ENGINEERING ETHICS: DECISION MAKING USING FUNDAMENTAL CANONS

Preethi Baligar[1], Gopalkrishna Joshi[2]

[1,2]Centre for Engineering Education Research, KLE Technological University, Hubballi, India
[1]preethi.b@bvb.edu
[2]ghjoshi@bvb.edu

Abstract: An engineering professional's work demands that the technological solutions designed to solve practical problems of society are addressing the safety, health and welfare of the public. An engineer thus works in an environment where equally competing considerations for different stakeholders need to be accounted for before providing uncompromised solutions. In such a professionally obligatory setting, ethical dilemmas come into foreplay which will decide the course of action which the problem solver will seek to take. However, the ethical problems are ill-structured and lack a set of prescriptive and enumerable solutions. Thus, the professionals need to be trained in exploring the solution space of problems related to engineering ethics during their formative four years. An aim to achieve this will require engineering educators to include of the principles of Engineering Ethics is the curriculum.

The objective of this paper is to explore the existing solution space for the curriculum design, content and assessment of ethics instruction. It also presents the approach followed in designing a module on Engineering Ethics in an introductory freshman course in our university. We have designed an assessment in which the students are required to provide a resolution to the ethical dilemma by basing their decision on fundamental canons of National Society of Professional Engineers (NSPE). From the results we conclude that students are able to identify and resolve ethical dilemmas which lie in the domain of public welfare, health and safety more than the others.

Keywords: Ethics, Morals, Case study, ethical dilemma, Freshman,

I. INTRODUCTION

The nature of an engineer's work consists of in providing solutions to ill structured engineering problems, the solutions of which affect the society, both with its direct altruistic benefits and its unintended detrimental consequences of the future. An engineer can never be certainly sure about the impact a solution will have on all stakeholders. Thus, to a large extent, an engineer's job is to manage the unknown (Fleddermann, 2008). Thus, during the formative years, engineering education must contribute to the development of professionals who can face new and difficult engineering situations with imagination and competence (Shuman et al, 2005). A landmark development in Engineering education came in the form of the ABET criteria (ABET, 2012) which provided a prescriptive framework of twelve competencies, six of which relate to professional skills. One among those professional competencies is related to engineering ethics which states that the students must be able to apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice. Apart from this extrinsic rationale, the intrinsic justification for addressing ethics education in engineering curriculum is the ubiquity of ethical issues in its core. Throughout their careers engineers will encounter ethical problems which affect the quality of the solutions; impacting the health, welfare and safety of public at large and affecting business practices (Fleddermann, 2008). (Colby et al 2008) argue that ethical, technical and "professional" competencies are the drivers of high quality engineering work without any gap between ethical competency and other competencies. Projecting this thought as an intrinsic need to include the ethics instruction in the undergraduate curriculum, the aim of this paper is to provide syntheses for the need for ethics instruction, its goals and objectives, the content and the pedagogical practises followed in engaging the students and the possible assessment strategies. Further on, the authors describe an attempt to introduce engineering ethics in a freshman course. We describe its revisions though three iterations and along with is assessment strategy.

A. Nature of Engineering ethics Problems

Engineering practitioners through their solutions are obligated to different stakeholders like the public, the employers, the fellow professionals and the professional association. Adding to this, due to the complexity of the technological solutions which they provide to solve the practical problems, we cannot exhaustively predict the impact (present as well future) of solutions on the stakeholders. Thus, the cross-obligatory nature of this profession which is centred on the technological solution and the inability to foresee all consequences leads to ethical dilemmas.

A complicating characteristic of the problems which engineers solve is that they are "wicked", "ill-structured" or "fractious" which is described as those which do not have a set of solutions which are systematically and exhaustively enumerable. More importantly, the "rightness" of the solutions depends on the standpoint of the stakeholders.

