A Survey of Engineers' and Engineering Students' Perceptions on Ethical Behavior

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Abstract
The engineering industry is known for its low ethical performance. Professional ethics instruction in Kenyan engineering faculties is commonly conducted by examining case studies in light of the code of ethics and conduct for engineers. Although the tenets of a code of ethics may leave a lasting impression, students generally gain their professional identity from relatives, colleagues, and practicing engineers. Their engineering professional ethics tend to be mostly an extension of their personal ethics. Instruction on ethics during training generally serves only to reinforce students' inclination to act ethically and encourages them to act on these beliefs. This study based on survey on engineering ethics adopted moral awareness which is one of the Rest's model four processes. The survey was conducted (n = 164) to examine the personal ethical perceptions of engineering students (n = 120, consisting of n = 79 for 1st year and n = 41 for 5th year) and practicing engineers (n = 44). The survey consisted of 16 acts that challenged respondents by examining their personal ethical beliefs in light of the professional ethics requirements of the Engineering Board of Kenya (EBK) code. The survey measured how respondents perceive their own ethical beliefs and how they perceive the ethical beliefs and actions of their peers. After familiarization with the EBK code, respondents were also invited to comment regarding their beliefs regarding adherence to the code. Results indicate that, although generally, engineers and engineering students sampled agreed that the acts listed down were unethical, several items raised concern. In particular, the item concerning "continuous professional development" was rated as one of the least unethical behaviors. This result points strongly to the need to further reinforce the need for relevant lifelong learning for engineers both during training and practice. Also, results indicated that there is evidence of self-versus-other disparity. For six unethical acts for students and four acts for engineers, in the surveyed list, the means of data for self and colleague perceptions were statistically significantly different at the alpha level of 0.05. When the act was perceived as more unethical, both engineers and students tended to rate themselves more ethical compared to their peers. Action research through mentorship is recommended as part of the solution to addressing ethical issues in engineering practice.

Keywords: identity, ethics, engineering practice, perceptions, student, professional, development

1. Introduction

The engineering community has experienced numerous scandals involving unethical and illegal engineering practices; many of them are committed by large and well-known engineering companies and government agencies (Bairaktarova and Woodcock, 2017). According to (Bowen et al., 2007), ethical and codes of conduct, bribery and corruption, and favoritism have a negative implication on engineering processes in any organization and may lead to decreased performance and service delivery. This occurs at a time when professional engineers have a personal and professional obligation to society to act ethically (Passino, 1998). To address the challenge, the Engineers Board of Kenya (EBK) has developed a code of conduct and ethics which forms the basis and framework for responsible professional practice in Kenya as it prescribes standards of conduct to be observed by all engineers. The code is based on broad tenets of truth, honesty, trustworthiness, respect for human life and welfare, fairness, openness, competence, accountability, engineering excellence, protection of the environment and sustainable development (EBK, 2016).

Development of ethical judgment skills in future engineers is a key competency for engineering schools as engineering ethics is part of the engineering thinking, identity, and professional practice of engineers (Harris et al., 1996). A study by (Loui, 2005) on ethical and moral development revealed that the greatest benefit of professional engineering ethics

education is to reinforce students' inclination to act ethically. Therefore, instruction on moral reasoning frameworks and professional codes of conduct to engineering students encourages them to act on the personal ethical and moral convictions already held (Stappenbelt, 2012). Naturally then, the question arises regarding the ethical inclination of engineering freshmen at the onset of their engineering education and what can be done to promote and encourage further personal ethical development as they progress with their studies and later when they start practicing in the industry after graduating. The present study is aimed to assess the personal ethical perceptions of engineering students and practicing engineers by examining their personal ethical beliefs in light of the professional ethics requirements of the EBK code.

2. Literature Review

Ethics is the philosophical discipline of studying what contributes good and bad conduct, including related actions and values (Barry, 1979). It is concerned with the nature of specific decisions made and the goodness or badness of those decisions in terms of the consequences of those decisions (Chonko, 1995). (Thompson, 2005) defines ethics as the study of right and wrong; of the moral choices, people make and how they seek to justify them. In the engineering industry, engineers are required to keep up with a fast-paced, constantly changing environment, which makes it even more important for engineers to be taught ethics and professionalism (Li and Fu, 2012). (Harris et al., 2013) mention that ethics education in engineering programmes is important in preparing the engineering undergraduate students - the future engineers - to carry out their duties professionally with a sense of responsibility towards society and the biosphere. Consequently, engineering ethics education has been made a compulsory subject as part of the conditions for accreditation in many countries. Despite its importance, ethics is not much investigated in engineering education (Sethy, 2017).

