

Freshmen Engineering Students' Perspectives on Engineering Ethics – A Qualitative Study

Shradha Binani¹

¹Department of Chemistry, Hyderabad Institute of Technology and Management, Hyderabad

shradhabinani88@gmail.com

Abstract: Engineering ethics is a vital topic in engineering education. Despite its importance, ethics is not much investigated in engineering education as compared to other disciplines. There is need to enhance understanding of undergraduate engineering student's outlook on ethics at well-established levels to help them appreciate its importance. The study explores the assessment of freshman engineering students' perception on engineering ethics by analyzing students' perceptions qualitatively. Engineering ethics applies to every engineer and is very important in professional career which will impact lives. An open-ended survey was designed which was distributed to 23 freshman engineering students. Analysis of the students' responses resulted in different themes: perceptions about ethics in engineering, ethical dilemma, role of ethics in engineering, morals and ethics, and training requirements on ethics. During the analysis the differences in students' responses by discipline and gender were particularly examined. Responses from participants of computer sciences and its applied discipline showed relatively more detailed explanation on ethical values compared to other disciplines. Male participants' responses were more elaborate and with better rationale than female participants. The output of this study will clarify undergraduate engineering students' understanding on engineering ethics which could be used as a reference in introducing some workshops, webinars, courses, etc. related to engineering ethics to help advance students' understanding.

Keywords: engineering ethics, freshman students, qualitative study

1. Introduction

Owing to rapidly changing technology and environment around, ethics is and should be the core of engineering. Engineering ethics is the field of moral principles that apply

to the practice of engineering. The field of ethics examines and sets the obligations by engineers to society, to their clients, and to the profession. Engineering ethics comes under the branch of applied ethics. Ethics as a course in engineering has increasingly drawn attention in the past decade and has ended in a field of research and teaching generally referred to as engineering ethics [1]. The field of engineering ethics has made significant progress over the past decade. A variety of strategies and methods of teaching engineering ethics have been researched and experimented [2].

The ethical decisions and moral values of an engineer need to be considered because the decisions of an engineer have an impact on the products and services - how safe they are to use, the company and its shareholders who believe in the goodwill of the company, the public and the society who trusts the company regarding the benefits of the people, the job and his/her moral responsibilities and about how the environment gets affected, etc. all the above shows positive influence of ethics in engineering [3].

On the contrary, the field of engineering has no doubt simplified our lives and marked some unmistakable achievements in human history, engineering failures due to ethics are not new. From the sinking of Titanic in 1912 to the Fukushima Daiichi nuclear disaster in 2011, engineering failures have been caused by problems in design, construction and safety protocol. The blame can often be laid at ignorance, miscommunications and, in some extreme cases, indifference or negligence. After many of these engineering disasters however, professionals and leaders have learned from the wrong ethical decisions that were made. Rest assured, all these tragedies have left the new generation of engineers more cautious than ever [4].

Engineering ethics in education exists through different enterprises like Universal human values (UHV) which is an initiative program taken by All India Council for Technical Education (AICTE) as faculty development programs [5], where faculties are trained rigorously for five days and aimed to have gained a lot of knowledge on ethical values which is further targeted to imbibe on students at freshman level by orientation program for around 21 days in all

Shradha Binani

Department of Chemistry, Hyderabad Institute of Technology and Management, Hyderabad

shradhabinani88@gmail.com

engineering colleges [5]. This exposure of training faculties under AICTE has created a buzz and people have started talking about human values in engineering education.

Decision making is an important part in ethics irrespective of the discipline or field. Some of the common examples of decision-making used in the engineering education which do not directly relate to ethics involve some sort of optimization techniques, which requires to eventually make decisions based on different attributes [6-11]. However, ethics in engineering is not as evidently present as other decision-making methods in engineering. A few exceptions include engineering ethics courses established by National Society for Professional Engineers, EiEE, Accreditation Board for Engineering and Technology (ABET), and at Texas A&M university where they address the need for ethics in the engineering curricula [12].