The solutions which when implemented can also set into action a wave of "unintended" consequences which outweigh the positive effects. It is in such problems and their underlying solutions that ethical dilemmas arise and the students must be equipped to resolve them (Hoffmann, & Borenstein, 2014). Research speaks about different types of problems, troubleshooting, decision making, design, dilemmas and engineering ethics problems are categorised as either decision-making problems or dilemmas. While decision making problems require the actor to choose a solution among a set of alternative actions, in ethical dilemmas need to be supported by a moral judgement for choosing one among actions in the solutions space (Jonassen et al 2009). Regardless of the type of problem that we attribute engineering ethics to, the intellectual rigor and behavioural skills need to imparted during the formative years.

B. Goals/Objectives

Literature states a number of goals and objectives for including ethics instruction. These lie in both cognitive and behavioural domain. The goals of ethics instruction in the cognitive domain consist in training students in moral imagination (*moral imagination involves recognizing the role, scheme or mental model that one is adopting, disengaging from it and evaluating alternative perspectives and courses of actio.)* using principles of argumentation (cite). The ethics option designed in the doctoral and masters program as described in this paper has been designed to achieve the same. Here, both masters and doctoral students are trained to recognise and overcome the problems of compartmentalization (Gorman et al, 2000). To restate the same positively (Haws, 2001) states three "enabling objectives" of ethics education are to develop the mindset of divergent thinking, enable engineers to assess the impact of solutions from the standpoint of non-engineers and empower them with knowledge of ethical vocabulary which provides them with the language for grounded articulation of their judgements. Harris et al, (1996) additionally write about persuading students to behaviour ethically, to increase the knowledge of relevant standards, to improve ethical judgement and increase student's ethical will-power. Davis and Feinerman (2012) also highlights objectives on a similar scale.

C. Barrier to Ethics Instruction

Despite the established need and objectives for ethics instruction, there have been active and unintended barriers to ethics instruction. These blockades are forced both by the faculty and students. (Haws, 2001) states that Engineering educators have adopted a convergent mindset which has been shaped by our training in core engineering streams, which itself may have had little (or nil) focus on engineering ethics. This has relegated the ethics instruction to the background mostly because we do not have an expertise in it. Learning and passing on tangible skills is relatively easy, moral grounding takes time. As Aristotle pointed out, "A young instructor is perfectly capable of teaching mathematics, but it takes an old instructor to teach ethics". The other end of the problem in reception of ethics instruction has been brought out by (Johanssen et al 2009,) which lies with the students who rate ethics as the least interesting module and irrelevant to their learning engineering

D. Content of ethics

Keeping the objectives and goals for including ethics instruction in mind the content for the same has been surveyed. Literature basically uses two approaches to help students learn engineering ethics and its application.

Professional Code of Ethics (PCoE)

Colby et al (2008) trace the history of the Codes of ethics with special highlight on American Code of Civil Engineers. They argue that PCoE provide an effective starting ground for initiating ethics instruction as they take birth in the profession of engineering itself and their overall articulation projects the kinds of dilemmas and issues that practising engineers will face. In their study of 25 engineering institutions, the authors observed its inclusion in the contents of ethics education in different resolutions. At one end of the spectrum they saw in a program a passing mention to PCoE in the orientation lecture and at the other end a graded assessment was planned around these codes and its application to case studies.

However despite the widespread usage of CoE, (Haws 2001) categorically states that CoE does not contribute to the attainment of the three "enabling" objectives which have been mentioned under the section B. Goals/Objectives.

Usage of Moral theories

Most introductory ethics courses are woven around the moral theories and their application to resolution of dilemmas in engineering issues and cases. (Colby et al, 2008).Educating the students in moral theories will help in achieving the third "enabling" objective, which empowers the students with the vocabulary grounded in the moral theories will provide a stable footwork needed to defend their decisions. However, there have been doubts regarding the efficacy of moral theories for teaching ethics and argue that moral theories are not required or are even "counter-productive. The texts by (Roland and Martin, 1998) Fleddermann (2008) have been used as texts extensively. The author recommends the adoption of active learning pedagogies like role-play, discussion, writing in conjunction with the textual material. (Haws, 2001)

