Which Factors are Correlated with Engineering Students' Expectations of Ethical Issues?

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Which factors are correlated with the cultivation and maintenance of an ethical frame? Bringing behavioral ethics and moral psychology to bear on engineering ethics

Introduction

The following paper describes the background for and a study carried out in 2016 concerning engineering students' knowledge of and views regarding engineering ethics. To bridge the fields of engineering ethics, behavioral ethics, and moral psychology, the study sought to determine correlations between the cultivation and maintenance of an "ethical frame" – indicated by students' expectations of ethical issues or conflicts during their working lives as engineers, and perceived importance of being ethical in their personal and professional lives – and previous ethics education, experiences of unethical behaviors, and sources of moral beliefs.[1]

A growing body of literature shows unethical actions result less from individuals making reflective decisions to act unethically and more from an inability to see choices as having ethical import, resulting in many cases from biases based on human psychology/environmental factors. Conversely, expectations of ethical issues or conflicts should motivate and maintain an "ethical frame," recognizing the ethical dimensions of situations and decisions. Maintaining an ethical frame should, thereby, improve ethical awareness and mitigate against "ethical fading" – a variant of "bounded rationality" in which the ethical dimensions of situations and decisions take on less or no importance. An ethical frame should increase the likelihood of moral awareness and, therefore, moral judgments, intentions, and actions.[2] Rather than the nature of ethical judgments and decisions as such, however, this paper argues for the primary importance of ethical actions and behaviors.

Significant correlations were discovered between expectations of ethical issues/conflicts and 1. the perceived usefulness of engineering ethics education and 2. the extent of engineering ethics education, as well as between the importance of being ethical and 1. the perceived usefulness of engineering ethics education and 2. instructor performance.

To motivate and orient the importance of our study and these findings, the first part of this paper outlines the importance and nature of engineering ethics – especially trends towards "macro-ethics" and their relation to behavioral ethics and moral psychology – as well as findings regarding problems related to engineering ethics specifically and the efficacy of ethics education in general. The second part reviews empirical findings related to engineering and research ethics, arguing that the actions and behaviors of engineers – rather than decisions and judgments – should be given priority as criteria for determining the efficacy of ethics education, relating this claim to relevant perspectives within behavioral ethics and moral psychology. The third part of this paper explains the design and execution of our study – orienting its theoretical perspective within behavioral ethics – outlines its results, and briefly discusses these results and makes recommendations concerning engineering ethics education.

The importance and nature of engineering ethics, and problems with engineering ethics and ethics education

Since engineers and the technologies they develop profoundly impact human life and the environment, it is vital that engineers act ethically. In general, engineering ethics has focused on the consequences of the actions of engineers and the technologies for which they are responsible, giving priority to public safety in normative endeavors to define right and wrong within the field of engineering.

These tendencies are reflected in the emphases of various engineering ethical codes, where a variety of ideals and rules for action are outlined, aimed at and applying to the individual engineer.[2,3,4,5,6,7] This orientation could be described as "micro-ethics," aimed at fostering the capacities of individual engineers to engage in ethical reflection, decision-making, and action. In recent years, the focus of engineering ethics has expanded, encompassing the responsibilities of professional and social organizations, "macro-ethics."[8,9] This shift has raised and invites reflection on a number of issues related to philosophy and the social sciences.

Philosophically, a focus on macro-ethics raises questions regarding the manner and extent to which groups might be considered responsible, and what to do when responsibility is dispersed throughout a group.[10,11] In instances such as these, empirical work carried out in the fields of cognitive, developmental, evolutionary, and social psychology can benefit philosophical analyses concerning, for instance, the way broader environmental and social factors contribute to the (im)moral judgments and behaviors of individuals, moral ecology, as well as what can be done to shape environments, formal, and informal cultures to insure more ethical actions – commonly referred to as "nudging."[2,12,13]

Efforts such as these are well underway in the interdisciplinary field of moral psychology, and are being brought to bear on business[1,14] and legal ethics[15] via behavioral ethics. With a few exceptions[9], however, these efforts are largely absent from engineering ethics. However, they are increasingly necessary, given empirical findings regarding the efficacy of engineering ethics education specifically and ethics education in general.

McGinn found widespread disagreement among engineering students and practitioners regarding what constitutes an ethical conflict or issue – criteria that would be used to decide whether a problem was one appropriately considered in terms of ethics – emblematic of relativism. Additionally, comparing their responses with those of practicing engineers, he found that engineering students underestimated the extent to which they would be faced with ethical issues/conflicts in their working lives as engineers.[16]

Further, assuming that ethics cannot be taught – but that the value of engineering ethics education consists in honing one's preexisting ethical convictions – Stappenbelt set out to explore the personal moral convictions of engineering students. Using a survey consisting of sixteen ethically questionable practices, he asked engineering students to rank these practices on a scale of one to five, one being very unethical and five "being not at all unethical." After that, students were taught about the Institute of Engineers Australia (IEAust) Code of Ethics and asked whether they believed 1. they always acted in "accordance with the tenets of the IEAust code of conduct?," 2. "that most practicing engineers always abide by the IEAust code of conduct?," and 3. "that professional engineers can realistically be expected to abide at all times by the IEAust code of conduct?," answering with a yes, no, or unsure response.[17]