Engineering ethics is an old yet a fully unexplored field in Indian universities. The major reason that motivated the researcher to conduct this study was to understand the perceptions of engineering students about the concept and importance of engineering ethics. In this paper study the focus is mainly on understanding freshman students' perspective on role of ethics in engineering as guiding students at freshmen to follow ethical guidelines and monitoring it throughout their engineering degree program can help them practice ethics in engineering before they graduate and start their careers as professionals.

2. Literature Review

The supporting literature for this study explores the perception of ethics in engineering students in their engineering program. It is not easy to teach professional ethics or to motivate students towards the aspects of ethical values [13]. In many engineering curricula engineering ethics is not a mandatory course. However, engineering students are still expected to show that they are ethically and professionally grounded. ABET's engineering criteria 2007 requires engineering program exhibit that their graduates have a considerate professional and ethical responsibility but teaching engineering ethics is still not a high priority in engineering education [14].

Few researchers argues that engineering ethics should be an independent academic discipline or a stand-alone credit course in the semester which will discuss about discipline specific issues within undergraduate engineering course [15]. If the ethical lessons or modules are introduced in the first year, then students will have more time to practice before they graduate. [16] There could be many reasons such as lack of awareness of engineering ethics, lack of formal training to faculty on engineering ethics, unavailability of an expert in engineering ethics for guidance, being uninformed about the need of engineering ethics, being unclear about the process to be followed in engineering ethics to not incorporate engineering ethics in curriculum [17].

On the contrary, engineering ethics is now the subject of full-time study by numerous professional philosophers, social scientists, and other academics who research and write at the undergraduate or graduate level [18]. By

learning ethical values at undergraduate or graduate level there may be impact at professional level students' unethical actions could correlate to future professional engineers' misconduct [19]. According to [20] the study of the moral problems confronted by individuals and organizations involved in engineering ethics lack in proper delivery of content.

Few studies determine ethical dilemma in undergraduate students who are going to face ethical issues throughout their career. It is critical that they be prepared for these decisions. They must understand the impact their decisions have on the products or tools they are working on, the customer who buys the product, and their reputation as an engineer and as a person [21]. It is recommended to teach ethics for undergraduate students in four aspects of moral processes: awareness, judgment, intention, and behaviour [22]. It further explores the impact of gender and academic disciplines on these four moral processes and discussed about possible connection and other connections to perceptions of ethics involving gender, age, and engineering education. Codes of ethics can offer guidance in designing an engineering ethics education curriculum [23]. However, codes cannot substitute either for individual capabilities in solving ethical dilemmas or substitute for ethics education [24]. There is considerable agreement in the literature that the superior method for teaching engineering ethics is using case studies [25]. Case studies have been credited with introducing students to "the complexities and ambiguities of real-world ethical problems in an effective and memorable way" [26].

Despite these important advances, a critical gap still exists in perception of freshman students in engineering ethics and training requirements to produce the best possible ethical engineers in today's fast changing environment.

3. Methods

An open-ended survey was designed to collect data in this study. For conducting this survey, the important part was to know the process we needed to follow to come up with the appropriate interpretation. The researcher selected participants from the different disciplines to have a broader demographic variation. After collecting the data, the responses were assessed to evaluate the awareness in engineering ethics among freshmen engineering students and to come up with solutions to help students imbibe ethical values which will help them professionally in future. The data was analysed qualitatively.

Procedure

Firstly, a one-hour online session on basic definitions of engineering ethics based were explained to 23 participants. Then survey questions were designed, three participants were selected from nine discipline to provide feedback on the wording and the phrasing of the questions. The survey instrument was designed in Qualtrics and was administered via WhatsApp to the students. Students were asked to complete the survey in less than 48 hours and a reminder was sent after 24 hours.

Participants

Below is tabular format of 14 selected participants whose responses were recorded with pseudo names, gender, and discipline of targeted freshman students at the affiliated engineering college.