Engineering ethics is an important topic in the engineering education curriculum therefore 'professional ethics' is offered as a compulsory course to undergraduate engineering students in many countries including India and Kenya. In teaching engineering ethics courses, various pedagogical approaches have recorded a positive impact on students' attitudes towards ethics, opening up a new dimension in ethics education which highlights the importance of teaching strategies in developing the attitude towards engineering ethical issues (Balakrishnan et al., 2020). Therefore, it has been recommended that for engineering institutions to "strengthen their students' ethical development, they should consider tracking students' exposure to these issues, identifying where and how this learning takes place" (Colby and Sullivan, 2008).

Engineering solutions through design are humanity's way of facing the continuous stream of various global challenges (Barakat, 2015). Design shares a broadly common understanding of design ethics and that the main difference is in the scope, complexity, and the human interface. However, certain phases of the design process appear to prompt consideration of specific principles, students' interactions with users and project partners stimulating the most reflection on their ethical decision making (Humphries-Smth, 2014).

The present study adopts Rest's model that consists of four processes, namely moral awareness, moral judgment making ability, moral intention, and moral character (Rest, 1986). In this study, moral awareness process which is very important as it triggers one's thought and cognition before one makes judgment and act is considered. According to the model, in the awareness process, an individual generally has the ability to recognize that there is a moral issue in a situation, which serves as a kind of an activating mechanism that initiates the ethical decision-making process (Sparks and Merenski, 2000). Moral awareness involves an

individual undertaking role-taking, but the person must realize that violating some moral norm, or allowing unethical situations to occur, can "affect the needs, interest, welfare, and expectation of others". However, (Rest, 1986) asserts that not everyone can interpret situations or be sensitive to unethical situations. Thus, a disparity exists in how sensitive an individual is to a particular moral situation.

Codes of ethics are widely understood to act as a mechanism for facilitating and ensuring ethical behaviors within organizations (Yallop, 2012). Codes of ethics may be variously described as codes of conduct, codes of practice, ethical codes, corporate ethical codes, ethical guidelines, business conduct, codes of professional behavior, operating principles, and so on (Fisher, 2001), (Marnburg, 2000). Internationally, several studies stress the importance of codes of ethics as a necessary tool for creating and establishing an ethical environment within organizations (Ferrell and Skinner, 1988), (Hunt et al., 1984), (Oliver et al., 2005), (Schlegelmilch and Houston, 1989), (Segal and Giacobbe, 2007), (Ziegenfuss and Martinson, 2002). Therefore code of ethics develops standards by which a leader can judge the effects that different behavior has on one another (Hickman, 1998). In summary, ethics comes down to a choice to influence self and others in doing the right thing.

In the present study, survey was used to measure how three sets of participants (first year and final (fifth) year engineering students, and practicing engineers) perceive their own ethical beliefs and how they perceive the ethical beliefs and actions of their peers. And after familiarization with the EBK code, respondents were also invited to comment regarding their beliefs regarding adherence to the code.

3. Methods

This study used questionnaire to conduct survey on perception of personal ethical behaviour of engineers. A pilot survey involving 30 randomly sampled respondents was conducted to determine the effectiveness of the questionnaire in meeting the objectives of the study, and whether the questions selected represent personal ethical perception understudy, and to ascertain whether the target respondents could understand and interpret the questions easily. The respondents were requested to be honest when filling and were informed that they had the right to rescind their participation in the survey at any time and were assured of confidentiality of their answers, used for research purposes only. The obtained pilot survey results indicated that the questionnaire could assure validity, trustworthiness, and reliability of the results.