Stappenbelt discovered that students gave higher scores to practices where the potentially negative consequences were the furthest removed from personal morality but the most relevant to public safety, items two and thirteen: "Undertaking work in an area you know little about" and "Not keeping up to date with the latest developments in your area," respectively. Additionally, he found that less than half of students responded in the affirmative to questions regarding their own or that of practicing engineers' adherence to the IEAust Code of Ethics, as well as to the question concerning the expectation that professional engineers abide by the IEAust Code of Conduct at all times.[17]

Along similar lines, Kuczenski sought to determine rates of unethical behavior among engineering students, comparing students from three different institutions. "Unethical behavior" in her study refers primarily to forms of dishonesty, for example, cheating on an exam or copying a homework assignment. Interestingly, students reported lower rates of dishonestly at institutions with honor codes.[18] Regarding the efficacy of engineering ethics education, Holsapple and colleagues found inverse correlations between engineering students' knowledge of ethics and their satisfaction with their ethics education, seemingly showing that engineering ethics curricula were too simplistic to satisfy the best, most reflectively inclined students.[19]

These findings highlight problems related to engineering ethics education specifically, the facts that: relativism exists among engineering students, engineering students underestimate the extent to which they will be faced with ethical issues as engineers, personal morality is relatively removed from ethics within engineering, cheating is widespread among engineering students, and education within engineering is too simplistic. Although disheartening, questions regarding the efficacy of ethics education are not unique to engineering.

Schwitzgebel and colleagues tested the hypothesis that studying ethics would lead to more ethical behavior. They assumed that only graduate students and professors in ethics would be interested in higher-level ethics books, and examined the rates at which these books were stolen from major research libraries. It was concluded that more of these books were stolen than those corresponding to other subjects.[20] Coupled with findings regarding problems in engineering ethics, these results concerning the efficacy of traditional ethics point towards the need to rethink the nature of ethical inquiry and the teaching of ethics.

Engineering and behavioral ethics, and moral psychology: Moral judgments/decisions and actions/behaviors
Along with the studies addressed above, a growing body of work now exists exploring engineering ethics from an empirical perspective, regarding not only what students and practitioners[16], but also and faculty members[21], know and think about ethics, as well as developing guidelines and criteria for determining effective curricular interventions.[22, 23, 24, 25, 26] However, much of this work remains disconnected from the fields of behavioral ethics and moral psychology, which could yield valuable insights to engineering ethics education.

Rather than exploring ethics from purely or primarily a speculative and normative perspective, focusing on guidelines for correct actions and the conditions under which actions would be right or wrong – the purview of traditional ethical inquiry – research in these fields consists in

empirical and descriptive explorations regarding the intuitive and emotional nature of moral judgments[28, 29], as well as the social and environmental mechanisms responsible for assessments of right and wrong, mentioned above. This is important, since findings suggest than many of the commonsense intuitions grounding understandings of the relations between moral judgments and decisions, and actions and behaviors, are incorrect.

Intuitively, one might suppose actions/behaviors directly follow from judgments/decisions. For example, if a civil engineer makes a judgment regarding the permissibility of designing or the decision to design a faulty bridge, then his or her actions and behaviors would follow, resulting in the design of a faulty bridge. This understanding meshes well with commonsense experience – understood as introspection and observations of others, and probably intuitions resulting from innate and evolved folk psychology.

This experience and these intuitions lie at the basis of J.R. Rest's influential model of ethical decision-making, which consists in four-stages: 1. moral awareness, that a decision has ethical content; 2. moral judgment, about the right-/wrong-ness/praise-/blame-worthiness of actions; 3. moral intention, to act in a certain way; 4. moral action, acting according to one's intention.[1] A framework such as this is commonly assumed and tacitly invoked in discussions of engineering ethics education.

Many guidelines for and discussions of engineering ethics tend to blur the distinction between ethical judgments/decisions and actions/behaviors, assuming the ability to make ethical judgments/decisions will simply lead to ethical actions/behaviors – where unethical actions/behaviors result from either a lack of knowledge regarding ethics or the inability to apply this knowledge. Charles Huff draws attention to this dichotomy, in terms of "decision-oriented approaches to teaching ethics and approaches that are intended to develop ethical behavior over the course of an entire scientific or engineering career."[26] However, personally and professionally, the actions and behaviors of others seem more important than their decisions and judgments.

For example, the decision of a civil engineer to design an unsafe bridge, or his or her judgment that designing such a bridge is ethically acceptable, seems unimportant if the bridge ends up being safe. Within professional ethics, conflicts of interest are often discussed in terms of the tension between personal and professional ethics, when the personal moral judgments of professionals conflict with their professional duties to act in a particular manner.[30, 31, 32, 33] However, research shows unethical actions and behaviors result less from individuals making judgments and decisions to act unethically and more from an inability to see situations and choices as having ethical import, resulting from the nature of human cognition itself – biases rooted in human psychology and affected by environmental factors.