E. Pedagogies

Literature describes the usage of six basic approaches for imparting the tenets of professional ethics viz., Engineer's Code of Ethics, humanist readings, grounding in theoretical ethics, ethical problem solving heuristics, case studies, and service learning/community learning. With an eyes towards the objectives (divergent thinking, theoretical foundations and impact analysis of solutions from the viewpoint of a non-engineer), the author assesses each of the six objectives with respect to achieving the objectives and finally conclude that service learning approach in conjunction with theoretical grounding makes ethics instructions active and "real" (Haws 2001). An additional pedagogical strategy demonstrated in (Musib, 2014) uses role play as an effective means for ethics instruction

Pedagogy: Case study

The case study approach is the most common means used to initiate the students into the ethical dilemmas. The advantages of case studies lie in their simplicity which allows the students to get easily absorbed in them. In this same simplicity lies their drawback as they project the ethical dilemmas as a "micro" issue without due regard to other players in the resolution of ethical dilemmas. This agent-based approach incorrectly portrays that the onus of moral decision making lies on the lone engineer. However, there are some disaster-laden case studies like Hyatt Regency walkway collapse, the challenger disaster (Colby et al, 2008) which address both macro and micro ethical issues. They involve a cumulated concoction of human error compounded by managerial failure which project that ethical dilemmas come to picture only during the post facto analysis of issue (Colby et al, 2008). The nature of the cases also has significant bearing on student's perception of ethics. The case studies can be hypothetical/realistic, catastrophic or positive and those involving preventive ethics. The problems with hypothetical and catastrophic case studies are that the students compartmentalise their work and perceive that the probability that they will be involved in such situations is unlikely. The solutions for crisis cases generally end with whistle blowing or resignation, which does not leave a middle ground for resolutions. Also, instead of introduction ethics as a tool for post de facto analysis, care must be taken to involve ethical decision making early on in the design phase, which is termed as preventive ethics (Gorman et al, 2000). (Santi 2008) presents a work in which nine case studies/exercises were developed/adopted in a course on civil and geological engineering. The case studies were mapped to Dale's Cone of Learning and higher order educational outcomes of Bloom's taxonomy. (Harris et al, 1996) strongly favour the case study method to teach engineering ethics. The authors differentiate between two types of cases; cases which bring to light what behaviours are acceptable and unacceptable i.e., "drawing the line" between controversial and non controversial cases. The other category is the "conflict resolution cases" in which the protagonist is pulled between equally competing situations. The paper also highlights the sources of such cases.

Despite of this approach being the most popular, it is not far from criticism. (Haws, 2001) argues that though case studies spark the moral imagination of the student, provide an application for codes, and engage the students in argumentation, their "uninformed" dialogues are devoid of arguments which should ideally have been grounded in theoretical bases. To overcome the drawbacks of case study usage, (Jonassen et al, 2009) have designed an interactive online learning environment, EYE (Engineer Your Ethics) based on Cognitive Flexibility Theory (CFT Spiro et al., 1988, 1987; Spiro and Jehng, 1990) as the preferred model for instructional design. In trying to simplify the complexity of engineering ethics problems, the cross connectedness between relevant issues, which forms as the crux of resolution, is generally ignored. CFT prescribes "crisscrossing the knowledge landscape" which when applied to engineering ethics problems involves examining the cases from alternative perspectives of the case, stakeholder and moral theories.

.

F. Assessment

Case study presentation

(Colby et al) The key observation for instructors to assess students on their analysis of ethical issues related to any case study is the interconnectedness of many considerations which criss-cross between possible solutions. One of the dimensions of the rubrics is the effective application of the principles of argumentation. This being the core, the other items to grade are the formulation of key questions and their analysis and the soundness of their viewpoints.

Using the pedagogy of argumentation, (Jonassen et al, 2011) have conducted a study to compare the two forms of arguments, dialectical and rhetoric on ethics case studies and concluded that argumentation is an effective means for resolving dilemmas. In (Hoffmann and Borenstein, 2014) the use of argumentation is further extended by using an interactive software tool called AGORA-net, a Computer Supported Argument Visualisation Tool (CSAV Tools) which teams use to create argument maps for different stakeholders and their perspectives to solutions along with justifications. Problem Based Learning approach is applied to ethically-rich cases. In (Herket, 2004), problem based learning has been argued as the most favourable approach to teach ethics. Further on, the authors separate the "content-side" and "skills-side" of ethics instruction. They conclude that argumentation is a skill that should be imparted to students to guide them so resolve ethical dilemmas.