After the pilot survey was completed, the actual survey was conducted (n = 164) examining the personal ethical perception of the first year and fifth year Moi University, School of Engineering students, and practicing engineers. The students were all enrolled in respective courses during a semester where professional ethics was taught. The first sample response of 79 out of a population of 260 first-year students following the Introduction to Engineering Profession & Safety a common course offered in all the six engineering programs during the first semester of the 2019/2020 academic year was gathered. The second sample response of 41 out of a population of 45 fifth-year students following the Law, Ethics & Professional Practice course during the second and the final semester in the 2019/2020 academic year in the Civil and Structural Engineering program was gathered. In the fifth-year course case studies is one pedagogical approach used in delivery. The third sample response of 44 practicing engineers who attended a seminar on continuous professional development (CPD) was sampled from the Institution of Engineers of Kenya (IEK), western branch data base. The sample size of 164 respondents was adopted based on an estimated large population of 5,000

engineering students and practicing engineers in the IEK western branch, to allow the study to determine the personal ethical perception with a confidence interval of ±7.5%.

The questionnaire used was developed in Google Form (Kuczenski, 2013) and consisted of a list of sixteen acts that were developed by (Stappenbelt, 2012) by adopting a set of twelve from the study by (O'Clock and Okleshen, 1993). Whereby, respondents examined their personal ethical beliefs in light of the professional ethics requirements of the EBK code (EBK, 2016). The sixteen acts were as follows:

1. Accepting gifts or favours in exchange for preferential treatment
2. Undertaking work in an area that you are not competent
3. Passing blame for errors to an innocent colleague
4. Not supporting a colleague who is trying to do the right thing
5. Giving gifts or favours in exchange for preferential treatment
6. Claiming credit for someone else's work
7. Not reporting others' violation of organization policies
8. Divulging confidential information
9. Withholding relevant information from a colleague or client
10. Calling in sick to take a day off
11. Pilfering organization material and supplies
12. Doing personal business on organization time
13. Not keeping up to date with the latest developments in your area
14. Concealing one's errors
15. Taking extra personal time (lunch hour, breaks, early departure)
16. Using organization services for personal use

The survey measured how respondents perceive their own ethical beliefs and how they perceive the ethical beliefs and actions of their peers. In the survey, participants were to rank the sixteen unethical acts on a five-point Likert scale with (1) being very unethical and (5) not being unethical at all. The ranking, given in the list below, was both in terms of their personal beliefs and their perceptions towards the actions of their peers.

1. Very unethical
2. Basically unethical
3. Somewhat unethical
4. Not particularly unethical
5. Not at all unethical

After familiarization with the EBK code, respondents were also invited to comment regarding their beliefs in adherence to the code. Also, data relating to personal details were collected in the survey: age, gender, religion, and professional class.

The survey was presented to the three sets of respondents after a presentation and discussion of ethics in the classroom/seminar. The intentions of the study was first introduced to the students, they were then asked to respond anonymously, and were assured that the responses would only be taken en mass and could not affect their grades. The practicing engineers were briefed on the study after a seminar on CPD organized by IEK western branch held on 29th February 2020 in Eldoret, Kenya. The same survey that was set to receive only one response per respondent was given online via Google Form (Kuczenski, 2013) to the three sets of samples separately.

The respective student's class representative circulated the survey questionnaire through their respective class social media and e-mail platforms and the students had a maximum of two days after class to fill and submit the questioner online. The survey questionnaire was circulated to the practicing engineers using their respective e-mails captured during registration for attendance of the seminar. The procedure used ensured that all the respondents were surveyed anonymously with only time stamp information collected. Although the questionnaire consisted of many questions, every respondent participated willingly as the subject seemed to be of wide interest. However, a general limitation attributed to survey method used in this study is oversimplification of social reality, by an arbitrary design of the questionnaire and adopting multiple-choice questions with pre-conceived categories overly simple view of reality.

Data were summarized using means and standard deviation for continuous data while frequency and percentages were used for categorical data. The t-test was used to compare ratings between groups while ANOVA was used to compare ratings across the three groups.

4. Results and Discussions

4.1 Basic data

4.1.1 Gender of participants

The study had the participation of 79.9% (131) males and 20.1% (33) females (Table 1). Though the observations made from the responses indicate that engineering is still a male-dominated field, the proportion of females in Year 5 (26.8%) that responded is more than Year 1 (19.0%). This may indicate a moderate increase (7.8%) in persistence and active participation of female students in activities in undergraduate engineering programs in the recent years. However more need to be done to address the gender imbalance in engineering practice since the ratio is still lower than the recommended one third for either gender.