Based on situationist psychology, for example, philosophers have questioned parts of the moral psychology on which this perspective is based: Supposing global character traits/virtues and the "character" of individuals in which these inhere, where the actions and behaviors of individuals would be outcomes of character traits determining judgments and decisions, rather than simply environmental stimuli.[34] The common though erroneous tendency to attribute character traits

based on potentially under-representative experiences is known as "fundamental attribution error."[35]

Additionally, a variety of dual-processing accounts of cognition – commonly presented in terms of fast, unconscious, frugal, heuristic, "system-one" versus slow, conscious, expensive, algorithmic, "system-two" thinking – have arisen within psychological research related to decision theory. These accounts highlight the roles that various biases play in cognition, for example, presentation and confirmation biases, as well as time constraints and increased cognitive load. Rather than an anomaly, system-one thinking is central to and comprises the largest part of human cognition, calling into question an understanding of people's actions and behaviors as following directly from their conscious judgments and decisions in an unproblematic fashion.[36] Hence, the model of Rest described above consists in a number of potentially spurious assumptions.

Employing assumptions related to a dual-processing, system one-two model instead, Bazerman and Tenbrunsel claim that we often "lack moral awareness, judge before reasoning, and misjudge moral intentions."[37] As a result of cognitive framing biases, lack of moral awareness would prevent one from making moral judgments, forming moral intentions, and carrying out moral actions downstream in Rest's model. Bazerman and Tensrunsel explain this discrepancy in terms of the difference between a "should" and "want" self, roughly corresponding to processes of system two and one thinking, respectively. Whereas system two thinking dominates before and after decisions are made and actions taken, system one dominates in the process of making decisions and taking actions.[2]

The above-described findings and framework call into question the efficacy of traditional approaches to engineering ethics education, which tend to emphasize the acquisition of knowledge and the practice of applying this knowledge. If human beings do not, for the most part, think in this fashion, and a disconnect exists between this type of thinking and the ethical actions and behaviors one would want from engineers, then the need exists to rethink engineering ethic curricula and assessments of their effectiveness.

Study design and execution
Evidence suggests expectations of confronting ethical issues/conflicts facilitate more ethical action – when individuals are armed with better understandings of their motivations and feelings when confronted by ethical issues/conflicts then they can act in a more ethical fashion.[38] Additionally, the perceived importance of being ethical should motivate an awareness of and concern with acting ethically. These expectations and motivations would condition and maintain an "ethical frame," recognizing the ethical dimensions of situations and decisions and then acting accordingly. Maintaining an ethical frame would mitigate against "ethical fading" – a variant of "bounded rationality" in which the ethical dimensions of situations and decisions take on less or no importance – increasing the likelihood of moral awareness, judgments, intentions, and actions.[2]

To determine factors that might contribute to the development and maintenance of an ethical frame, our survey employed two groups of five independent variables (group one – items 9, 7,

and 12/16; group two – 17 and 11) and two dependent variables (items 7 and 19). (The entire survey can be found in the Appendix.)

The first group of independent variables were used to examine the effects of perceptions regarding the usefulness, extent, and instructor performance of engineering ethics education. These were as follows:
1. Usefulness – "On a scale of 1-5 (one being the least and five being the most), rank how useful you think it might be to study such issues and conflicts as part of your engineering curricula."

2. Extent – "On a scale of 1-5 (one being the least and five being the most), rank the extent to which you feel your engineering studies have addressed ethical issues or conflicts that arise within engineering."

3. Instructor performance – "Have your engineering instructors ever said or done anything that would lead you to believe they think ethics is *important* as an engineer? (Y/N)" and "On a scale of 1-5 (one being strongly disagree and five being strongly agree), rank the extent to which you agree with the following statement: 'In the course of my engineering education, I have gotten a message to the effect that *there is more to being a good engineering professional in today's society than being a state-of-the-art technical expert?*'"

The second group of independent variables were used to examine the effects of experiences and sources of ethics, outside the context of formal ethics education. These were as follows:

1. Experience – "If you have been employed in an engineering-related position, e.g., in a summer job or internship, have you ever encountered an engineering-related deed, practice, or policy that you considered morally questionable or wrong?" (If you have never had such a position, write "NA.") (Y/N/NA)

2. Sources – "Who or what has had the most significant influence on the ethical/moral values, attitudes, ideals, or approach to making ethical judgments that you call upon when faced with a difficult situation? Please circle one and only one: A. Religion B. Teachers C. Parents D. Friends E. Other – please specify: _____"

Assuming the cultivation and maintenance of an ethical frame is based on expectations of facing ethical issues and the importance of being ethical, our two dependent variables are as follows:

1. Expectations – "On a scale of 1-5 (one being the least and five being the most), how likely do you think it is that you will be faced with ethical issues or conflicts during your working life as an engineer?"

2. Importance – "On a scale of 1-5 (one being the least and five being the most), how important do you think it is to be ethical in your personal and professional life?"

