designed with a view to breadth, aiming to encompass different aspects of moral perspectives, even across different cultures, as opposed to maximizing consistency.[54] This approach is well-suited when sampling from large populations with participants that exhibit a wide variety of outlooks. The MFQ is meant to capture this diversity, while the breadth of the population will compensate for any deficiencies in consistency.

The validation study for the MFQ used exploratory and confirmatory factor analyses to test models with different numbers of underlying factors, using response data from visitors at yourmorals.org [54]. Ultimately, the authors endorsed a five-factor model, corresponding to the five moral foundations.[54] However, some have criticized the methodology used in that study and the conclusions drawn, arguing the evidence only supports a two-factor model, corresponding to the care and fairness versus loyalty, authority, and sanctity foundations.[47] Although the sample for the validation study included more than 34,000 participants from all over the world, all responded in English, had access to a computer, and chose to visit the site.

Since then, versions of the MFQ have been used in different languages in over thirty countries. Subsequent studies have found the five-factor model a better fit than alternatives in Italy [55], Germany [56], New Zealand [57], Sweden [58], the Netherlands[59], France [60], Turkey [61] and South Korea [62]. However, other studies have been unable to replicate this structure, or have had to change behaviors described in the MFQ to do so. The five-factor model was a poor fit in studies involving Chinese [63] and black participants [64]. Additionally, a twenty-seven country study failed to confirm the five-factor model, although the version of the MFQ used was shorter [65].

MFT has also been criticized on conceptual grounds. Suhler and Churchland have claimed: first, the notions of innateness and modularity with which MFT works are incoherent; second, the number and nature of foundations it proposes are contrived; third, MFT links poorly with neuroscience and genetics.[66] In testing the reliability of the MFQ, Smith and colleagues found substantial variability in the moral foundations of individuals over time, such that moral foundations would not be “relatively stable dispositional traits” indicative of nativism – or innateness and modularity.[67]

Haidt and colleagues have addressed these criticisms. In response to Suhler and Churchland, Haidt and Joseph have countered: first, the criteria for innateness and modularity proposed by Suhler and Churchland are too stringent for any type of nativism, and that the motivation for these criteria is precisely that they exclude the possibility of nativism; second, creators/advocates of MFT have never claimed there are only five foundations, but they have actively sought out other possible foundations; third, troubles linking MFT to neuroscience and genetics are not troubles unique to MFT.[68] Addressing Smith and colleagues, Haidt has noted that their study used a shortened, unvalidated version of the MFQ, such that the results do not support their claims.[69] Although the authors of this paper find those responses convincing, as Owen Flanagan has recently and rightly noted, not all characteristics of MFT proposed by its creators/advocates logically entail each other, such that trouble for one or some does not necessarily entail trouble for all.[70]

The chief interest in MFT for the present study is as a pluralist, social intuitionist theory of morality – in other words, that, first, morality is about many things rather than only one; second, the contents

of moral judgments are socially oriented and culturally variable; third, moral judgments are closer to/result from feelings than rational reflection. As mentioned above, this is intended as a supplement to studies in engineering ethics to date, which have tended to use the DIT, DIT 2, or similarly neo-Kohlbergian instruments, based on monist, rationalist theories of ethics. For these reasons, neither criticisms 2 nor 3 by Suhler and Churchland are of great concern for the present purposes. Both innateness and modularity are used in psychology and philosophy to denote a wider range of characteristics/phenomena than is probably justified, and the claim that moral judgments are close to/result from feelings is often associated with innateness and modularity, although there is no reason it has to be.

### *An ethical frame and moral motivations*

Based on a review of findings related to behavioral ethics and moral psychology, Max Bazerman and Ann Tenbrunsel have argued unethical behaviors are less the result of a decision to make an unethical choice than a failure to *perceive* behaviors and situations as having ethical import, a phenomenon they term “ethical fading.”[44] Ethical fading is a type of “bounded cognition,” where people fail to attend to and, therefore, perceive information, due to diverted attention and limited cognitive resources.

In a study demonstrating bounded cognition, participants watched a video of basketball players and were told to count how many times players in a certain color uniform passed the ball to each other. In the middle of the video, a person wearing a gorilla suit walks into the middle of the court. Afterwards, only approximately half of participants reported having seen it, although the person in the gorilla suit is obvious if one is looking for it.[71] Variations of the video have also shown players leaving in the middle of the game and the color of the background changing. Even if viewers report having seen the gorilla, they are unlikely to report having noticed the players leaving or color of the background changing.