Written Responses

Another extension of assessment is the grading of written responses (for scenarios) for which (Shuman et at 2005) have identified five dimensions; recognition of the ethical dilemma, use of appropriate facts, ability to support arguments by use of analogous cases, the capacity to consider multiple perspectives and resolutions. Research using this instrument has supported its validity as a measure of ethical reasoning about engineering dilemmas.

Students Developed case studies

In the work by (Gorman et al, 2000) the authors present an ethics option in their PhD and Masters Programs (Systems Engineering) which enables students to reside at the site of the case, develop a case study incorporating both ethical, social and technical aspects rooted in the complex heterogeneous systems by adopting a participant-observation method.

Defining Issues Test

Assessment can be seen as the depth of the student's engagement with the content. This engagement can be witnessed in two ways. First one being the artefacts which are a reflection of engagement; presentations, write-ups, projects etc. These are relatively easier to measure as compared to the cognitive process that an actor undergoes while involved in creating the artefacts. Similar is the case with assessment of moral reasoning skills in ethics. The Defining Issues Test (DIT) is a popularly uses tool for ethics assessment which assess the test taker's maturity level for moral reasoning w.r.t to the Kohlberg's theory of moral reasoning. (Self et al, 1998) conducted a study in which 300 students were assessed using the DIT both before and after the course in ethics instruction and was observed that the course significantly increased the moral reasoning skills in students. The authors finally conclude that it is possible to measure the learning from ethics training.

Rubrics based on the principles of reflexive principlism

In a much recent work, the authors in (Hess et all 2014) designed an assessment tool by testing the application of the knowledge on a case which is outside of the course. The application of learnings and the subsequent transfer of knowledge can be near: as applied to a similar context or far: as applied to a dissimilar context. This is based on the difference in time and space between the learning and the point of application. For the given case, the students reasoned through the cases to provide the most appropriate solutions. For such an activity, by adopting the principles of Reflexivity, the rubrics for assessment have been designed, the dimensions of which are Identification of ethical principles, specification of the ethical dilemma in context of those principles, evaluating the perspectives of different stakeholders, resolution of the dilemma by considering the competing perspectives of all stakeholders and analysis of the proposed solution.

G. Ethics and Engineering Design:

Engineering Ethics is a part of Engineering in as much as engineering design is. Both shape the intellect of the future practitioners. The rudimentary training for both can be only provided during the academic years of the student (Harris et al, 1996). Though there are a multitude of courses planned around the principles of design, there seems to an intrinsic barrier to the incorporation of engineering ethics. Instead of the reactive nature of application of ethics principles on disaster cases, attempts are being made to project preventive ethics by integrating the principles of ethics during the phases of engineering design (Gorman et al, 2000). To avoid a reactive approach to engineering disasters using the principles of ethics instruction, it is now desirable to adopt moral imagination for preventive ethics early on in the design process (Wynsberghe & Robbins, 2014). With this understanding from literature, it becomes essential to incorporate ethics in the early stages of discussion in which design of solutions happens. There have been attempts in this regard which include Value Sensitive Design (Friedman, 1996), the embedded values approach (Nissenbaum, 2001) and values at play (Flanagan et al, 2005). In continuing this stream of thought, the authors have proposed an approach called pragmatic Value Analysis in which the designer takes on the role of an ethicist in the multidisciplinary team and performs tasks related to value discovery and translating them into requirements for design. In (Colby et al, 2008) a parallel is drawn between Engineering Decision and Engineering Ethics in as both are characterised by multiple solutions, but only one solution is chosen keeping in view the constraints and objectives. In (Dyrud, 2010), the authors compare and contrast the nature of process of problem solving in Engineering and ethics.