Independent variables

Dependent variables

| 1. Formal – ethics education
a. usefulness
b. extent
c. instructor performance |

| 2. Informal
a. experience
b. sources |

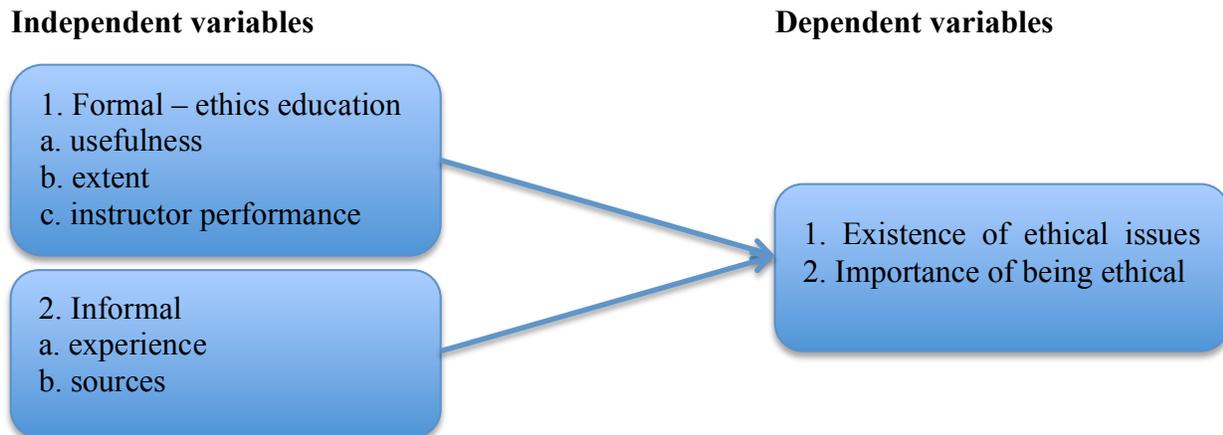| 1. Existence of ethical issues
2. Importance of being ethical |

Figure 1

During the fall semester of 2015 and summer and fall semesters of 2016, a survey was distributed to engineering students in courses at two Chinese-international engineering joint institutes, at the beginning of "Professional Ethics" in the University of Michigan-Shanghai Jiao Tong Joint Institute (JI) and "Engineering Practice 2" "Electrical Engineering Practice 2," and "Manufacturing Operations Management" at the Sino-British College (SBC).[1] Although none of the students surveyed had taken standalone courses in engineering ethics, most had previous engineering ethics education through modules embedded in other courses, for example, "Introduction to Engineering" at JI and "Engineering Applications, Practice and Design" at SBC.

The survey was based on two earlier studies[2, 38] with the questions modified to gather more continuous than discrete data. As the primary language of instruction in both institutions is English, the survey was administered in English.

Participants were 142 university students majoring in engineering, including 23 females who identified as mainland Chinese nationals, and 119 males, 114 who identified as mainland Chinese nationals, 4 of whom identified as Taiwanese, and 1 from elsewhere.

Results
Finding 1: The perceived usefulness of engineering ethics education is correlated with expectations regarding ethical issues/conflicts and the importance of being ethical.

Regarding the usefulness of engineering ethics education, 60.4% of participants replied with a 4

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[1] Considering the settings and participants, it would be appropriate to explore the nature and role of culture in ethical awareness and behavior. A growing body of literature points to the importance of culture in not only moral development but also professional ethics. Further considering these perspectives would undoubtedly motivate the transferability of the findings presented here, although that is beyond the scope of this paper. Going forward, however, our team will definitely pursue these lines of inquiry, and we are grateful to an anonymous reviewer for raising this point.

or a 5 (useful or absolutely useful), and 9.3% of participants replied with a 1 or 2 (of no or little use) (Fig. 2). The correlation test showed that perceptions of usefulness are significantly correlated with expectations regarding ethical issues/conflicts (r=0.360, p=0.000, two sides) and the importance of being ethical (r=0.291, p=0.001, two sides).

A weak correlation was discovered between two dependent variables – expectations of ethical issues/conflicts and the importance of being ethical – but of only marginal statistical significance (r=0.143, p=0.098, two sides).
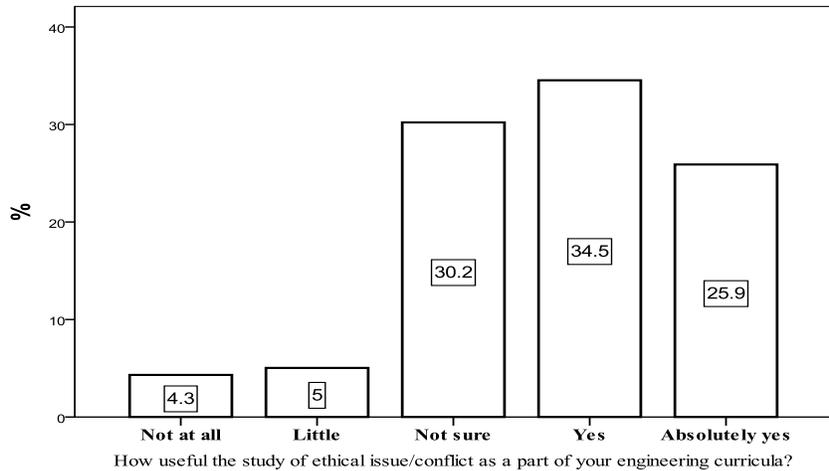

Figure 2

Finding 2: The extent of engineering ethics education was correlated with expectations of ethical issues/conflicts, but not with the perceived importance of being ethical.