Table 1. Demographic information of participants

Sl.no.	Pseudo Name	Gender	Discipline
1	Myra	Female	Cyber Security
2	Yuvraj	Male	CSE
3	Aachman	Female	Cyber Security
4	Samay	Male	EEE
5	Malay	Male	CSE
6	Aarav	Male	Mechanical
7	Aahan	Male	CSE
8	Sarthak	Male	IOT
9	Krishna	Male	Data Science
10	Sarahana	Female	Data Science
11	Sanat	Male	CSE
12	Kushagra	Male	Mechanical
13	Aaradhya	Male	CSE
14	Dhruv	Male	CSE

4. Results and Analysis

In this section open-ended survey questions are presented as a qualitative data with the themes emerged from questionnaire. In addition to the description about the themes, the participants' perceptions/understanding about each of the themes is also included.

Theme 1: Perceptions about ethics in engineering

Ethics in engineering plays a crucial role and needs to be given adequate attention. According to participant Myra and Yuvraj, ethics in engineering is basically rules and standards which govern the conduct of engineers in their role as professionals. To maintain honesty and integrity in their professional dealings ethics is necessary. Ethics play a major role in engineering profession; it is an individual's decision which will reflect an engineer's personality/attitude from choosing between their own profit or customer satisfaction and how they can confront the issues and make right decision

"Ethics refers to the moral standard that an individual has to differentiate between right and wrong. Each person has their own ethical standards. Although we might not realize it, ethics plays an important role in almost every field. Some example might include having to choose either profits or quality in a product to be delivered to customers or copying a piece of code from someone else and not crediting them for your own benefit."(Myra).

"I believe the ethics in engineering arises with the discussion of money/ monetary funds, since any engineering project would need funds how an engineer uses these funds such that they can earn money and at

the same time deliver quality product is the question of ethics. As an example an engineer constructing buildings would need to buy materials such as cement, brick, iron rods etc. but at the same time they also need to earn money so the right balance between not over spending on the materials and at the same time making sure they don't buy poor quality materials are their ethics." (Yuvraj).

According to Aachman response, it reflects confusion among students about perception of understanding ethics in engineering.

It is a way in which we deal our situations in life after becoming engineering. (Aachman)

Basing on above analysis of about perceptions of ethics in engineering it is discussed that mostly participant's shown positive perception on ethics in engineering which will aim them to build a person having a high ethical conduct in their future profession.

Engineers shall hold paramount the safety, health and wellbeing of the community. This finding is in line concluded with study discussed on perception towards the importance of engineering ethics for their future profession and how engineering students perceive their own ethical beliefs and how they perceive the ethical beliefs and action of their peers [27,28].

Theme 2: Ethical dilemma

Ethical dilemma is one of the crucial parts of ethics which expresses conflicts between two different choices at same situations either to follow ethics/conscience or to follow law. Some participants explain ethical dilemma as, a situation in which a difficult choice must be made between two courses of action, either of which entails transgressing a moral principle. According to Samay and Malay they say that ethical dilemma usually takes place in a decision-making context where any of the available options requires the agent to violate or compromise on their ethical standards. A person has to choose between two choices; both are morally correct but in conflict with each other like either to see individual perspective or to follow company policies. Few participants' reaction to the contexts involving ethical dilemma is presented below.

.....Now, during present situation of corona due to economic losses all over the country. companies are in dilemma that to let the worker or employees work for free or should their remove some of the employees and gives the salary to only some people. Removing employee who are working for their company by gaining some profits or letting them work for free without paying is also wrong (Samay).

....For example, there is a project, whose lead and creator is absent on the day of its presentation. In such a situation, the subordinate takes over the duties to be carried ahead. And the subordinate has to chose between stealing all the credit and not stealing the credit.(Malay).

A few of the responses related to the question on ethical dilemma expressed that the participants were confused. For

example, Aarav still quoted some confusing statement regarding ethical dilemma so there is high need of attention in this area which will help them to take a better decision.

In my view ethical dilemma refers to actually person can manage many things based on only interestbut when he didn't manage both things at a time that is ethical dilemma that what I know and ex..helping father in work and not helping brother in studies at the same time(Aarav)

Basing on analysis of ethical dilemma it is concluded that there is increased level of human interrelationships, technical and ethical issues faced by future engineers. The factors that motivated the research participants towards engineering ethics were constantly in search of answers to problems that they encounter in professional life, enhancing students' decision-making capabilities in workplace and measuring its impact on society. This finding is in line supported that engineer face ethical dilemmas in every discipline [29]. Few authors even argue that much of that ethical instruction runs the risk of being only superficially effective so to overcome this ethical dilemma of both students and professionals need to be educated to respond ethically [30,31].

