Ethical Attitudes Among Engineering Students: Some Preliminary Insights

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Abstract. There is a rising interest in engineering ethics education. As research in this field shows, the most common reasons for that are rather formal implying to satisfaction of accreditation requirements and complying with the recommendations of a disciplinary professional association. Resistance to notions such as professional judgment and the absence of any substantial reference to engineering ethics in general conversations about educational decision-making and governance is also witnessed. Teaching engineering ethics to students could be considered a crucial course that builds the necessary basis so that engineering students can develop better, i.e. more sustainable and responsible, technological solutions to societal challenges. At the same time, we do not have much information or many studies about the actual beliefs or ethics attitudes of future engineers and methods of influencing their attitudes concerning challenges related to sustainable development. The purpose of the study is twofold, we 1) explore the ethics and sustainability attitudes of engineering students and 2) make preliminary proposals for the betterment of engineering ethics teaching. Our study shows that shaping attitudes and behavioural intention towards certain values, for example towards sustainability, needs clearer manifestation in societies in general, as well as in professional communities.

Keywords: Engineering ethics · Teaching engineering ethics · Ethics attitudes · Sustainable development

1 Introduction

The beginning of the 21 century has shown that engineers need to have well developed soft skills to cope with the situations of a new kind. For example, the United Nations (UN) Sustainable Development Goals (SDGs) expect engineers to be aware of challenges in various fields, where problems and possible solutions are linked to technology development. Also, globalization has brought new types of problems to all countries, to name the virus Covid-19 specifically, and fighting with new challenges expects broader and more responsible approaches from all professionals. All this creates a huge demand for a new form of engineering education because just giving better technology education might not lead to finding responsible and problem-solving solutions.
It is expected that the engineering education of the future has a broader basis and involves more courses intended to develop the requested soft skills so that the students learn to better handle present and coming societal challenges utilizing technological developments. For example, what to do in cases when technology companies and engineers face a dilemma to prefer human lives or profit (e.g. the extraordinary legal action taken against a company producing Covid-19 tests which not the only example of some individuals putting profits before people [1]). Cultivating students to become proficient in reasoning about ethical issues and practices is thus becoming more and more important in Engineering in the context of worldwide scandals involving unethical and illegal practices in professional communities.

The 17 SDGs are “an urgent call for action by all countries - developed and developing - in a global partnership. They recognize that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality, and spur economic growth – all while tackling climate change and working to preserve our oceans and forests” [2]. There is an expectation that future generations can face and provide solutions to those challenges.

2 Problem Formulation

There is a rising interest in engineering ethics education (e.g. [3, 4]), but the most common reasons for that are rather formal implying to satisfaction of accreditation requirements, and complying with the recommendations of a disciplinary professional association [5]. Resistance to notions such as professional judgment and the absence of any substantial reference to engineering ethics in general conversations about educational decision-making and governance are also witnessed [5]. At the same time, we do not have much information or many studies [6, 7] about the actual beliefs or ethics attitudes of future engineers and methods of influencing their attitudes concerning challenges related to the SDGs.

Teaching engineering ethics to students could be considered a basic course intended to build a necessary basis so that engineering students can develop better, i.e. more sustainable and responsible, technological solutions to societal challenges. As ethical behavior has become a part of the professional identity and practice of engineers [8, 9], an important goal of teaching ethics to engineering students is to enhance their ability to make well-reasoned ethical decisions in their engineering practice: a goal in line with the stated ethical codes of professional engineering organizations [10]. Also, a well-structured, integrated, and innovative pedagogy for teaching ethics has an impact on the students’ attainment of ethics education objectives and their attitude towards engineering ethics [6].

Thus, there seems to be a gap between contemporary global goals expressed in SDGs, established value sets expected from engineering practitioners, and expressed in engineering codes of ethics and actual values of students. Codes of ethics emphasize on the fields of safeguarding the quality of life and protect the public interest as well as consumers’ interests, for example in the Code of Conduct for European Chartered Engineers [11] or health, safety and welfare of the public, for example in the NSPE Code of Ethics for Engineers [12] and not so much on sustainability or SDGs.
A general question arises from here: should universities provide a professional training which prepares future professionals in accordance with the values and attitudes agreed on among professional communities and expressed in codes and value statements (classical professional training) or should universities prepare future professionals according to the future needs even if the value set might not coincide with agreed professional engineering ethics statements expressed in codes? In other words, should the engineering ethics teaching be compliance-based or should it pay more attention to moral reasoning and justification?