Regarding the extent of engineering ethics education, 50.3% of participants replied with a 1 or a 2 (not at all or little), only 13.4% replied with a 4 or a 5 (yes or absolutely), and 36.2% replied with a 3 (felt unsure) (Fig. 3). The correlation test showed that the extent of engineering ethics education was significantly correlated with expectations of ethical issues/conflicts (r=0.225, p=0.008, two sides). However, no correlation was discovered between the extent of engineering ethics education and the importance of being ethical (r=0.125, p=0.151, two sides).

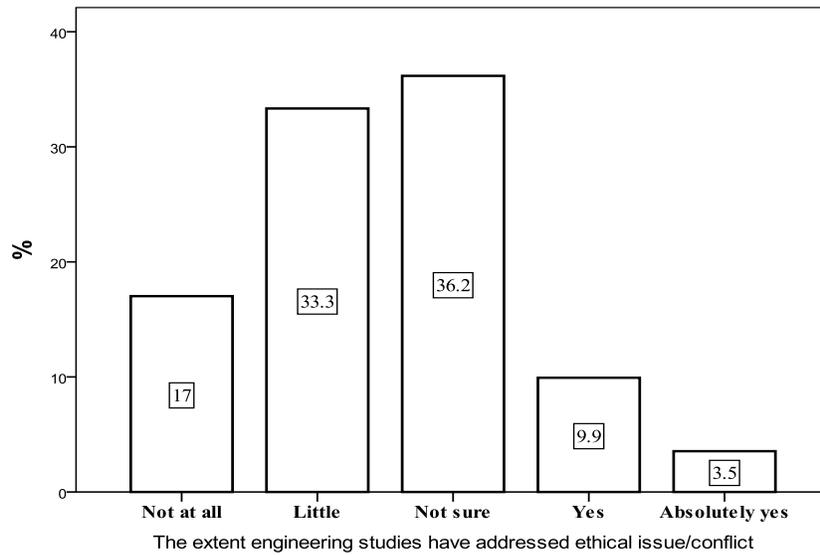The extent engineering studies have addressed ethical issue/conflict

Figure 3

Finding 3: Instructor performance was significantly correlated with the importance of being ethical, but only marginally correlated with expectations of ethical issues/conflicts.

73.8% of participants replied that their engineering instructors had said or done something that led them to believe instructors think ethics is *important* as an engineer (Fig 4). Instructor performance was significantly correlated with the importance of being ethical (r=0.322, p=0.000, two sides).

A weak correlation was discovered between instructor performance and expectations of ethical issues/conflicts, but of only marginal statistical significance (r=0.148, p=0.083, two sides).

Have you engineering instructors ever said or done anything that lead you to believe they think ethics is important as an engineer?
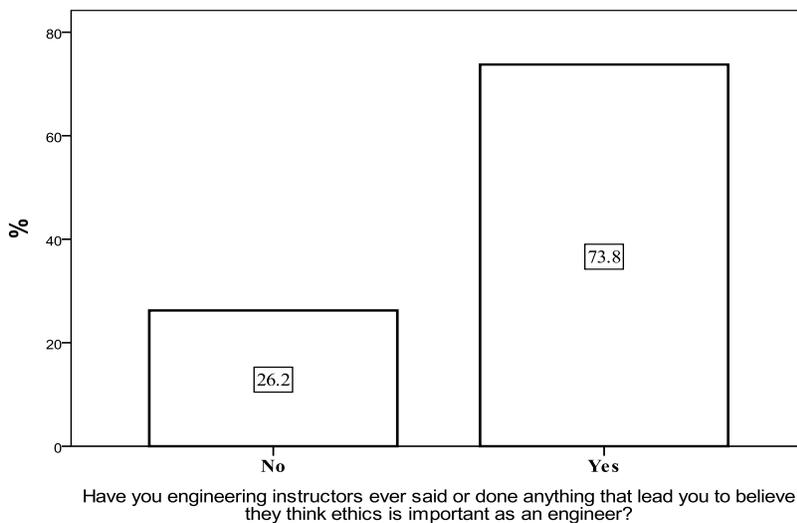
Figure 4

Finding 4:

No correlation was discovered between receiving the message there is more to being a good engineer than technical knowhow and either expectations of ethical issues/conflicts or the importance of being ethical.

Regarding the extent to which students felt they received this message, 36.5% of the participants replied with a 4 or a 5 (agree or strongly agree), 41.8% with a 3 (not sure), and 11.6% with a 1 or 2 (not at all or a little) (Fig 5). Tests failed to show that receiving such a message was correlated with either expectations of ethical issues/conflicts (r=0.034, p=0.695, two sides) or the importance of being ethical (r=0.080, p=0.358, two sides).

Figure 5
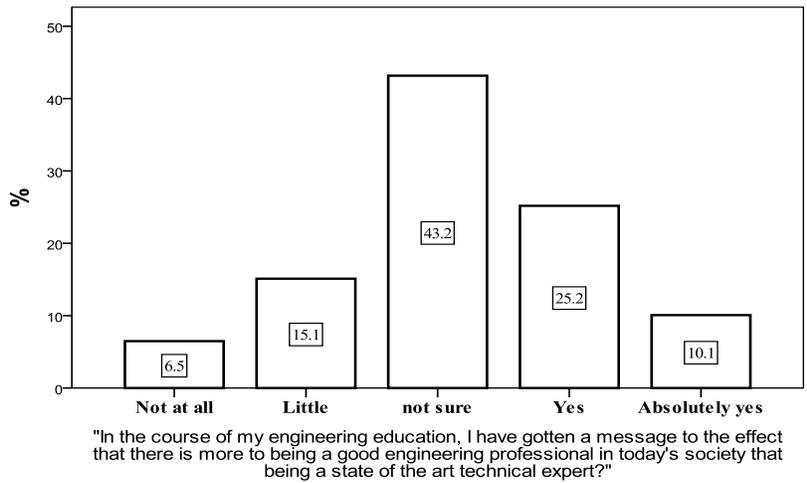
Finding 5: No significant impact was discovered between the sources of ethics/morals and expectations of ethical issues/conflicts.