Theme 3: Role of ethics in engineering

Role of ethics in engineering is an age-old process whose improper knowledge leads to lack of disaster in past, so to overcome these circumstances every engineer should know the professional engineering ethics. Once students understand their role as engineers in future it is not only to provide good service but also to maintain it which means few ethical things must last till the end.

Participants Aahan and Sarthak quoted that in four years of engineering they wanted engineering ethics to be a part of curriculum in their undergraduate course and at least two hours weekly which will help them have in-depth knowledge of ethics and contribute towards public safety moving towards sustainable development and reflects the nature of mind of engineer. A proper understanding of ethics in engineering professional will impact thousand lives. Even few students are ready to be part of curriculum design with their own experiences. Precognizant ethics is a new approach that integrates ethics into technological development (add a reference here). The participants responses presented below show the major aspects of ethical values in their engineering curriculum to become better professional in future.

.....And every decision and action that is ethically right, will cause a positive change and development in the society which will take the world towards the new realm where everyone is equally attaining a sustainable development. Hence, engineering ethics plays a crucial role, in deciding the nature of mind of an engineer and hence, will influence the actions done by the engineer (Aahan).

.....As professional engineers, we are trusted with projects that impact the lives of hundreds of thousands of people. And so many people lives are in a engineer hands. If a civil engineer doesn't follow ethics and

construct a faulty designed apartment because of his profit then the people who are living in the apartment after construction then their lives are in danger. The stuff which we learn in 4 years may help us lead a luxurious life but we should need to learn what is ethics also in engineering to lead a happy life by giving our best (Sarthak).

The above analysis agrees with finding that role of ethics playing a major role in engineering education. The course was based on the assumptions that identifying major ethical issues in the discipline and analyzing them in the classroom [32]. The Canon of Ethics should be incorporated in the students from first day as a freshman until graduation day that is the reason many firms today are placing the ability to make ethical decisions in the real world first and foremost on their lists of desired qualifications for new hires [33].

Theme 4: Morals and ethics

Morals and ethics play a major role in shaping up an engineer student in their undergraduate program. Morals and ethics are very close conceptually where usually students get misguided with the terms. Moral means a set of principle followed in a group and ethics it is an individual set of behavior.

According to responses of participants Krishna, Sarahana and Sanat it can be inferred that here is some sort of confusion in their understanding between ethics and morals and how to apply it in a situation, whereas one participant had understood difference between both but was unable to apply it to a context.

Ethics is something that someone can take the decisions based upon individual character. Whereas moral is something that the decision has to be taken in a group based on the topics and considering other decisions then thinking the advantages and disadvantages then we need to take a decision (Krishna).

.....As an example it is considered morally good to not interrupt adults when they talk that is an ideal set by society but my own ethics of interrupting people when are saying things that I consider wrong irrespective of their age is my ethics (Sanat).

Moral is something you follow within our team and ethics is followed with people from other company (Sarahana).

Basing on analysis of difference between morals and ethics it is argued that moral notions and practices inevitably must be influenced by teaching engineering ethics. Objective of teaching engineering ethics course at freshman level must imbibe both morals and ethical values. By getting knowledge of this they will understand how to resolve moral issues in their profession and how to act ethical in varied situations. It is intended to develop a set of beliefs, attitudes, and habits that engineers should display concerning morals and ethics to the society. it is proposed to include pedagogical techniques in teaching and learning process that may foster, understanding of morals and ethics in students' mentality that develop various attributes and skills necessary for success in engineering education [34].

Theme 5: Training requirements on ethics

It is an urgent need of training on ethics in engineering education and to uncover themselves from these values which will help them to be a better individual in their profession. According to participants Kushagra, Aaradhya and Hitrath it is suggested that training of ethics should be given from the primary education where their mind gets fertile with ethical values which will ultimately help for betterment of their future endeavor and help them to think ethically at times of decision making ultimately affecting quality of service they provide. Some participants' responses indicated that they misinterpret ethics with philosophical study.