Between this situation and ethical fading, one can draw an analogy, where the ethical contents of behaviors and situations are often missed but easily perceived if one expects them. To reduce ethical fading, knowledge of behaviors and situations with ethical import would be necessary, as well as the expectation one would encounter these. This knowledge and these expectations contribute to the development and maintenance of what could be termed an “ethical frame,” allowing those who possess an ethical frame to perceive ethical contents, thereby removing a hindrance to ethical actions and behaviors. This is especially important in engineering, as previous studies have shown engineering students tend to underestimate the extent to which they will face ethical issues in their working lives as engineers[72], and rank as relatively unimportant principles most important to ethical engineering.[73]

Such behaviors and actions also require a motivation to act ethically. Ethical action could be motivated, in part, by the importance one attaches to being an ethical person in one’s personal and professional life. Without this motivation, just possessing an ethical frame – the ability to identify and anticipate ethical contents – would not lead to ethical actions and behaviors. The MFQ can be used to discern the nature of ethical issues participants implicitly expect to face and behaviors they associate with moral character, by looking for relations between indicators of an ethical frame and moral motivation, and MFQ responses.

### *Questions and hypotheses*

As studies regarding morality among Chinese are relatively rare[14]–[16], and studies of morality using validated instruments with Chinese engineering participants nonexistent, this study sought to gather data to form concrete hypotheses for future studies. Using the theoretical frameworks and methods associated with MFT and behavioral ethics described above, the following hypotheses/questions were posed, for the sake of analyzing data and presenting results:

The current study predicted mean scores for the individuating foundations (harm and fairness) would be higher than the binding foundations (loyalty, authority, or purity), based on results reported in the validation study[54] and studies with East Asian samples from China[63] and South Korea.[62]

Additionally, it was predicted mean scores for binding foundations would be higher than in the validation study, based on findings in studies using East Asian samples from China and South Korea, and the fact mean scores for loyalty and purity were significantly higher among participants from Eastern than Western cultures in the validation study. Those results have been explained in terms of the influences of Confucian culture on contemporary, collectivist values in East and Southeast Asia, and the observance of such tendencies in non-Western Educated Industrialized Rich Democratic (WEIRD) samples.[54], [74], [75]

How likely are Chinese engineering students to expect to face ethical issues, and what kinds of ethical issues do they expect to face? In the absence of previous studies/comparative data, the current study made no predictions regarding these questions.

How important do Chinese engineering students think it is to be ethical? Again, no specific hypotheses were made in response to this question.

### **Method**

*Participants.* Participants were bilingual (Chinese-English) Chinese national freshmen students attending the University of Michigan-Shanghai Jiao Tong University Joint Institute (UM-SJTU JI) (N = 133; 39% female), and the average age was 18.

The UM-SJTU JI was founded in 2006 and is a US-Chinese joint educational venture based in the Minhang campus of Shanghai Jiao Tong University (SJTU), Shanghai, China. It has ABET-accredited programs in mechanical engineering and in electrical and computer engineering, which are modelled on those of the University of Michigan (UM). The official language of the UM-SJTU JI is English, and all course instruction takes place in English. Admission of domestic students to the UM-SJTU JI is based on having been first admitted to SJTU, based on Gaokao scores, the Chinese college-entrance exam. SJTU is consistently ranked as one of the top four universities in China, and has top programs in engineering. Tuition for the UM-SJTU JI is much higher than that of SJTU, currently 75,000 RMB (approximately 10,000 USD) per year. More than half of freshmen students during the fall 2018 semester came from Shanghai.

As a result, students in the UM-SJTU JI tend to excel academically and come from more affluent socio-economic backgrounds. Although this sample would be unrepresentative of Chinese in



general, they are likely similar to Chinese engineering students at other elite institutions. Students of this type are more likely to study and/or work abroad, where their perspectives might be different from those of their classmates, colleagues, instructors, or supervisors. Also, they are the most likely to enter higher-level, managerial positions in industry and government, where their actions and behaviors would have a greater impact. Therefore, the normative perspectives of that demographic are the focus of this study. Freshmen were used as participants to reduce the impact of previous university education.<sup>3</sup>

*Materials and procedure.* This study used the thirty-item, English-language version of the MFQ, available on [moralfoundations.org](http://moralfoundations.org), adding items concerning ethical expectations, moral motivation, and sources of ethical values, as well as age, gender, and parental education.<sup>4</sup> The thirty-item version of the MFQ was used, since it has greater internal consistency than the shorter version.

In the middle of October, these questions were posted on the Canvas course pages of two parallel mathematics classes, either of which is compulsory for mainland Chinese students at the UM-SJTU II. Students from Hong Kong, Macao, Taiwan, and international students take a third, separate version of the course. In this way, nearly all enrolled mainland Chinese students had the opportunity to participate in the study.