With regard to the sources of ethics/morals, 41.1% of participants replied with parents and 21.3% with friends. Given that most of the participants identified as mainland Chinese, it is unsurprising that only 14.2% replied with religion (Fig. 6).
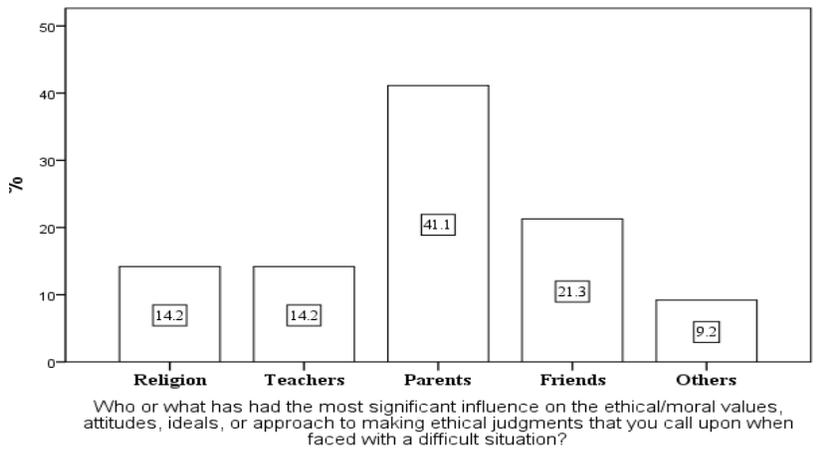

Figure 6

Although only 14.2% of participants replied with teachers as the sources of their ethics/morals, these participants were more likely to expect ethical issues/conflicts (replying with 4 or 5, yes or absolutely yes) than those who replied with another category (Table X). However, a Chi-square test failed to show the significant impact of the sources of ethics/morals on expectations of ethical issues/conflicts ($\chi2=18.007$, df=16, p=0.323, two sides).

Table X

			Will you face with ethical issue/conflict in working life?					
			Not at all	Little	Not sure	Yes	Absolutely yes	total
Who or what has had the most significant influence on the ethical/moral values, attitudes, ideals, or approach to making ethical judgments that you call upon when faced with a difficult situation?	Religion	count	0	6	7	4	3	20
		Exp. count	.1	3.2	6.0	5.3	5.3	20.0
	Teachers	count	0	0	5	9	6	20
		Exp. count	.1	3.2	6.0	5.3	5.3	20.0
	Parents	count	1	7	17	15	17	57
		Exp. count	.4	9.0	17.2	15.2	15.2	57.0
	Friends	count	0	6	11	7	5	29
		Exp. count	.2	4.6	8.8	7.7	7.7	29.0
	Others	count	0	3	2	2	6	13
		Exp. count	.1	2.1	3.9	3.5	3.5	13.0
Total		count	1	22	42	37	37	139
		Exp. count	1.0	22.0	42.0	37.0	37.0	139.0

Finding 6: No significant impact was discovered between the sources of ethics/morals and the importance of being ethical.

Again, however, although only 14.2% of participants replied with "teachers" as the sources of their ethics/morals, these participants were more likely to attach importance to being ethical (replying with 4 or 5, yes or absolutely yes) than those who replied with another category (Table XX). Those who replied with religion and other ranked second and third, respectively. Again, a Chi-square test failed to show the significant impact of the sources of ethics/morals on the importance of being ethical ($\chi2=11.583$, df=12, p=0.480, two sides).

Table XX

			How important do you think is to be ethical in your personal and professional life?				
			Little	Not sure	Yes	Absolutely yes	Total
Who or what has had the most significant influence on the ethical/moral values, attitudes, ideals, or approach to making ethical judgments that you call upon when faced with a difficult situation?	Religion	Count	1	2	3	12	18
		Exp. count	.5	2.3	5.5	9.7	18.0
	Teachers	Count	1	1	7	11	20
		Exp. count	.6	2.5	6.1	10.8	20.0
	Parents	Count	1	11	16	28	56
		Exp. count	1.7	7.1	17.0	30.3	56.0
	Friends	Count	0	3	12	14	29
		Exp. count	.9	3.7	8.8	15.7	29.0
	Others	Count	1	0	3	8	12
		Exp. count	.4	1.5	3.6	6.5	12.0
Total		Count	4	17	41	73	135
		Exp. count	4.0	17.0	41.0	73.0	135.0

Finding 7: No significant impact was discovered between experiences of ethical issues/conflicts and expectations of ethical issues/conflicts.