With this context in mind, we next present our work in introducing Engineering ethics via a module in a mandatory freshman course at our institution.

II. OUR WORK

Our 3 hours module on Engineering Ethics is included in a mandatory freshman course titled Engineering Exploration. The aim of this introductory course is to provide the students with a holistic view of the functions which characterise his profession. This module has undergone three iterations. The topic learning outcomes for the first and second revision are as stated below:-

Topic Learning Outcomes: Revision 1

1. Distinguish between etiquette, law, morals and ethics
2. Explain the need for ethics in engineering profession
3. Explain moral theories
4. Analyse engineering solutions for ethical dilemma

Topic Learning Outcomes: Revision 2

1. Summarise the importance of ethical code of conduct for engineering professionals
2. Identify the ethical issues/dilemmas which arise in the tasks related to engineering
3. Apply moral theories and professional codes of conduct for resolving ethical dilemmas

The Graduate Attributes of the Washington Accord served as the point of initiation in which the Attribute 8 ("*Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice*") was highlighted. The faculty reasoned the need for Graduate Attributes and established the extrinsic and intrinsic rationale for need for ethics instruction.

A. Case based approach

A case study based approach was followed in which a local case of a bride collapse was provided to students. Though literature does not wholly support the use of crisis-laden case studies, this case brought in the context of localisation of the issue as a bridge had indeed collapsed recently. The discussion brought in the identification of stakeholders, their perspectives and the onus of responsibility of the collapse. A similar approach was followed in the second iteration. But the drawback of these case studies was that we failed to establish the context of engineering ethics. We overcame this in the subsequent delivery by including introductory video based cases as Toyota Unintended Acceleration and Volkswagon Cheat Software. This discussion hinged around the following questions:

1. Who are the people responsible for these incidents?
2. Who are people who designed the system?
3. What do you think is the reason for these cases?
4. Are such incidents preventable? If yes, how?
5. Who are the people affected by these issues?
6. What did people/ company violate?
7. For the VW case, if you want to buy a car, would you consider the car manufactured by this company? Justify your answer.

Four faculty members engage each session of three hours in a class of 70 students. To actively involve the students, we decided to conduct localised discussions (16:1 student teacher ratio) which gave greater control over the proceedings and increased interaction with students. With this context the differences in etiquette, law, morals and ethics was highlighted by use of appropriate examples

B. Use of Code of Ethics and cases

In all three deliveries, the codes of Professional Ethics were shown to the students. In the first two iterations the IEEE and ASME codes were centrally displayed to the students during the session but it was not effective as no other engagement with the codes was planned. Also, the students belonged to different streams due to which they did not personally feel for the code of ethics (only codes for Mechanical and Electrical Engineering were shown). During the third iteration, we overcame the inefficacies by providing the codes of ethics on the students desktops (preloaded). The code of ethics for different streams helped in establishing a personal identity for the students (Mechanical engineering, Civil engineering, Computer science and all other streams). Again, localised discussion was initiated on the following points:

1. What does the first code for your specialisation speak about?
2. What does the last code for your area of specialisation speak about?
3. If the codes of ethics are so systematically specified, why do engineers still follow unethical practises?
4. Can you suggest one solution for the problem above?

Though the students were engaged with the code of ethics, we needed them know its realm of application within the professional space. For this we again used a video-based case study regarding the functions of a Responsible Engineer. We effectively used it to demonstrate that there is an inherent ordering in the canons with public safety, health and welfare holding paramount importance when compared to the other canons in the list. This was a breakaway discussion with the students presenting arguments/counter arguments for the case.