Table 1: Gender of participants per category

Participant Category	Male (N)	Male (%)	Female(N)	Female (%)
First year students	64	81.0	15	19.0
Fifth year students	30	73.2	11	26.8
Practicing engineers	37	84.1	7	15.9
Total	131	79.9	33	20.1

4.1.2 Age of participants

Table 2 shows the distribution of respondents by age for the three sets of participants.

Table 2: Age distribution of participants per category

Age of Participants (Years)	First-year students (%)	Fifth-year students (%)	Practicing engineers (%)
15 – 19	67.1		
20 – 24	31.6	70.8	
25 – 29	1.3	29.2	2.3
30 – 34			22.7
35 – 39			27.3
40 – 44			15.9
45 – 49			4.5
50 – 54			11.4
55 – 59			13.6
60 – 64			0.0
>=65			2.3

Two thirds (67.1%) of first-year students were older teenagers of age group 15-19 years, while the majority (70.8%) of fifth-year students were emerging adults of age group 20-24 years. On the other hand, half (50%) of the practicing engineers were adults aged between 30-39 years.

4.1.3 Recent ethical perception of Kenyans

The data for the survey question: *in the last 6–10 years in Kenya, have people in general become*; less ethical, remain the same or become more ethical, to the three sets of 164 participants is presented in Table 3. The IEK membership classes of practicing engineering participants consisted of Graduate Engineers (56.8%) and Corporate Members (43.2%).

Table 3: Engineers recent ethical perception of people in Kenya

Question*: in the last 6–10 years in Kenya have people in general*	First-year students		Fifth-year students		Practicing engineers		Total
	N	(%)	N	(%)	N	(%)	(%)
become less ethical	67	84.5	32	79.5	32	72.7	79.9
remain the same	1	1.9	5	11.4	7	15.9	7.9
become more ethical	11	13.6	4	9.1	5	11.4	12.2

Results indicate overall that perception of the majority (79.9%) indicated that people have become less ethical, 7.9% indicated that people have remained the same, and 12.2% indicated that people have become more ethical, however, 98% of the responses indicate that they are religious. This response is interesting given the religious inclination, because particular groups of people were not specified, just people in general, and it is not clear what might be driving this response. One possible reason could be an increase in ethics perception due to prevalence of similar issues in recent Kenyan media coverage or increased awareness due to ethics instruction after the lecture/presentation before this study was carried out.

4.2 Ethical awareness and conduct of participants

The results of the survey for the three sets of participants are presented in Figures 1, 2, and 3 for the three sets of participants self and their perception of colleagues' beliefs regarding unethical behavior. The mean ratings in the three Figures 1, 2, and 3 indicate that the participants generally understood all the sixteen acts or behaviors listed in the survey to be unethical to some degree ranging from very unethical, basically unethical, or somewhat unethical. The most unethical acts rated by the three sets of participants are six acts 1, 3, 5, 6, 8, 11 that they rated as very unethical. This was closely followed by nine acts 2, 4, 7, 9, 10, 12, 14, 15, 16 that they rated as basically unethical. The major difference in the results for the three sets of participants was in act 13: *not keeping up to date with the latest developments in your area*, where fifth-year students and practicing engineers both rated it least unethical (somewhat unethical) while the first year students rated the act basically unethical.

The rating of act 13: *not keeping up to date with the latest developments in your area* as the least unethical is somewhat disturbing. The rating of act 13 by the final year students and practicing engineers as the least unethical behavior is similar to the findings of (Stappenbelt, 2012) and this points strongly to the need to reinforce the relevant lifelong learning mainly in the final year of study before graduating from university and continuously during engineering practice in academia or the industry based on CPD policy (EBK, 2017). Demonstration of the dynamic nature of engineering knowledge through periodic review in the teaching curriculum will also alert the engineering students on the need to stay updated while in the industry. This is because, it is generally accepted that a person's ability to maintain high levels of

professional competence is achieved by continually upgrading his/her skills and knowledge (EBK, 2017).