This is rather counterintuitive, but a Chi-square test suggests experiencing ethical issue/conflicts does not significantly impact expectations of ethical issues/conflicts ($\chi2=7.703$, df=8, p=0.460, two sides). More surprising, compared with participants who reported having experienced ethical issues/conflicts, those who replied "No" or "NA" were more likely to expect to be faced with ethical issues/conflicts, although the difference between the former and latter was not statistically significant (Table XXX).

Table XXX

			Will you face with ethical issue/conflict in working life?					
			Not at all	Little	Not sure	Yes	Absolutely yes	Total
Have you ever encountered an engineering-related deed, practice or policy that you considered morally questionable or wrong?	No	Count	1	2	5	8	8	24
		Exp. count	.2	3.8	7.1	6.4	6.4	24.0
	NA	Count	0	18	32	26	25	101
		Exp. count	.7	16.1	30.0	27.1	27.1	101.0
	Yes	Count	0	2	4	3	4	13
		Exp. count	.1	2.1	3.9	3.5	3.5	13.0
Total		Count	1	22	41	37	37	138
		Exp. count	1.0	22.0	41.0	37.0	37.0	138.0

Finding 8: No significant impact was discovered between experiences of ethical issues/conflicts and the importance of being ethical.

Participants who reported having experienced ethical issues/conflicts were less likely to perceive the importance of being ethical, while those who replied "No" or "NA" were more likely to perceive the importance of being ethical (Table XXXX). However, a Chi-square test failed to show that experiences of ethical issues/conflicts impacted the perceived importance of being ethical significantly ($\chi 2$ =10.540, df=6, p=0.104, two sides).

Table XXXX

			How important do you think is to be ethical in your personal and professional life?				
			Little	Not sure	Yes	Absolutely yes	Total
Have you ever encountered an engineering-related deed, practice or policy that you considered morally questionable or wrong?	No	Count	0	6	8	9	23
		Exp. count	.7	2.9	6.7	12.6	23.0
	NA	Count	4	8	29	59	100
		Exp. count	3.0	12.8	29.3	54.9	100.0
	Yes	Count	0	3	2	5	10
		Exp. count	.3	1.3	2.9	5.5	10.0
Total		Count	4	17	39	73	133
		Exp. count	4.0	17.0	39.0	73.0	133.0

Finding 9: Comparatively, the perceived usefulness of engineering ethics education is likely a powerful predictor of expectations of ethical issues/conflicts and perceived importance of being ethical.

To examine the predictive power of independent variables correlated with dependent variables, we administered a linear regression analysis and found that the 1. perceived usefulness of engineering ethics education can predict both dependent variables; 2. extent of engineering ethics education marginally predicts expectations of ethical issues/conflicts; 3. instructor performance predicts perceived importance of ethics.

However, the R^2 values in both regression models are smaller than 0.20, suggesting the models can only explain a very small proportion of variance in the independent variables (Tables XXXXX-1 and -2).

Table XXXXX-1

	Unstandardized Coefficient		Std. Coefficient	t	Sig.
	B	Std Error	Beta		
(Constant)	1.892	.419		4.511	.000
Usefulness	.388	.085	.379	4.548	.000
Extent	.145	.085	.139	1.710	.090
Performance 1 (Instructor)	.011	.100	.010	.115	.909
Performance 2 (Message)	-.019	.083	-.019	-.234	.815

a. Dependent variable: "On a scale of 1-5 (one being the least and five being the most), how likely do you think it is that you will be faced with ethical issues or conflicts during your working life as an engineer?"
b. R=0.420 R^2=0.176 Adj. R^2=0.151

Table XXXXX-2

	Unstandardized Coefficient		Std. Coefficient	t	Sig.
	B	Std Error	Beta		
(Constant)	3.311	.340		9.749	.000
Usefulness	.180	.069	.226	2.613	.010
Extent	.063	.073	.073	.863	.390
Performance 1 (Instructor)	.231	.081	.245	2.864	.005
Performance 2 (Message)	.035	.068	.043	.505	.614

a. Dependent variable: "On a scale of 1-5 (one being the least and five being the most), how important do you think it is to be ethical in your personal and professional life?"
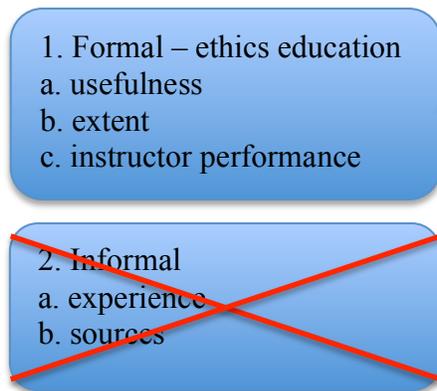b. R=0.392 R^2=0.154 Adj. R^2=0.126

Recommendations and discussion
The perceived usefulness of engineering ethics education seems to have the biggest impact on cultivating and maintaining an ethical frame, followed by the extent of previous ethics education and instructor performance. These findings support the importance of formal ethics education in general, as well as raising interesting questions regarding the impact of informal experiences with ethics and sources of moral beliefs.

Of the two groups of independent variables, those related to formal ethics education were positively correlated with independent variables related to ethical framing, whereas those related to informal sources of and experiences with ethics were not (Fig. 7).