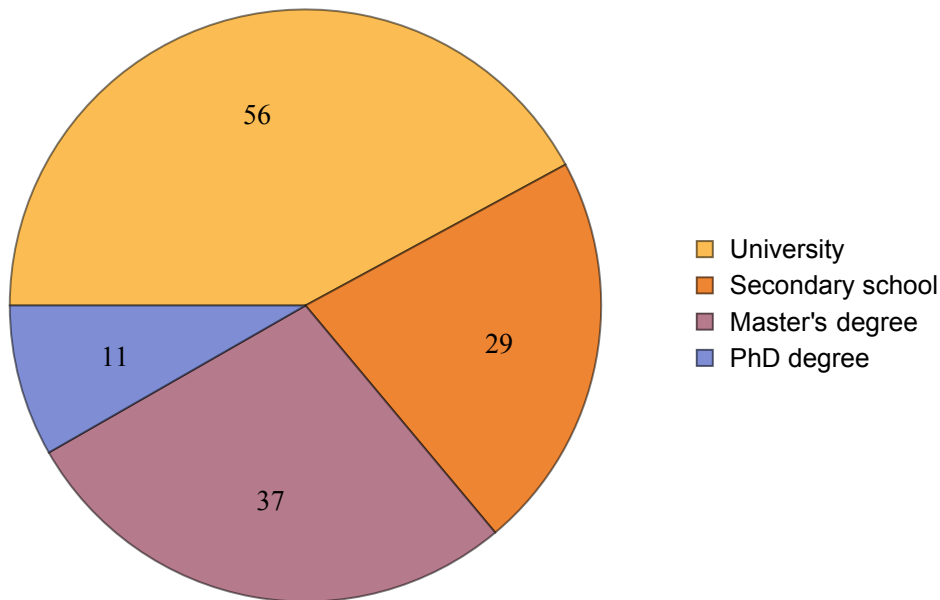
Participation was voluntary, and no incentives were offered. Students were directed to read and complete a consent form outlining the nature of the research before being able to answer questions. They were told responses would be confidential but not anonymous, to allow for the possibility of comparing responses at a later date. Out of a total of 300 students in both courses, 157 responded. Following the MFQ protocol, those students whose responses to the “math” catch question with 4 or above, and any whose responses to the “good” catch question were 3 or below, were excluded from analyses. After eliminating incomplete surveys and those that failed to respond adequately to the “catch” questions, 133 responses remained that are included and analyzed here. To gauge SES, participants were asked the highest level of academic education of their parents (Figure 1).

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<sup>3</sup> Another, longitudinal study will track the effects of education, age, and experience on normative perspectives over a four-year period.

<sup>4</sup> The additional items were previously used in other studies.[72], [79]

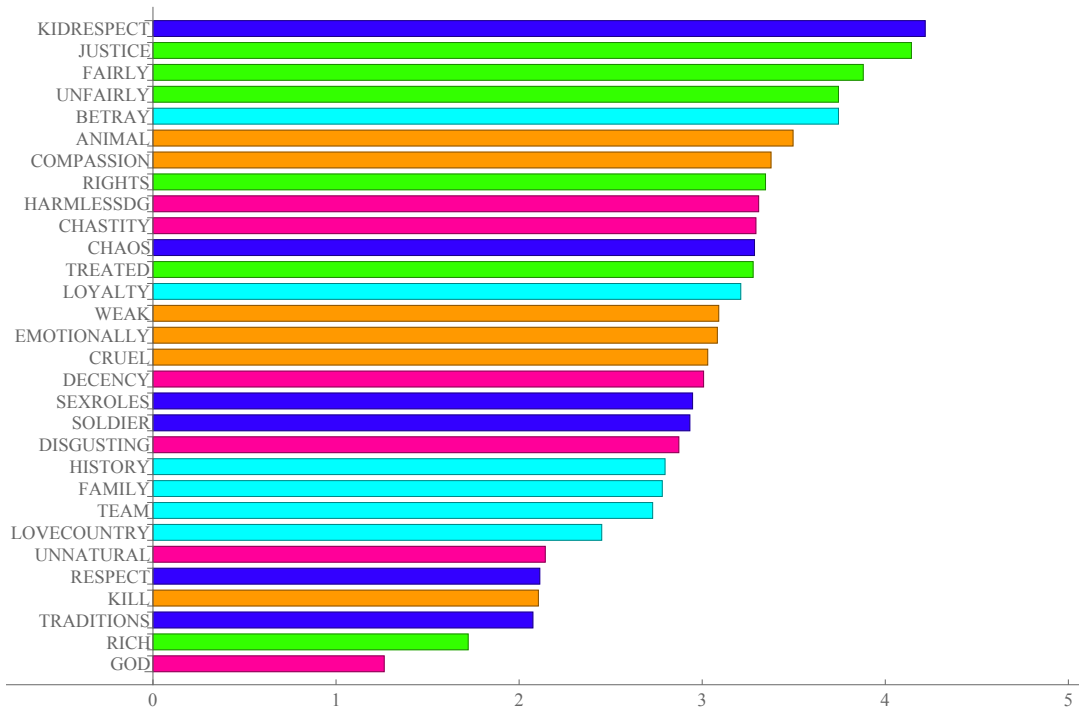
Figure 1: Highest levels of parental education among survey participants