Even though it is clear, that updating codes of engineering ethics is a long-term undertaking. However, at the same time, all students are also citizens and expected to act and behave responsibly. SDGs are not only goals for professionals but everyone.

Against this background, the purpose of the present ongoing study is twofold: 1) to get a better understanding of factors influencing engineering students’ ethical decision-making to improve the methodology and content of ethics courses, and 2) to explore the link between ethics attitudes and SDGs. With this study we want to develop insight into the development of ethical attitudes among engineering students, as previous studies in other professional fields [13, 14] have demonstrated mixed results about the effect of ethics courses on developing ethical reasoning skills of students.

3 Method

To reach our overall research purpose we took advantage of a survey design. In the following, the steps taken are outlined.

We replicated the study by Riemenschneider et al. [15] that investigated ethical decision-making of students in an academic setting. This study was grounded in the Theory of Planned Behavior (TPB), and studied the influence of attitude, subjective norm, perceived behavioral control, moral judgment, and perceived importance of an ethical issue on a student’s behavioral intention. We used the same methodology but designed cases related to compliance and responsibility to make them fit our research purpose.

Two cases were developed to estimate the ethical decision-making of students (see Table 1). The first case is related to norms of data protection (GDPR), and the second case tested a broader attitude towards sustainability-related responsibility. Scenarios were developed considering the relevance of students’ expected experiences. Both scenarios were followed by 15 specific measurement items for latent constructs of behavioral intention (1 item), attitude (3 items), subjective norms (1 item), perceived behavioral control (3 items), moral judgment (4 items), perceived importance (3 items) using seven-point rating scale with assigned values for numbers 1 and 7 (see Table 1).

Reliability scores (Cronbach’s alpha) for constructs with two or more items were calculated for both scenarios (see Table 3). Cronbach’s alpha of most constructs was close to 0.8 as recommended reliability standard for applied research by Nunnally, and two scales had modest reliability of over 0.7 which is also considered acceptable [16].

1 SDGs 10 Reduced Inequalities, and 3 Good Health and Well-Being.
The survey was conducted among engineering students from the Tallinn University of Technology (TUT). TUT is the only university in Estonia giving engineering education. Engineering ethics courses are not compulsory to all engineering students and teaching of ethics-related courses depends on curricula. In the spring semester of 2020, ethics-related courses were taught to students from the curricula of information technology (IT), civil engineering (CE), and architecture. For the IT students, attending the ethics course was voluntary while for civil engineers it was compulsory. The target group of our study were all participants of ethics courses who were enrolled in the courses via TUT’s CMS Moodle.

Altogether 96 students were invited to participate in the survey (39 from IT and 57 CE Department). Data were collected via an online survey between 7–20 May 2020. We received 32 responses (of which 6 came from female students): 16 responses from IT students and 16 from engineering students, which meant a response rate of 33%. The students were aged between 19–29 years (90.6% of them were between 19–23 years old). 16 respondents were 1st-year students, eight were 2nd and the remaining eight students were 3rd-year students.

Data were analyzed using SPSS vers.26.0. We used means, standard deviation, and frequencies to illustrate the distribution of responses. Pearson correlation coefficients, pairwise Student’s t-test, and OLS regression analysis were performed to estimate relationships between variables.

4 Results

Firstly, we analyzed the distribution of responses concerning behavioral intention as well as other latent variables used to measure ethical decision-making. In Fig. 1, one can see that the answers from 32 respondents to Case 1 were distributed rather uniformly - on a scale from 1 to 7 where smaller values indicated unethical and higher values ethical behavior.

Regarding behavioral intention in Case 2, a rather similar pattern of responses emerged (see Fig. 2) with respondents choosing all possible answers in a way that a clear trend in favor of either ethical or unethical behavioral intention cannot be determined.

In Table 2, the means, standard deviations, and statistics describing the results of the T-test we used to compare the components of ethical decision-making are presented. We can see that ethical decision-making regarding behavioral intention, ethics attitude and subjective norms (or personal normative beliefs concerning the moral obligation to perform an act) are rated quite similar in two scenarios with mean values around 3.93–4.59 scale points and rather large standard deviation indicating no clear positive or negative attitude towards ethical issues. In other words, what concerns 1) behavioral intent (i.e. the intention that shows the motivation behind behavior and that indicates the amount of effort one is willing to exert to perform that behavior), 2) attitude towards the topics (i.e. the degree how favorably or unfavorably evaluates the behavior) and 3) subjective norm or how morally one would feel obligated to take corrective action, there is considerable variance in ethical decision-making of students.
Also, the mean values of all these three constructs are not significantly different from each other with $\alpha \leq 0.05$.