Independent variables   **Dependent variables**

1. Formal – ethics education
a. usefulness
b. extent
c. instructor performance

1. Existence of ethical issues
2. Importance of being ethical

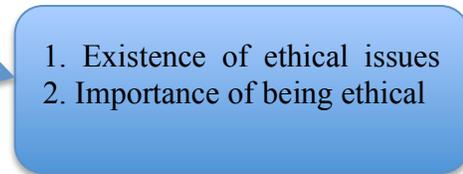2. Informal
a. experience
b. sources

Figure 7

The perceived usefulness and extent of ethics education, as well as instructor performance, were correlated with expectations of ethical issues/conflicts and the importance of being ethical, highlighting the importance of formal ethics education. On this basis, in addition to formal education in engineering ethics, we make two additional recommendations regarding the content and form of ethics education.

First, we recommend that ethics education highlight the usefulness or pragmatic value of ethics, rather than simply emphasizing the importance of being ethical as such. In addition to focusing on the negative consequences of acting immorally – for example, that one could get in trouble – curricula and instructors should highlight the positive consequences of acting ethically – for example, that one could be happier, praised, or make more money. Curricula could use classical case studies in aspirational ethics,[4] as well as creating new ones that focus on recent trends towards greater corporate social responsibility – for example, cases of "doing well by doing good." As we found no correlation between the extent of ethics education and the importance of being ethical, we would dissuade curricula from spending too much time emphasizing the importance of ethics in general or directly, and more time highlighting the usefulness or pragmatic value of ethics, ultimately emphasizing the importance of ethics but in a roundabout fashion.

Second, we recommend that engineering instructors be cognizant of their roles as ethical paragons, speaking and acting in ways that lead students to believe they think taking ethics seriously is important. This would consist in more than merely stating the importance of ethics, or that good engineering is more than technical knowhow. Rather, it is important that engineering instructors highlight their own commitments to ethics. When prompted to specify what instructors said or did, students mentioned the names of instructors considered ethical, prohibitions on plagiarism and cheating, and discussions of sustainability and integrity from other courses.

The fact no correlations were discovered between the second set of independent variables and the dependent variables raises questions regarding the impact of informal experiences of ethical issues/conflicts and sources of moral beliefs. If experiences of ethical issues/conflicts affect

expectations of ethical issues/conflicts, then one would expect to discover correlations between these experiences and expectations. However, no such correlations were discovered. This might be explained in terms of overexposure, where greater exposure to unethical behaviors and policies would lead to ethical fading.

Additionally, although no significant correlations were discovered between the sources of moral values and dependent variables related to ethical framing, those who responded with "teacher" as the source of their moral values were more likely to expect ethical issues/conflicts and perceive the importance of ethics. This finding would be worth investigating in greater detail, especially probing any social or cultural differences that might affect this relation.

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Appendix: Survey

1. Major field: _____

2. Yr: _____ (1 = Fr, 2 = So, 3 = Ju, 4 = Sr, 5 = Grad 1, 6 = Grad 2, 7 = Grad 3)

3. Nationality: _____

4. Gender: _____

5. On a scale of 1-5 (one being the least and five being the most), how likely do you think it is that you will be faced with ethical issues or conflicts during your working life as an engineer?

6. Which kind of issue or conflict do you think you are most likely to encounter?

Please circle one and only one.

A. Relation between human beings and technology

B. Unfair competition

C. Intellectual property

D. The environment

E. Quality/costs

F. Lack of experience/training/supervision

G. Dishonesty

H. User privacy

I. External pressures

J. Bribery

K. Other – please specify: _____

7. On a scale of 1-5 (one being the least and five being the most), rank the extent to which you feel your engineering studies have addressed ethical issues or conflicts that arise within engineering.

8. What kind of issue or conflict, in which course?

9. On a scale of 1-5 (one being the least and five being the most), rank how useful you think it might be to study such issues and conflicts as part of your engineering curricula.

10. As you see it, what makes an issue or a conflict an ethical one? In other words, how would you determine that an issue or conflict is one concerned with ethics rather than, for example, law, personal preference, etc.?

11. Who or what has had the most significant influence on the ethical/moral values, attitudes, ideals, or approach to making ethical judgments that you call upon when faced with a difficult situation? Please circle one and only one.

A. Religion

B. Teachers

C. Parents

D. Friends

E. Other – please specify: _____

12. Have your engineering instructors ever said or done anything that would lead you to believe they think ethics is *important* as an engineer? (Y/N)

13. What gave you that impression?

14. Have your engineering instructors ever said or done anything that would lead you to believe they think ethics is *unimportant* as an engineer? (Y/N)

15. If so, what gave you that impression?

16. On a scale of 1-5 (one being strongly disagree and five being strongly agree), rank the extent to which you agree with the following statement: "In the course of my engineering education, I have gotten a message to the effect that *there is more to being a good engineering professional*

in today's society than being a state-of-the-art technical expert?"

17. If you have been employed in an engineering-related position, e.g., in a summer job or internship, have you ever encountered an engineering-related deed, practice, or policy that you considered morally questionable or wrong? (If you have never had such a position, write "NA.") (Y/N/NA)

18. If you answered "Y" to #20, briefly describe what you encountered.

19. On a scale of 1-5 (one being the least and five being the most), how important do you think it is to be ethical in your personal and professional life?