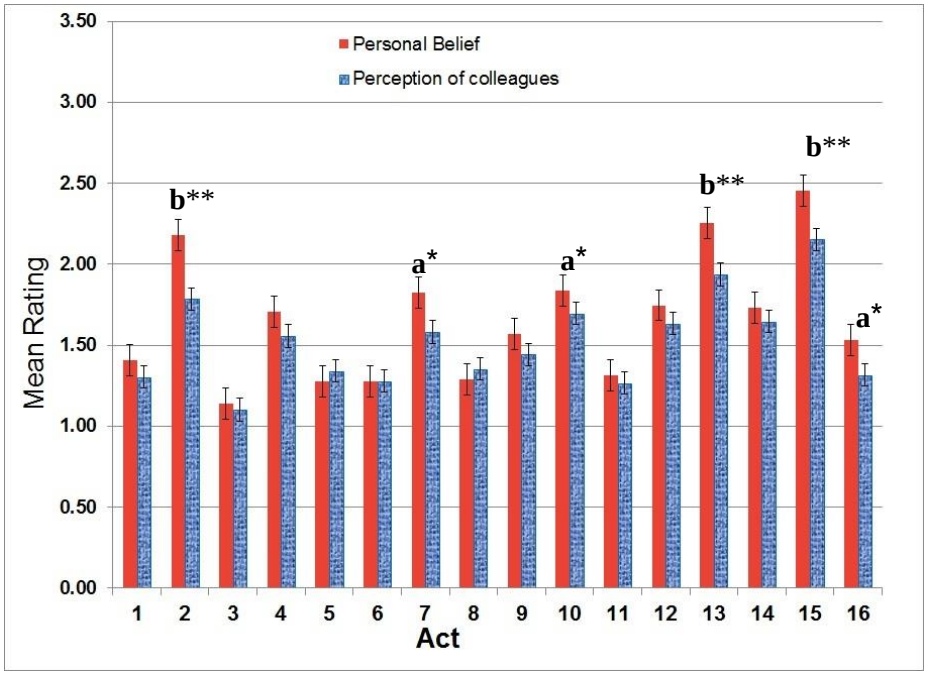

Figure 1: Mean rating of first-year engineering students' self and their perception of colleagues' beliefs regarding unethical behavior (statistically significant difference in means between self and colleague ethical perception rating a* at α=0.05 level; b** at α=0.005 level)

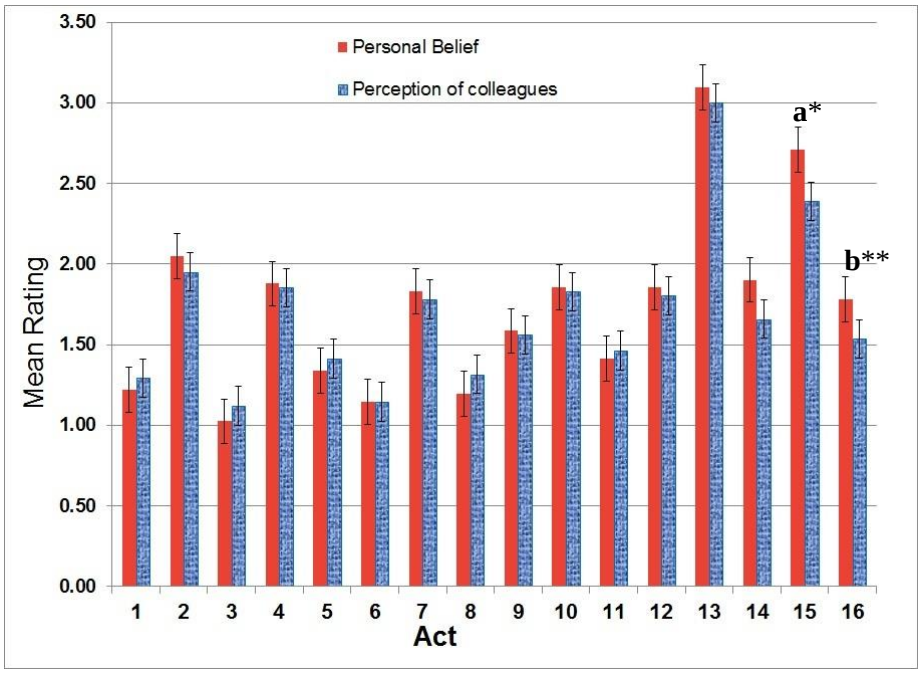

Figure 2: Mean rating of fifth-year engineering students' self and their perception of colleagues' beliefs regarding unethical behavior (statistically significant difference in means between self and colleague ethical perception rating a* at α=0.05 level; b** at α=0.005 level).