## Results

*MFT*. Response means to the individual questions were calculated and are presented (Figure 2). The full MFQ and additional items can be found in the appendix.

Figure 2: Response means to the individual questions with color-coding associated moral foundations (Harm: orange, Fairness: green, Ingroup: light blue, Authority: dark blue, Purity: magenta)



The response means to many items representing the same foundations are relatively similar – for instance, “justice,” “fairly,” and “unfairly” representing fairness, or “animal” and “compassion” representing harm – while others are not – for example, “rich” for fairness and “kill” for harm.

To mitigate skewing due to “outlier” items – questions that potentially poorly represent/ elicit the intended foundation – without having to drop or replace items, medians are reported. This negates the effects of outlier items, resulting from cultural differences and/or the homogeneity of the sample, while preserving the cross-cultural ambitions of the MFQ and comparability with other studies that use it.<sup>5</sup> As previous studies have generally reported means and standard deviations, these have also been calculated and reported, as well as interquartile ranges. The foundation quartiles were calculated by taking the mean of the quartiles for each question (Table 1).

*Table 1: Means and medians for the moral foundations with standard deviations and interquartile ranges in parentheses*

Foundation	Mean (SD)	Median (IQR)
Harm	3.03 (0.72)	3.15 (1.30)
Fairness	3.35 (0.64)	3.59 (1.52)
Ingroup	2.95 (0.71)	3.05 (1.68)
Authority	2.93 (0.65)	3.01 (2.08)
Purity	2.65 (0.81)	2.76 (1.83)

These results support hypothesis one, that mean scores for the harm and fairness foundation would be higher than the loyalty, authority, or purity foundations. No effects were observed from gender, parental education, or sources of ethical beliefs on the means and medians of foundation responses.

For comparison with the validation study[54], response means are summarized and 95% confidence intervals reported (Table 2).

*Table 2: Summary of response means, confidence intervals, and those of the validation study[54]*

Foundation	UM-SJTU JI freshmen			Validation study	
	Mean	SD	95% Conf. Interval	Mean	SD
Harm	3.03	0.72	[2.91, 3.15]	3.42	0.84
Fairness	3.35	0.64	[3.24, 3.46]	3.55	0.73
Ingroup	2.95	0.71	[2.83, 3.07]	2.25	0.87
Authority	2.93	0.65	[2.82, 3.04]	2.27	0.90
Purity	2.65	0.81	[2.51, 2.79]	1.54	1.08

<sup>5</sup> This problem, possible explanations, and correctives are further considered in the discussion section and conclusion. Another approach would consist in dropping questions for Chinese participants or modifying the MFQ.[63]

Items associated with the individuating foundations were moralized to a lesser extent and those associated with the binding foundations moralized to a greater extent among Chinese engineering students than participants from the validation study. Observed differences between the means were calculated using independent t-tests and effect sizes were calculated and are reported (Table 3).

*Table 3: Comparison of response means with those of the validation study with statistical significances and effect sizes*

Foundation	Comparison		
	Diff. of Means	P-Value	Cohen's d
Harm	-0.39	< 0.00	-0.5
Fairness	-0.20	< 0.00	-0.3
Ingroup	0.70	< 0.00	0.9
Authority	0.66	< 0.00	0.8
Purity	1.11	< 0.00	1.2

All differences were statistically significant, although this is not surprising, given the sample size of the present study. All effect sizes were also large by conventional standards, and were largest with regard to differences between the loyalty, authority, and purity foundations.

These results support hypothesis two, that mean scores for the loyalty, authority, and purity foundations among Chinese engineering students would be significantly higher than those among participants from the validation study.

For future studies using the MFQ among Chinese participants, elements of the MFQ were compared for response consistency within our sample, in a manner similar to previous studies.[54], [63], [65] Cronbach's alpha (Table 4) and correlational coefficients (Table 5) were calculated to assess consistency between mean responses for the relevance and judgments subscales of the MFQ.