Yah (yes) from children in the school onwards it should be developing in mind....thinking by himself... A teacher can do it when tree is in seed position itself (Kushagra).

Ethics I feel develop over a time so I would like to actually study philosophy because it is out of the study of various ideas and ideals that one would derive their own set of ideas and ideals which would later accumulate into their ethics so, yes I believe in the study of ethics but I believe the path of teaching to ethics is through the aid of philosophy unless there is another way (Aaradhya).

Yes of course. We should, because we all land on jobs and we will be able to withstand obstacles in our workspace and real life with ethics. We should learn those keeping morals also in mind give the best solution to any obstacle, we must also pass on these ethics to future generations or else the workspace will be in chaos, because there are no proper guidelines to hold them back from doing something wrong, without themselves knowing the outcome (Dhruv).

Based on the students' responses in this study it was found that the students were few students have some level of understanding and few students are confused about engineering ethics. Overall, there was lot of confusion in the student responses stated by most of the participants and this calls for some sort of training requirement on the concepts related to engineering ethics. While most of the engineering students have basic knowledge of ethical principles, they just need more practice to understand and deal with the complex and subtle problems of professional responsibility in engineering before they encounter ethical problems in the real engineering world [35].

To deal with students' confusion related to engineering ethics, it can be stated that students in four years of engineering education need to undergo training on ethics program for developing a standard of ethical conduct in their professional behaviour. Some participants also pointed need for students to learn values and services contributed by engineers like honesty, impartiality, fairness, and equity of their discipline which will be committed for the protection of public health, safety, and welfare.

Training requirements on ethics will be focused to develop moral reasoning and increasing ethical awareness within engineering profession. In addition, engineers shall act with

zero-tolerance for bribery, fraud, and corruption in all engineering fields. A study [36] suggested that proper pedagogical approaches with appropriate assessments for training students on ethics should be provided to students. Besides that, students preparing to function within the engineering profession need to be introduced to the basic issues in engineering ethics. One of the ideals for engineers is to always keep their knowledge and skills up to date

It was observed that open-ended survey questions helped students to understand the importance of engineering ethics which will help them to take well-informed decisions. For author, it created awareness in area of engineering ethics which had a direct impact on establishing relevance to the research work by identifying the gap in the research topic.

Further, to understand students' responses effectively additionally five extracurricular survey questions were inclined to further understand students' opinions about specific formats of knowledge sharing events related to engineering ethics. The following survey was given to participants, and they were asked to rate from 1-5 to know how they likely they would actively engage in engineering ethics programs like (a) annual lecture on ethics (b) ethics students club (c) quarterly short-term program on ethics (d) pizza and principle meeting twice a month (e) annual symposium.

From the survey results, it was observed that ethics student club, pizza, and principle meeting twice a month and annual symposium are of major interest to students where they strongly agree with these three aspects. Thus, including above extracurricular activity in curriculum/course will help students to discuss about their perceptions of ethics in engineering and how training on these aspects will help them build a better professionalism at workplace.

Few demographic variations were observed, for example, the trend in engineering discipline like core engineering discipline students show less tendency of expressing their views towards ethical values. In precise, mechanical and electrical and electronics engineering students' participations and approach towards these concepts seem to be minimum when compared to students of computer science engineering disciplines. Based on these observations, it is suggested that deeper analysis and survey of students from specific branches will be required for justifying the above trend.

Findings also suggested some differences in the ways male and female students perceived the ethical understanding and awareness. Overall, the survey analysis reveals that male students seem to have expressed better ethical values in comparison to female students which are similar to the findings reported in [37], where the findings showcase that female student seem to have lower ethical perceptions in comparison to male students on perceiving the ethical roles and responsibilities. On the contradictory [38] in another study, it was statistically proven that female students had higher ethical values than males.