C. Other Activities

During the first delivery, a milk adulteration testing activity was carried out to sensitise the students to presence of ethics is business processes. This activity laid the initial groundwork for initiation of ethics in the practise of engineering. You may refer to the complete work by the authors here (Joshi et al 2016)

III. ASSESSMENT

Literature has well established the problems associated with assessment in engineering ethics. Our effort is also directed towards devising effective assessment strategy for this module. But since the topic is engaged only for six hours, conducting an elaborate assessment does not qualify for the time spent w.r.t the allotted time for this module. Also, the freshman course within the scope of this modules lies, includes a course project in which the learnings of other modules (Engineering Design, engineering Analysis, Data Analysis, sustainability in Engineering) are systematically applied to the course project. Hence, we tested the students in the same was as other modules did. During the first two iterations, the students were required to apply the learning from the module on engineering ethics to the course project. The students produced a write-up on the questions mentioned below. The rubrics for assessment are listed below:-

1. List atleast 5 stakeholders impacted / affected by your project. This list shall include direct as well as indirect impacts.
2. For each of the listed stakeholder, write down the positive and negative impact of the project.
3. Justify your intervention through project by applying moral theories in these contexts for every stakeholder.

The dimensions for its assessment are ability to identify stakeholders impacted / affected by project or solution, ability to visualise the positive and negative impact of project on stakeholder, ability to apply moral theories and arrive at inferences. But, it was difficult to ground students in moral theories in only 6 hours of session time. Also, we realised that the projects carried out by students did not have real stakeholders. During the third and current iteration, "preventive ethics" case studies were provided to students along with the following rubrics: Rubric1: Ability to identify the Ethical Dilemma, Rubric 2: Ability to provide three alternate and feasible solutions and Rubric3: Ability to identify a solution and provide a justification by relating the solution to relevant canon/code of ethics. It is

Table 1 RUBRICS FOR ASSESSMENT

Criteria/Scale	Exceeds expectations	Meets Expectations	Needs Instructor Intervention
Ability to identify the Ethical Dilemma	The student is able to clearly state the ethical dilemma.(3 marks)	The student has a hazy idea about the ethical dilemma (2 marks)	The student needs instructor intervention to identify the ethical dilemma. (1 mark)
Ability to provide three alternate and feasible solutions	The student is able to provide three feasible solutions to resolve the dilemma (3 marks)	The student is able to provide two feasible solutions to resolve the dilemma (2 marks)	The student is able to provide only one feasible solution to resolve the dilemma (1 mark)
Ability to identify a solution, provide a justification by relating to relevant canon/code of ethics	The student is able to identify a possible solution along with the justification for choosing it, by relating to the relevant canon/code of ethics. (4 marks)	The student is only able to identify a possible solution but is unable to justify the choice, by relating it to the relevant canon/code of ethics.(2 marks)	The student is neither able to identify a solution nor provide a justification.(0 mark)

Table 2 ANALYTICAL VIEW OF CASES, CANONS AND RUBRICS

CS No.	Theme	NSPE Canon	No. Of Students	Score 10/10	Identify Ethical Dilemma (3/3)	Provide 3 feasible solutions(3/3)	Choose 1 solution and justify with CoE (4/4)
1	Public health, safety & welfare	1	113	17%	43%	40%	58%
2	Faithfulness & avoiding conflict of interest	4	114	6%	56%	37%	29%
3	Area of competence	2	106	4%	45%	32%	16%
4	Public health, safety & welfare	1	99	8%	51%	29%	11%
Summative Values across all case studies			432	9%	49%	35%	29%