*Table 4: Means, standard deviations (in parentheses) and Cronbach's alpha for the MFQ subscales*

MFQ Subscales	Relevance	Judgement	Total
Harm	3.07 (0.82) $\alpha = 0.64$	2.99 (0.93) $\alpha = 0.42$	3.03 (0.72) $\alpha = 0.62$
Fairness	3.46 (0.81) $\alpha = 0.61$	3.25 (0.78) $\alpha = 0.41$	3.35 (0.64) $\alpha = 0.59$
Ingroup	3.14 (0.88) $\alpha = 0.63$	2.77 (0.94) $\alpha = 0.45$	2.95 (0.71) $\alpha = 0.56$
Authority	2.49 (0.79) $\alpha = 0.31$	3.37 (0.85) $\alpha = 0.32$	2.93 (0.65) $\alpha = 0.45$
Purity	2.38 (0.91) $\alpha = 0.54$	2.91 (0.97) $\alpha = 0.49$	2.65 (0.81) $\alpha = 0.68$

There appear to be significant differences in the means between the two subscales, particularly with regard to the authority and purity subscales. Similar differences are reported in the validation study, especially noticeable among homogeneous sub-populations, for instance, respondents with politically libertarian views.[54] Additionally, the Cronbach's alphas reported here are smaller than those reported in the validation study, a finding consistent with other studies that have used the MFQ.[58], [61]

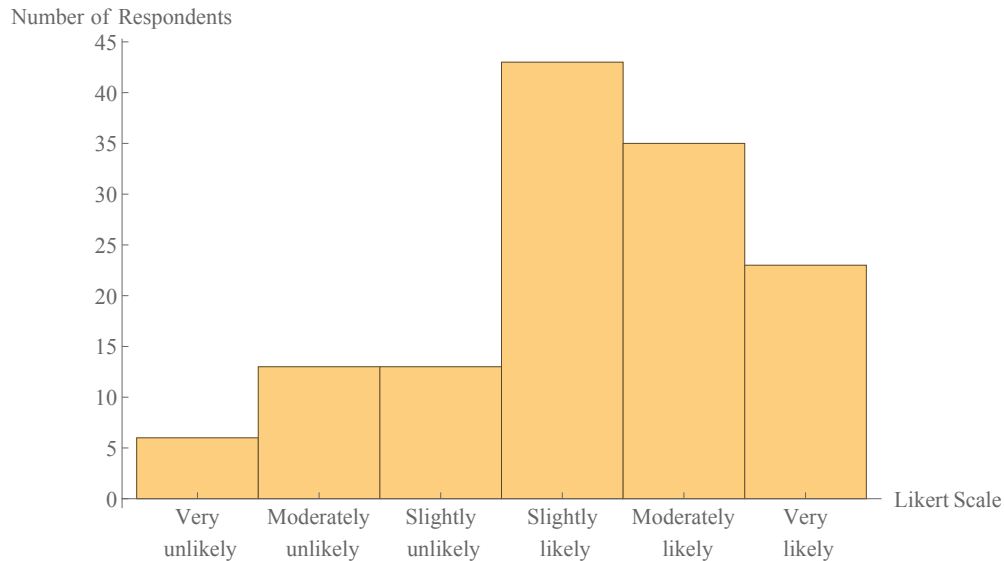
Table 5: Internal relations between relevance and judgment subscales as expressed by Pearson correlation coefficients.

MFQ Judgement Subscale	MFQ Relevance Subscale				
	Harm	Fairness	Ingroup	Authority	Purity
Harm	<b>0.35</b>	0.26	0.29	0.36	0.43
Fairness	0.2	<b>0.29</b>	0.14	0.13	0.17
Ingroup	0.04	0.01	<b>0.21</b>	0.38	0.15
Authority	0.05	-0.01	0.33	<b>0.27</b>	0.08
Purity	0.33	0.08	0.45	0.45	<b>0.51</b>

In general, the correlation coefficients reported here are smaller than those in the validation study, and there are surprisingly large correlations between subsets of seemingly unrelated domains, for example, harm and purity, which should be explored further.

*An ethical frame.* To assess the extent to which participants possessed an ethical frame, they were asked, “How likely do you think it is that you will be faced with ethical issues or conflicts during your working life as an engineer?”, replying with a Likert scale from very unlikely (0) to very likely (5). Response rates are displayed (Figures 3).