However, engineering ethics as a course in affiliated colleges in India has been shown lesser extent of

importance. Thus, present study helped to address gap to understand freshman students' perceptions of ethics in engineering education. The author believes that ethics in engineering should be given serious consideration in engineering courses which ultimately will have vital impact on the decisions and actions of students now and in future.

5. Implications and Recommendations

By collecting and analysing student responses from the open-ended survey questions, the author suggests that ethics in engineering can indeed be taught and will have a strong impact on students' personal beliefs and behaviours. The author further recommends that firstly at institutional level engineering ethics must be treated in par with engineering core subjects in all possible ways to attract more students' interest in engineering ethics. Second, there must be some local and national webinars for engineering ethics in affiliated/deemed/autonomous colleges in India so that ethical values in engineering will reach to a broader audience and will eventually help build a robust community of faculties who train student's basic ethical values to lead a good professional career which ultimately benefits society at large. Ultimately, the author recommends that there is a full scope for integrating ethics in engineering curriculum either as a core or as an elective course.

After conducting this study, it is highly recommended to have strong ethical values at organizational level, so that every individual may be students/faculties must feel the essence of ethical environment they are living in and transform their thinking and behaviour by stopping all malpractices like allowing students to cheat, leaking of assessment items, and giving attendance without attending classes. Hence, it is recommended to imbibe ethics to the core from organizational level to freshman student level which can be achieved by prioritizing the teaching and learning of ethics in their curricula or program.

6. Conclusions

In this study the author concludes that ethics in engineering should be a vital part of engineering education curriculum. The survey analysis played an integral role in understanding freshman students' perspectives on ethics in engineering education. Where ethics in four years of engineering can be introduced by extracurricular activity in curriculum which will help students to discuss about major role of ethics in engineering and how training on these aspects will help them build a better professional at workplace. The students' responses fall under the category ethical egoism or the utilitarianism theory [38].

Freshman engineering students need to be taught how to make a value decision, understand what is ethically important, and assess the impact of their actions which is in support of AICTE initiative taken to train faculty on UHV and to inculcate these values at freshman engineering level. Overall, the agenda of the UHV initiative is aligned with incorporating ethical values at freshman level in engineering education.

7. Future Work

While the current research provides a macro view of how freshman engineering college students perceived ethics on campus, future research will focus on a more in-depth examination of the differences in their perception associated with participants gender, academic discipline, and freshman student perception from different affiliated, autonomous, and deemed colleges. Future research would even involve students quantitative survey to collect data from the students of all the four years of engineering and their ethical perspective in engineering education which will help to better understand how to incorporate ethics in curriculum [39-41]. Further research will be carried out by conducting qualitative interviews that can be designed to investigate deeper understandings and perceptions of ethics in engineering [41-44]. Lastly, qualitative research studies can also be conducted to investigate the perceptions / opinions of the faculty members perspectives on engineering ethics. Concept assessment tools can also be created and used to assess students' understanding and knowledge in applying their learnings related to engineering ethics under different circumstances [45-48].

Acknowledgement

The author would like to thank the HITAM for their continuous support in helping complete this study without any inconvenience. The author would also like to acknowledge the students for sincerely completing the survey.

References

1. Herkert, J. R. (2005). Ways of thinking about and teaching ethical problem solving: Microethics and macroethics in engineering. *Science and Engineering Ethics*, 11(3), 373-385.
2. Arenberg, C. R., & Hollander, R. (Eds.). (2009). *Ethics Education and Scientific and Engineering Research: What's Been Learned? What Should Be Done? Summary of a Workshop*. National Academies Press.
3. https://www.tutorialspoint.Com/engineering_ethics/engineering_ethics_quick_guide.htm
4. <https://onlineengineering.case.edu/blog/disastrous-engineering-failures-due-to-ethics>
5. <https://fdp-si.aicte-india.org/>
6. Kittur, J., Pavankumar, M. P., Reddy, P., & Patil, P. R. (2016, January). Optimal generation evaluation by topsis method. In *2016 Biennial International Conference on Power and Energy Systems: Towards Sustainable Energy (PESTSE)* (pp. 1-5). IEEE.
7. Kittur, J., Vijaykumar, S., Bellubbi, V. P., Vishal, P., & Shankara, M. G. (2015, October). Comparison of different MCDM techniques used to evaluate optimal generation. In *2015 international conference on applied and theoretical computing and communication technology (iCATccT)* (pp. 172-177). IEEE.
8. Kittur, J., & Kavale, S. M. (2016). Teaching Decision Making Method in Engineering Exploration Course—An Experience. *Journal of Engineering Education Transformations*.