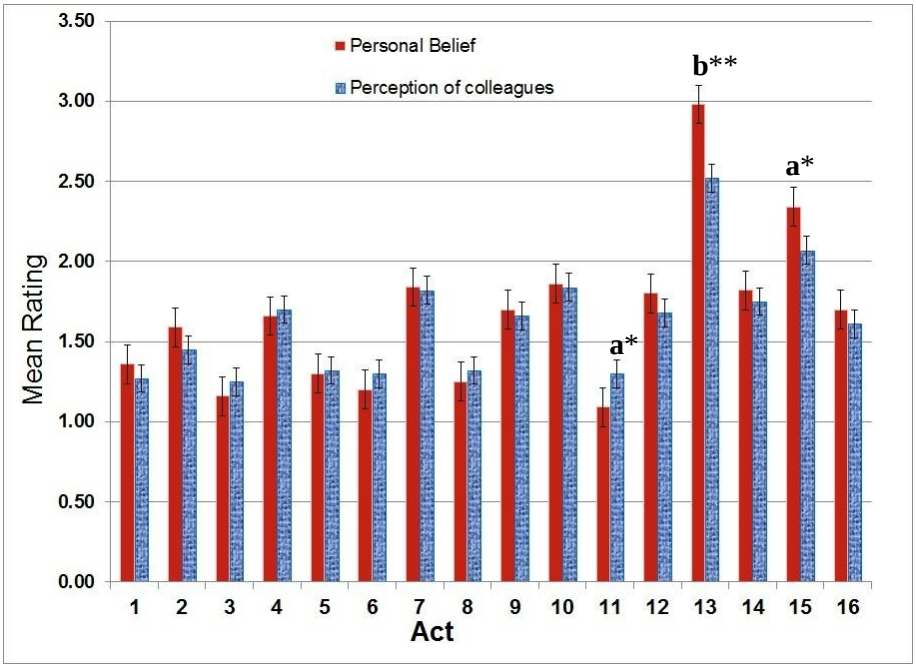

Figure 3: Mean rating of practicing engineers' self and their perception of colleagues' beliefs regarding unethical behavior (statistically significant difference in means between self and colleague ethical perception rating a* at α=0.05 level; b** at α=0.005 level)

From the comparison of data (Figures 1, 2, 3), for each of the three sets of participants self and their perception of colleagues' beliefs regarding unethical behavior, it is inferred that there is evidence of self-versus-colleague disparity. For three unethical acts (13, 15, and 16) in the survey list, the null hypothesis that the means of data for self and colleagues perceptions are statistically significantly different is accepted at the levels (α=0.005 and α=0.05) indicated in the three Figures 1, 2, and 3. Results indicate that when the act was perceived as more unethical, participants irrespective of their level tended to rate themselves consistently and significantly more ethical compared to their peers. This can be attributed to the fact that people generally view themselves as morally superior to others (Sezer et al., 2015).

We also compared the total scores from the 16 acts in the questionnaire by the three sets of groups as well as by personal beliefs versus perceptions of peers. This was done using a minimum total score of 16 for very unethical and a maximum of 80 for not at all unethical. We observed that the perception of own personal belief was not statistically significantly different from the perception of their peers ($\alpha > 0.05$). However, when we compared across the three groups there was a statistically significant difference in the scores for the perception of peers with scores higher among the fifth year students compared to the first year students and practicing engineers ($\alpha < 0.05$). The results are shown in Table 4.

Table 4: Comparison of total scores for the three sets of groups

	First-year	Fifth-year	Practicing engineers	Total	P-value*
Personal Beliefs	26.5 (7.9)	29.5 (6.8)	26.7 (5.8)	27.3 (7.2)	0.081
Perception of peers	24.4 (8.5)	28.7 (7.5)	25.9 (7.6)	25.9 (8.2)	0.023
P-value**	0.101	0.615	0.583		

* ANOVA by comparing by the three groups

** t-test by comparing personal versus peer perception

These results suggest that when students join an engineering program, they are very concerned with unethical issues among their peers compared to their final or fifth-year students. Overall there seems to be a consensus that unethical acts affect us in our day to day engineering practices and a lot need to be done to improve in ethical code of conduct as stipulated in EBK code of conduct.