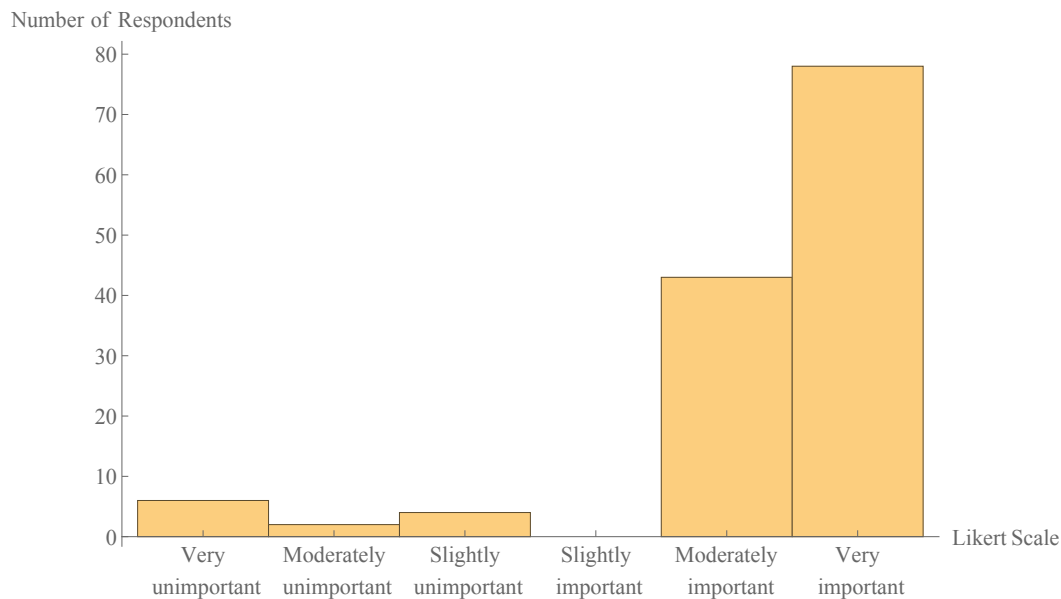
Figure 3: Likelihood of facing ethical issues or conflicts in working life as an engineer



The average reported likelihood was 3.18. No significant differences were discovered between the likelihood of expecting to face ethical issues and responses on the MFQ. Additionally, no effects were observed from gender, parental education, or sources of ethical beliefs on the likelihood of expecting to face ethical issues.

*Moral motivation.* To assess the extent to which participants were motivated to act morally, they were asked, “How important do you think it is to be ethical in your personal and professional life?”, replying with a Likert scale from very unimportant (0) to very important (5). Response rates are displayed (Figures 4).

Figure 4: Importance of being ethical in personal and professional life



The average reported response was 4.3. No significant differences were discovered between the importance of being ethical and responses on the MFQ. Additionally, no effects were observed from gender, parental education, or sources of ethical beliefs on the importance of being ethical.

## Discussion

These results largely confirm previous findings reported from studies using the MFQ with Chinese and East Asian participants, supporting characterizations of non-WEIRD and collectivist cultures, as well as their differences from Western and individualist cultures.

Overall, Chinese engineering students gave highest priority to fairness, followed by harm, loyalty, and authority, with sanctity being relatively unimportant. However, they moralized fairness and harm to a lesser extent, and loyalty, authority, and sanctity to a greater extent, than Western participants in the validation study.

Although the fairness foundation was given the highest overall priority, responses to “respect for authority is something all children need to learn” had the highest score. This result could be interpreted as “Confucian” in nature, insofar as filial piety (孝) is a central Confucian virtue. The

fact this item received the highest mean score, while other authority items scored much lower, might be an effect of Confucian values on Chinese parenting styles – also, that freshmen students had just recently moved away from home for university. The mean response to this item was much lower in results from a pilot study conducted with older students.

These highlight the extent to which thinking or talking about adherence to authority in the abstract, as a general category, might be a mistake: Not all forms of adherence to authority are viewed the same or elicit similar reactions. The same is true of loyalty and sanctity. For example, responses to the lowest scoring item, “whether or not someone acted in a way that God would approve of,” could result from the absence/discouragement of religious practice in China rather than the low priority given to purity as such. Also, whereas most items concerning fairness received high mean scores, responses to “I think it’s morally wrong that rich children inherit a lot of money while poor children inherit nothing” were low, perhaps due to participants being children of high-income parents.

Although most participants thought it was important to act ethically in their personal and professional lives, not many expected to face ethical issues in their working lives as engineers. This result highlights a gulf between moral motivation and an ethical frame: Although students think it is important to act ethically, they might be unlikely to do so, as they would be unable to recognize issues and conflicts when confronting them.

To improve engineering ethics education among Chinese students, curricula should stress fairness and the extent to which engineers and those working with technology are likely to face ethical issues and conflicts in their working lives, and how appropriately addressing these issues is a reflection on oneself and country.