9. Kittur, J. (2015, August). Using the PROMETHEE and TOPSIS multi-criteria decision making method to evaluate optimal generation. In 2015 International Conference on Power and Advanced Control Engineering (ICPACE) (pp. 80-85). IEEE.
10. Kittur, J., Poornanand, C., Prajwal, R., Pavan, R. P., Pavankumar, M. P., Vishal, P., ... & Jagadish, B. (2015, March). Evaluating optimal generation using different multi-criteria decision making methods. In 2015 International Conference on Circuits, Power and Computing Technologies [ICCPCT-2015] (pp. 1-5). IEEE.
11. Kittur, J., Pavankumar, M. P., Reddy, P., & Patil, P. R. (2016, January). Optimal generation evaluation by topsis method. In 2016 Biennial International Conference on Power and Energy Systems: Towards Sustainable Energy (PESTSE) (pp. 1-5). IEEE.
12. Rodzalan, S. A., & Saat, M. M. (2016). Ethics of undergraduate students: A study in Malaysian public universities. *International Journal of Information and Education Technology*, 6(9), 672.
13. Bairaktarova, D., Evangelou, D., Woodcock, A., & Graziano, W. (2012). The role of personality factors in engineering students ethical decisions. *Ethics*, 23, 26.
14. Yehia a. Khulief (2008) Ethics education for Engineering Students Conference: 2nd Conference on Planning & Development of Education & Scientific Research, 1,1-9
15. V. Weil, "The rise of engineering ethics," *Technology in Society*, vol. 6, pp. 341-345, 1984.
16. Holsapple et al. (2012) Framing faculty and student discrepancies in engineering ethics education delivery, *Journal of engineering education* ,101 (2) ,169-186.
17. Diana Bairaktarova & Anna Woodcock(2017) Engineering Student's Ethical Awareness and Behavior: A New Motivational Model, *Science and Engineering Ethics* , 23, 1129–1157
18. D. G. (2010). The role of ethics in science and engineering. *Trends in Biotechnology*, 28(12), 589-590.
20. Mitcham, C., & Englehardt, E. E. (2019). Ethics across the curriculum: Prospects for broader (and deeper) teaching and learning in research and engineering ethics. *Science and Engineering Ethics*, 25(6), 1735- 1762.
21. Unger, S. H. (2005). How best to inject ethics into an engineering curriculum with a required course. *The International Journal of Engineering Education*, 21(3), 373-77.
22. Chowdhury, M. (2018). Emphasizing morals, values, ethics, and character education in science education and science teaching. *MOJES: Malaysian Online Journal of Educational Sciences*, 4(2), 1-16.
23. Colby, A., & Sullivan, W. M. (2008). Ethics teaching in undergraduate engineering education. *Journal of Engineering Education*, 97(3), 327-338.
24. Bucciarelli, M., Khemlani, S., & Johnson-Laird, P. N. (2008). The psychology of moral reasoning. *Judgment and Decision making*, 3(2), 121.
25. Lovrin, N., & VRCAN, Ž. (2009). Some considerations about engineering ethics. *Strojarstvo: časopis za teoriju i praksu u strojarstvu*, 51(3), 239- 248.
26. Kittur, J. (2016). Implementation of Student-Team-Achievement-Divisions Activity and Flipped Classroom to Enhance Student Learning. *Journal of Engineering Education Transformations*.
27. Crew Jr, R. E., & Anderson, M. R. (2018). The 2014 Elections in Florida: The Last Gasp from the 2012 Elections. Rowman & Littlefield.
28. Clancy, R. F. (2020). The ethical education and perspectives of chinese engineering students: A preliminary investigation and recommendations. *Science and engineering ethics*, 26(4), 1935-1965.
29. Starrett, S. (2013). Mentoring Recent Graduates on Tweaking Software Activity. *Leadership and Management in Engineering*, 13(3), 224-225.
30. Nudelman, G., & English, J. (2019). Ethical dilemmas experienced by engineering students during their vacation work. *Journal of Professional Issues in Engineering Education and Practice*, 145(2), 05019001.
31. Teer, F., & Kruck, S. (2012). Students' Responses to Ethical Dilemmas in an Academic Setting and in the Work Place. *Information Systems Education Journal*, 10(4), 4.
32. Bowden, P. (2010). Teaching ethics to engineers—a research-based perspective. *European Journal of Engineering Education*, 35(5), 563-572.
33. Jon E. Freckleton, P.E(1997),Case studies in engineering ethics,1997 Annual conference,10.18260/1-2-6440
34. Binani, S., & Chowdary, R. (2018). Enhancement of learning levels in engineering chemistry through effective use of tutorials. *Journal of Engineering Education Transformations*, 32(1), 31-36.
35. Kittur, J. (2018). Applying the General Analysis Procedure in Solving an Engineering Problem-An Assessment. *Journal of Engineering Education Transformations*.
36. Newberry, B. (2004). The dilemma of ethics in engineering education. *Science and Engineering Ethics*, 10(2), 343-351.
37. Baruah, B., Atesh, M., & Ward, T. (2017). A new framework for measuring the ethical awareness and perception among engineering students in Higher Education. In *Conference Proceedings. New Perspectives in Science Education* (p. 352). *libreriauniversitaria. it Edizioni*.
38. Xenos, M., & Velli, V. (2018, September). A serious game for introducing software engineering ethics to university students. In *International Conference on Interactive Collaborative Learning* (pp. 579-588). Springer, Cham.
39. Kittur, J. (2020). Measuring the programming self-efficacy of Electrical and Electronics Engineering students. *IEEE Transactions on Education*, 63(3), 216-223.
40. Kittur, J., & Brunhaver, S. R. (2020, June). Developing an Instrument to Measure Engineering Education Research Self-Efficacy. In 2020 ASEE Virtual Annual Conference Content Access.