However, perceived behavioral control, moral judgment, and perceived importance of ethical topics are evaluated differently in two scenarios. It appeared that data protection issue of scenario 1 was rated more important and fundamental (higher perceived importance) in comparison with scenario 2 where the interests of disabled people when solving a problem of accessibility as homework was not paid attention to (that ethical topic was rated as of medium importance). Also, moral judgment (the way person reasons when faced with an ethical decision) was significantly stronger in scenario 1 compared to scenario 2. The perceived behavioral control was somewhat stronger in the data protection scenario as compared to scenario 2, where not writing to the professor would be for students more easy, simple, and under their control.

In both ethical decision-making scenarios, the respondents’ major (IT vs CE) as well as whether s/he is 1st or 2nd or 3rd-year student did not affect the 6 ethics-related
variables we investigated. Respondents age was positively correlated to ethical beha-
vioural intent \( r = 0.38, p = 0.03 \), ethical attitude \( r = 0.43, p = 0.015 \) and
perceived importance \( r = 0.31, p = 0.087 \) in scenario 2 indicating that older
students conceptualize ethical issues not related to clear norms (e.g. protecting disabled
or disadvantaged groups) differently compared to younger students.

Looking at correlations between behavioural intention and other latent ethical
constructs (see Table 3) we can see that behavioural intention is related a bit more
strongly with ethical attitude in the first scenario (data protection in the context of
professional conduct) compared to scenario 2 (suggesting to modify the assignment in
a way it takes into account also disabled groups). Interestingly it appeared that sub-
jective norm is related to behavioural intention in 1st scenario but not in 2nd scenario;
and perceived importance of ethical topics is not correlated to behavioral intention in
scenario 1 but is strongly correlated with behavioral intention in scenario 2. It means
that the more Adele’s decision not to inform the professor was seen as an unimportant
and trivial issue, the higher was the probability of not contacting the professor and
suggesting a modification of assignment towards a more responsible one.

Regarding subjective ethical norm, we found that stronger felt obligation to take
corrective action in scenario 1 was related to lesser intent of unethical behavior (but in
homework assignment situation subjective norms were not related to behavioral
intention).

Analyzing correlations between latent constructs in two scenarios it appeared that
subjective moral norm, perceived behavioral control and moral judgments were posi-
tively strongly correlations in scenario 1 and 2 \( 0.67 \leq r \geq 0.61, p < 0.001 \)
whereas the correlation between behavioral intentions in scenario 1 and 2 was weak
\( r = 0.3, p = 0.064 \). The latter indicates that not all respondents with more ethical
behavior intention in the first scenario had also more ethical behavioral intention in the
second scenario. The perceived importance of the ethical issue in scenario 1 was
weakly correlated with the perceived importance of the issue in scenario 2 \( r = 0.32
p = 0.083 \).
5 Conclusion

We draw the following conclusions based on the survey results presented above.

Firstly, younger students have not developed their own ethics value system and they need stronger support by clearly stated norms. If they perceive the importance of...
ethical issues and the intention is supported by the norm, they are more intended to behave accordingly. Younger students might incline to more sustainable social behaviour but they need to have clearly stated behavioural expectations to act.

Secondly, skills to conceptualize ethical issues, not to expect clear norms, and behave on the basis of excogitated values comes with age and experience. When planning workplace practice as a part of the professional preparation of younger generations, ethics issues and their analysis should be included in the agenda to give students the opportunities to identify themselves with practitioners and to familiarize the students with situations of ethical decision-making.

Thirdly, clearly stated and concrete problems (in our case data protection) are perceived to be more important than issues which might have bigger importance on a global scale (in our case taking responsibility in reducing inequalities) but they do not have a concrete form and are not clearly made explicit in current social debates.

Thus, in the context of engineering ethics education, we can conclude, that clearly stated professional norms should be included in the professional preparation of younger generations. They are also important in shaping students’ attitudes towards ethical behaviour. If engineers want to develop stronger attitudes towards sustainability, they need to include respective norms in their codes of ethics as well. The balance between compliance and norms, and moral reasoning and justification should be found in ethics teaching in all universities.

As regards the limitations of our study, despite continuous reminders, we only managed to get a lower response rate than originally expected. The main reason was the pandemic of coronavirus and distance learning not allowing direct communication with students and consequently the weaker bound to respond. Thus the small sample did not allow us to make robust conclusions or provide conclusive solutions but rather they gave us promising initial insight for further studies. Yet, we consider the presented study as a relevant one to addressing the problems of shaping the ethics attitudes of engineering students towards professional responsibility and sustainability.

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