To achieve learning outcomes, educators should orient new content in terms of existing skill levels and knowledge. For instance, calculus is initially taught in terms of trigonometry, and essay writing in terms of paragraph writing. Without the requisite skills and knowledge, students are unlikely to succeed. Analogously, ethical contents and skills should be oriented in terms of what students already know and think, administering curricula in terms of this background.

This is not to claim that educators *should* teach to this knowledge and these views simply because they *are* what students know and think – thereby deriving an “ought” from an “is.” Rather, the claim is that this knowledge and these views are essential to effective pedagogy: If engineering students should think a certain way, and educators have an obligation to ensure they do, then educators also have an obligation to assess what students know and think, impediments to acquiring this knowledge, and ways of facilitating its acquisition.

For instance, public safety is of central concern to engineering ethics, ensuring the public is not harmed as a result of engineering. However, harm was not most intuitively associated with ethics among Chinese engineering students. The claim here is not that curricula in ethics for these students should abandon public safety, since harm is not central to their perceptions of ethics. Rather, this knowledge can be used to more effectively teach ethics to Chinese engineering students.

Based on the above results, this could consist in beginning with fairness, for example, discussing the importance of giving due credit or keeping confidentiality regarding proprietary information, as breaches in these would be unfair. On this basis, the harm caused by cheating or breaches in confidentiality could be explained, highlighting how these could result in betrayal of one's family, friends, peers, and country. In this manner, education would begin with intuitive and personal conceptions of right and wrong, connecting these conceptions to contents specific to engineering and technology, which might appear less intuitive and more impersonal. Insofar as study participants reported caring about being ethical in their professional and personal lives, they would be motivated to care about these things.

Findings related to loyalty and authority reported above would also be important. Both loyalty and authority are central to engineering ethics – for example, duties of loyalty to the public, profession, and employers, and adherence to professional authority based on expertise. Normatively, these are often justified with regard to harm – for the sake of ensuring public safety, engineers must sometimes navigate their duties of loyalty to employers with those to the public and their professions, as well as deferring to the judgments of those with the greatest professional expertise.[26] The results reported here show that judgments regarding loyalty and authority are especially sensitive to cultural differences. It would be wrong for educators to assume that loyalty or authority can be taught to or are conceived by students as global concepts, insensitive to the contexts in which they occur.

Finally, although study participants were motivated to act ethically, they did not expect to face ethical issues in their professional lives, easily causing them to miss such issues as a result of ethical fading. To address this concern, educators should stress the likelihood of encountering ethical issues and conflicts in engineering environments, perhaps inviting practicing engineers to share their experience.[72] Exposing students to vivid examples has been shown to increase abilities in ethical reasoning.[76] In addition to case studies on disasters – which comprise the mainstream of engineering ethics – students should also be sensitized to the less obvious ways engineering can have widespread, severe consequences.

Although information is still sparse, the first author has used the case of the Samsung Galaxy phone to good effect – very small mistakes in the size of the battery casing cost the company billions. In most situations, in one's personal life, a mistake on the scale of millimeters could hardly be considered unethical. This is not the case in engineering contexts, given the widespread and potentially serious effects of technology on human life. Being sensitive to this discrepancy and drawing the attention of students to it is important.

## **Conclusion**

As this study was only preliminary, it suffers from a number of shortcomings related to the study design, which will be addressed in future research. These concern study samples and instrument items.

The sample size was relatively small and perhaps unrepresentative of Chinese engineering students in general. The respondents comprise a relatively homogeneous group with regard to SES (high), academic preparation (high), and outlook (aspiring engineers). As mentioned before, this population should be of the greatest concern, since students of this type are the most likely to study



and work abroad, and eventually enter managerial or administrative positions. However, without larger, different samples, it is difficult to know how representative these are.

Additionally, at present, it is difficult to say with any certainty the causes of differences reported here. Rather than culture, perhaps reported differences result from acquired professional knowledge and training, such that if the MFQ validation study had been conducted exclusively with engineering students or practicing engineers, then no differences would have been found. Previous studies have found evidence for the effects of professional knowledge and training on the ethical judgments of hospital and healthcare administrators.[77] Although this explanation is unlikely, since it underestimates the impact of culture and overestimates the impact of professional knowledge and training on beliefs – as cross-cultural studies regarding the beliefs of doctors have demonstrated [78] – and participants in this study had only just begun their professional training, it remains a possibility.

Going forward, there are plans to include participants of lower SES and from non-top-tier universities and trade schools in China. Additionally, the survey will be administered to different types of engineering students and practitioners – for example, civil, mechanical, electrical, and computer – as well as non-engineering students and working professionals – for example, those in law and medicine – both in and outside of China. In all cases, the goal will be a better understanding of the characteristics of normative perspectives described here, and how these are related to SES, educational background, anticipated professions, training, and experiences. This allows for a broader, better understanding of similarities and differences between perceptions of right and wrong, but also which factors contribute to these differences.