41. McNabb, D. E. (2020). Research methods for political science: quantitative, qualitative and mixed method approaches. Routledge.
42. Kittur, J., Coley, B. C., & Kellam, N. N. (2020, June). Understanding how Novice Indian Faculty Engage in Engineering Education Research. In 2020 ASEE Virtual Annual Conference Content Access.
43. Kittur, J., Karway, G. K., Alrajhi, M. Z., Nelson, B. C., & Shin, S. (2021, July). Curriculum Design: Using the Five Discourses of Design Thinking. In 2021 ASEE Virtual Annual Conference Content Access.
44. Borrego, M., Douglas, E. P., & Amelink, C. T. (2009). Quantitative, qualitative, and mixed research methods in engineering education. *Journal of Engineering education*, 98(1), 53-66.
45. Lemunyon, J., & Gilbert, R. G. (1993). The concept and need for a phosphorus assessment tool. *Journal of production agriculture*, 6(4), 483-486.
46. Sachan, A., Bhadri, G. N., & Kittur, J. (2019). Design and Development of Concept Assessment Tool (CAT): A Concept Inventory. *Journal of Engineering Education Transformations*, 33(1), 16-21.
47. Ruiz-Primo, M. A. (2004). Examining concept maps as an assessment tool.
48. Won, M., Krabbe, H., Ley, S. L., Treagust, D. F., & Fischer, H. E. (2017). Science teachers' use of a concept map marking guide as a formative assessment tool for the concept of energy. *Educational Assessment*, 22(2), 95-110.

Appendix – Survey Questions

The following were the five open-ended questions asked in the survey in addition to the demographic information.

1. What do you know about ethics in engineering? Explain. Feel free to include examples.
2. What in your opinion about ethical dilemma? Explain with an example.
3. In your opinion, what is the role of ethics in engineering? Explain.
4. Explain with examples the difference between moral and ethics.
5. Should ethics be studied? Explain.