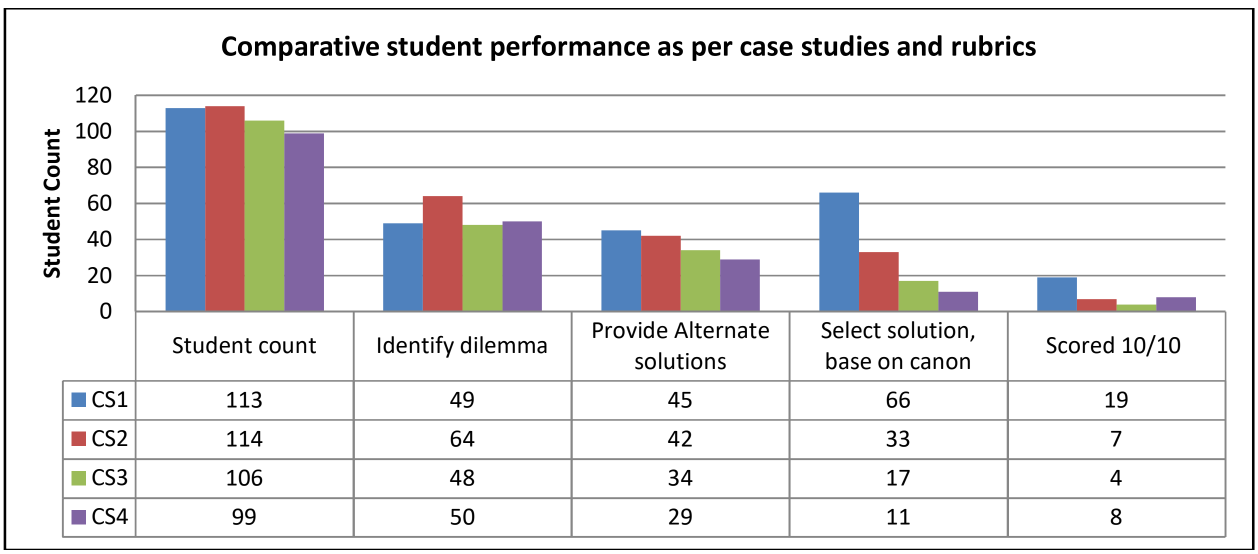

FIGURE 1. COMPARISON BETWEEN CASE STUDIES AND STUDENT PERFORMANCE

noteworthy that students have been able to establish the similarity between the Engineering design process and the process of ethical dilemma resolution. Another significant achievement is that we used National Society of Professional Engineers (NSPE) canons as the basis for resolving the ethical dilemma. Though this module was initiated at the start of the semester, the assessment was planned at the end. Therefore, both at the entry and exit stages, the Code of Ethics are exposed to the students. The subsequent section will discuss the results obtained in our study.

IV. Results and Discussions

In table 1, the analytical view of our work is presented. Out of four case studies (CS), two (CS 1 and CS 4) were related to NSPE canon 1 ("*Engineers shall hold paramount the safety, health and welfare of the public in the performance of their professional duties*"), CS 2 was related to NSPE canon 4 ("*Engineers shall act in professional matters for each employer or client as faithful agents or trustees, and shall avoid conflicts of interest*") and CS 3 was related to NSPE canon 2 ("*Engineers shall perform services only in the areas of their competence*").

For our analysis, we have identified certain questions as outlined next.

1. How many students are able to successfully resolve ethical dilemmas (present in the case studies) and base their decision on NSPE canons?
2. What can we say about the theme of the case study and ease of identification of dilemma?

From our analysis of data, we can conclude that only 9% of students (38/482) could successfully resolve ethical dilemmas (across all case studies). Out of this, the case studies which dealt with public welfare, safety and health were the highest contributors (27/38). We predict that this may because of existence of engineering disasters and their ease of identification. The case study 3 which was based on area of competency scored the lowest. This may be because the students are not exposed to the detailed application of this canon.

Our next analysis is based on the number of students who fall either in the first, second and third category of rubrics. 86% of students scored between 5 to 9 marks on scale of 10, which mean that atleast two scores come from the mid scale, i.e., meet expectations. Only 5% (21/482) need instructor intervention. These students have maximum scores contributed from last scale, i.e., needs instructor intervention. Thus, we can effectively state that

V. CONCLUSION

As a part of Engineering Exploration course, this module was been introduced to freshman who do not have any prior awareness of the practices of the profession of engineering. Nevertheless, we have been able to bring awareness of professional ethics in them. Also, we have used NSPE fundamental canons as the basis for decision making, which are very broad statements when interpreted without reading the associated rules of practise. Our next study will be based on the application of the rules of practise on the ethical decision making process.

References

Colby, A., & Sullivan, W. M. (2008). Ethics teaching in undergraduate engineering education. Journal of Engineering Education, 97(3), 327.

Davis, M., & Feinerman, A. (2012). Assessing graduate student progress in engineering ethics. Science and engineering ethics, 18(2), 351-367.

Dyrud, M. A. (2010). Problem Solving in Engineering and Ethics: Points of Intersection.