This will require modifying survey items in future studies, collecting information that could be used as input variables, as well as adding other measures. The only demographic information collected in this study concerned gender, age, and parental income. Although items regarding political orientation have different meanings internationally and cross culturally – and one would not expect much variance in religious affiliation among Chinese perspectives – normative perspectives are likely related to a variety of factors. In the immediate future, items related to personal or parental income, and city and province of origin will be added as indicators of SES. Further, as no relations were discovered between MFQ items, expectations of encountering ethical issues, and the perceived importance of being ethical, including questions about the kinds of ethical issues participants expect to face and they think constitutes being an ethical person would be more informative.

The survey has already been completed by bilingual, Chinese-English speakers in Chinese and English, to better understand the effects of foreign language on ethical judgments. Finally, as mentioned above, this survey will be re-administered to participants on a yearly basis for the next three years, to check the reliability of the MFQ and the effects of education on the normative perspectives described here.

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## Appendix – Moral Foundations Questionnaire and Additional Items

Part 1. When you decide whether something is right or wrong, to what extent are the following considerations relevant to your thinking? Please rate each statement using this scale:

[0] = not at all relevant (This consideration has nothing to do with my judgments of right and wrong)

[1] = not very relevant

[2] = slightly relevant

[3] = somewhat relevant

[4] = very relevant

[5] = extremely relevant (This is one of the most important factors when I judge right and wrong)

\_\_\_\_\_ Whether or not someone suffered emotionally

\_\_\_\_\_ Whether or not some people were treated differently than others

\_\_\_\_\_ Whether or not someone's action showed love for his or her country

\_\_\_\_\_ Whether or not someone showed a lack of respect for authority

\_\_\_\_\_ Whether or not someone violated standards of purity and decency

\_\_\_\_\_ Whether or not someone was good at math

\_\_\_\_\_ Whether or not someone cared for someone weak or vulnerable

\_\_\_\_\_ Whether or not someone acted unfairly

\_\_\_\_\_ Whether or not someone did something to betray his or her group

\_\_\_\_\_ Whether or not someone conformed to the traditions of society

\_\_\_\_\_ Whether or not someone did something disgusting

\_\_\_\_\_ Whether or not someone was cruel

\_\_\_\_\_ Whether or not someone was denied his or her rights

\_\_\_\_\_ Whether or not someone showed a lack of loyalty

\_\_\_\_\_ Whether or not an action caused chaos or disorder

\_\_\_\_\_ Whether or not someone acted in a way that God would approve of

Part 2. Please read the following sentences and indicate your agreement or disagreement:

[0] = Strongly disagree

[1] = Moderately disagree

[2] = Slightly disagree

[3] = Slightly agree

[4] = Moderately agree

[5] = Strongly agree

\_\_\_\_\_ Compassion for those who are suffering is the most crucial virtue.

\_\_\_\_\_ When the government makes laws, the number one principle should be ensuring that everyone is treated fairly.

\_\_\_\_\_ I am proud of my country's history.

\_\_\_\_\_ Respect for authority is something all children need to learn.

\_\_\_\_\_ People should not do things that are disgusting, even if no one is harmed.

\_\_\_\_\_ It is better to do good than to do bad.

\_\_\_\_\_ One of the worst things a person could do is hurt a defenseless animal.

\_\_\_\_\_ Justice is the most important requirement for a society.

\_\_\_\_\_ People should be loyal to their family members, even when they have done something wrong.

\_\_\_\_\_ Men and women each have different roles to play in society.

\_\_\_\_\_ I would call some acts wrong on the grounds that they are unnatural.

\_\_\_\_\_ It can never be right to kill a human being.

\_\_\_\_\_ I think it's morally wrong that rich children inherit a lot of money while poor children inherit nothing.

\_\_\_\_\_ It is more important to be a team player than to express oneself.

\_\_\_\_\_ If I were a soldier and disagreed with my commanding officer's orders, I would obey anyway because that is my duty.

\_\_\_\_\_ Chastity is an important and valuable virtue.

Part 3. Additional items

1. On a scale of 0-5 (0 being strongly disagree and 5 being strongly agree), how likely do you think it is that you will be faced with ethical issues or conflicts during your working life as an engineer? (If you do not intend to become an engineer, then write "NA.") \_\_\_\_\_

2. On a scale of 0-5 (0 being strongly disagree and 5 being strongly agree) how important do you think it is to be ethical in your personal and professional life? \_\_\_\_\_