The survey results for engineering participants' perception regarding adherence to the EBK code of conduct is presented in Table 5. The breakdown of responses to the question *Do you believe you always act in accordance with the tenets of the EBK code of conduct?* indicated that the majority of respondents (56% fifth-year students, and 79.5% practicing engineers) indicated Yes as a response. This is consistent with the personal ethical beliefs reported by the three sets of participants in this study.

More than half the number of fifth-year students (53.7%) and practicing engineers (52.3%) do not believe practicing engineers always act ethically is very worrying (Table 5). This result is similar to the earlier finding of the perception of the majority (79.9%) of participants in this study indicating that people have become less ethical in the recent past in Kenya. On a positive note, the majority of the fifth-year students (73.1%) and practicing engineers (86.4%) surveyed stated that they believe that professional engineers can realistically be expected to abide by the EBK code at all times. The awareness that has been created so far regarding abiding by the code of conduct needs to be stepped up starting from self-realization that the engineering profession will be better positioned in society and industry with ethical practices. Part of the solution to addressing these worrying results is providing mentorship to engineers based on action research, which is a values-based approach to researching one's professional work, contributing to the on-going development of the engineer and, potentially, the engineering industry. Through action research in engineering practice, it enables one to look at what they are doing from a critical point of view and reflect on how they do their work, to foster engineering professional growth.

Table 5: Engineers perception regarding adherence to EBK code of conduct

Question / Responses	Fifth-year students		Practicing engineers	
	N	(%)	N	(%)
Question: *Do you believe you always act in accordance with the tenets of the EBK code of conduct?*				
Yes	23	56.1	35	79.5
No	5	12.2	2	4.5
Unsure	13	31.7	7	15.9
Question: *Do you believe that most practicing engineers always abide by the EBK code of conduct?*				
Yes	10	24.3	10	22.7
No	22	53.7	23	52.3
Unsure	9	22.0	11	25.0
Question: *Do you believe that professional engineers can realistically be expected to abide at all times by the EBK code of conduct?*				
Yes	30	73.1	38	86.4
No	9	22.0	3	6.8
Unsure	2	4.9	3	6.8

5. Conclusions and Recommendations

The present study through a survey measured how three sets of respondents, first-year and fifth-year engineering students and practicing engineers; perceive their own ethical beliefs and how they perceive the ethical beliefs and actions of their peers. Although generally, the majority of participants sampled in this study agreed that people have become less ethical in the recent past in Kenya and that the acts listed in the study were unethical, the rating of the act *not keeping up to date with the latest developments in your area* as the least unethical raised major concern. It is concluded that there is a need to reinforce the relevant lifelong learning by incorporating action research using mentorship programs during engineering education in the university and continuously during engineering practice both in the academia and in the industry. Adopting action research in engineering practice will enable one to look at what they are doing from a critical point of view and reflect on how they do their work, to foster professional growth both in academia and engineering industry. The finding that half of both fifth-year students and practicing engineers do not believe practicing engineers always act ethically is of great concern. This suggests that action is urgently required in engineering ethics education and in shaping engineering students' professional identities and enforcement of the code of ethics by EBK. Results from the present study also indicated that when an act was perceived as more unethical, participants irrespective of their level tended to rate themselves more ethical compared to their peers. Specifically, for three unethical acts in the survey list namely, *not keeping up to date with the latest developments in engineering*, *taking extra personal time*, and *using organization services for personal use*, a notable statistical significant difference was observed between the ethical perception of the individual and their perception of their colleagues' beliefs. It is concluded that participants in this study rated themselves consistently and significantly more ethical than their peers. The findings from this study will be useful to the following institutions: EBK, IEK, Schools of Engineering, among others. The study recommends the need for engineering students and practicing engineers to be people of integrity to withstand the force to do the wrong. Further, there is a need to emphasize ethical lessons in engineering education and cultivate the change in attitude in practicing engineering. Areas for further research identified are on promoting professional identity and persistence in engineering.

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