Flanagan, M., Howe, D. C., & Nissenbaum, H. (2005, April). Values at play: Design tradeoffs in socially-oriented game design. In Proceedings of the SIGCHI conference on human factors in computing systems (pp. 751-760). ACM.

Fleddermann, C.B. 2008. Engineering ethics, 3rd Ed. Upper Saddle River, NJ: Pearson Prentice Hall.

Friedman, B. (1996). Value-sensitive design. interactions, 3(6), 16-23.

Gorman, M., Hertz, M., Garrick, L., & Magpili, L. (2000). Integrating ethics & engineering: A graduate option in systems engineering, ethics, and technology studies. Journal of Engineering Education, 89(4), 461.

Harris, C. E., Davis, M., Pritchard, M. S., & Rabins, M. J. (1996). Engineering ethics: what? why? how? and when?. JOURNAL OF ENGINEERING EDUCATION-WASHINGTON-, 85, 93-96.

Haws, D. R. (2001). Ethics instruction in engineering education: A (mini) meta-analysis. Journal of Engineering Education, 90(2), 223.

Herkert, J. R. (2004, June). Continuing and emerging issues in engineering ethics education and research: integrating microethics and macroethics. InPower Engineering Society General Meeting, 2004. IEEE (pp. 647-Vol). IEEE.

Hess, J. L., Beever, J., Iliadis, A., Kisselburgh, L. G., Zoltowski, C. B., Krane, M. J., & Brightman, A. O. (2014, October). An ethics transfer case assessment tool for measuring ethical reasoning abilities of engineering students using reflexive principlism approach. In 2014 IEEE Frontiers in Education Conference (FIE) Proceedings (pp. 1-5). IEEE.

Hoffmann, M., & Borenstein, J. (2014). Understanding ill-structured engineering ethics problems through a collaborative learning and argument visualization approach. Science and engineering ethics, 20(1), 261-276.

Jonassen, D. H., & Cho, Y. H. (2011). Fostering argumentation while solving engineering ethics problems. Journal of Engineering Education, 100(4), 680.

Jonassen, D. H., Shen, D., Marra, R. M., Cho, Y. H., Lo, J. L., & Lohani, V. K. (2009). Engaging and supporting problem solving in engineering ethics .Journal of Engineering Education, 98(3), 235-254.

Martin, M. W., Schinzinger , M. R., (1998), Introduction to Engineering Ethics, 2nd Edition , McGraw-Hill, Newyork.
MUSIB, M. K. Teaching Ethics by Adopting a Role-play, Scenario-based Learning Approach for an Authentic Learning Experience.

Nissenbaum, H. (2001). How computer systems embody values. Computer, 34(3), 120–119. doi:10.1109/
Santi, Paul M. "Ethics exercises for civil, environmental and geological engineers." JOURNAL OF ENGINEERING EDUCATION-WASHINGTON-89.2 (2000): 151-160.

Self, D. J., & Ellison, E. M. (1998). Teaching engineering ethics: Assessment of its influence on moral reasoning skills. JOURNAL OF ENGINEERING EDUCATION-WASHINGTON-, 87, 29-34.

Shuman, L. J., Besterfield‐Sacre, M., & McGourty, J. (2005). The ABET “professional skills”—Can they be taught? Can they be assessed?. Journal of engineering education, 94(1), 41-55.

Shuman, L. J., M. Besterfield-Sacre, and B. M. Olds. 2005. Ethics assessment rubrics. In Vol. 2 of Encyclopedia of Science, Technology, and Ethics, eds. C. Mitcham, L. Arnhart, D. Johnson and R. Spiers, 693–695. NY: MacMillan Reference Books.

Van Wynsberghe, A., & Robbins, S. (2014). Ethicist as Designer: a pragmatic approach to ethics in the lab. Science and engineering ethics,20(4), 947-961.

Velankar A, Joshi G & Baligar P (2016) Promoting Ethical Skills in First Year Engineering Students through Socially Relevant Experiments, In 2016, 6th Regional conference on Engineering Education (RCEE).