İş Ahlakı Dergisi
Turkish Journal of Business Ethics

Implementing Next-Generation Engineering Ethics in Education and Industry for Social Happiness: A Macroscopic Overview from Turkey to the World

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Abstract: An engineer is a professional who is involved in series of processes from designing to testing products. Engineers are experts in their specific fields and are constantly innovating and maintaining a variety of machines, structures, and data systems. However, the technology areas have expanded so much that engineers are now responsible for many social activities in daily life. Therefore, the fact that engineers are already equipped with unspecified responsibilities allows many problems to arise. Certainly, the acquisition and sustainability of ethical awareness are accompanied by expertise and seniority, but the problems we face today show confusion to be present in how students are taught ethical rules. The ethical problems faced by engineers has increased in line with the increase in artificial intelligence applications in our globalizing world. Consequently, learning techniques regarding engineering ethics should also be changed. While this study reminds candidate engineers of the importance of ethical rules, it also provides teachers with some tips about educational activities from an engineer's perspective. This study discusses the struggle engineers face regarding ethics, the skills they should gain in school to solve the problems they face, and what should be done to make ethics sustainable. In addition, the study comparatively addresses what needs to be done to raise engineering ethical standards in self-governed industries and the way engineering ethics education is presented in engineering faculties. The study also presents the ethical problems of the new generation and the steps to take for the future. The study only presents a brief review of the above topics, each of which needs to be examined separately in detail.

Keywords: Engineering ethics, Industry 4.0, student education, new generation, engineering standards.

Toplumsal Mutluluk için Eğitim ve Endüstride Yeni Nesil Mühendislik Etiğini Hayata Geçirmek: Türkiye'den Dünyaya Mikroskobik Bir Bakış

Mühendis, bir ürünün tasarımından test edilmesine kadar bir dizi süreçte yer alan bir profesyoneldir. Mühendisler, kendi alanları ile ilgili makineler, yapılar, hatta veri sistemlerin sürekli olarak kurulumunu ve bakımını yapan uzmanlardır. Bunanla birlikte günümüzde teknolojinin kapsadığı alan öyle genişledi ki, toplumun günlük yaşamdaki birçok faaliyetinden de artık mühendisler sorumlu hale geldiler. Ancak, hâlihazırda mühendislerin belirsiz sorumluluklarla donatılmış olması ortaya pek çok sorunun çıkmasına da olanak tanımaktadır. Etik farkındalığın kazanılması ve sürdürülebilirliği elbette deneyim ve kıdemle birlikte gelen bir durumdur, ancak karşı karşıya kaldığımız problemler gösterdi ki, etik kuralların öğrencilere öğretilmesi yolunda da bir kafa karışıklığı var. Küreselleşen

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Dikici, B. (2021). Implementations of New Generation Engineering Ethics in Education and Industry for Social Happiness: A Macroscopic Overview from Turkey to World. İş Ahlakı Dergisi, 14 (2), ss. 364-380
Research Paper

DOI: 10.12711/tjbe.2021.14.2.2303
İş Ahlakı Dergisi, 2021
isahlakidergisi.com

Başvuru : 21.02.2021
Revizyon : 29.07.2021
Kabul : 22.09.2021
Basım : 11.2021

dünyamızda artan yapay zeka uygulamalarına paralel olarak mühendislerin karşılaştığı etik sorunlar da artmaktadır. Sonuç olarak, mühendislik etiği ile ilgili öğrenme teknikleri de değiştirilmelidir. Bu çalışmada; mühendis adayı öğrencilere etik kuralları ciddiye almalarının önemi hatırlatılırken, öğreticilere de bununla ilgili eğitsel faaliyetleri nasıl yapacakları konusunda ipuçları sunulmaktadır. Mühendisin etik ile mücadelesi, karşılaştığı sorunları çözmek için öğrencilik yıllarında kazanması gereken donanımlar ve bunların sürdürülebilir hale getirilmesi için yapılması gerekenler tartışılmıştır. Ayrıca, özerkleşen endüstride mühendislik etiği standartlarının yükseltilmesi için yapılması gerekenler ve mühendislik fakültelerinde "mühendislik etiği" dersinin sunum şekli karşılaştırmalı olarak ele alınmıştır. Çalışmada, yeni nesil etik problemler ve gelecek için atılması gereken adımlar da sunulmaktadır. Belki her birisi ayrı ayrı incelenmesi gereken bu konu başlıklarına toplu bir göz gezdirme yapılmıştır.

Anahtar kelimeler: Mühendislik etiği, Endüstri 4.0, öğrenci eğitimi, yeni nesil, mühendislik standartları.

Applied Engineering and Engineers' Struggle

What work do engineers do? The simple answer is engineers do a world of work. For example, mechanical engineers design machines to progress the standard of human living or build spacecraft for planetary exploration, bioengineers work on drug delivery systems that work inside the cells, civil engineers establish cities, food engineers focus on the safe storage of food for consumption, while environmental engineers strive to protect drinking water. Whether headphones, high-speed trains, or mobile phones, all are in the field of engineering (Herkert, 2005; Wikipedia, 2020).

Meanwhile, TV screens show that buildings crack or collapse even from very small tremors, cars crumple like cardboard during a crash, planes fall, bridges collapse, and spacecraft explode; engineers design things like gas containers that explode and lead to the deaths of thousands, labs where accidents cause cancer, computer viruses that ruin computers, ships that sink when they strike a large enough iceberg, oil tankers that sink in the sea, and many more (Fleddermann, 2012). In fact, engineering is done not just for society but also for the world. Yet the world seems still unaware of its global challenges and responsibilities (Freckleton, 1997; Kelley, 2008; Nichols & Weldon, 1997).

Engineers also have a responsibility to future generations and to all living/non-living communities under their involvement because the technology areas have expanded so much nowadays that engineers have become responsible for many social activities in daily life. In fact, engineers assume ethics to be someone else's problem due to the burden of unclear responsibilities, or they feel they are not responsible for these types of events in many cases.

So what assurances can be had that engineer candidates take ethical rules and related educational activities seriously (Khulief, 2008)? How can ethics be taught

so as not to be dull? More importantly, how can engineer candidates be assessed on their ethical and moral values before graduation, or is this even enough? These kinds of questions are not only unique to today but are also the most frequent questions engineering educators ask worldwide regarding how to train a good engineer (Abaté, 2011; Fox, 2018; Herkert, 2005; Khulief, 2008).

Of course, an engineer should be an expert involved in inventing, designing, or maintaining a variety of machines, structures, and/or data systems. So, what about ethical rules? In their work life, they will have to deal with many ethical problems. I wonder if engineering students are aware of their responsibilities? This paper presents a discussion on this issue.

Conflicts Between Engineering Ethics and Moral Principles

Morality is known as the set of rules and guidelines that are applicable to the whole of society that is independent of individuals' professional or institutional roles. Ethics, however, represents the standards of a particular profession, job, institution, or group in society. Ethics tries to interpret rules logically and to create rules for individuals in order for them to live in harmony with society, while morality is the totality of the values and thoughts properly accepted without any justification and varies according to society. However, what is legal or moral may not always be ethical in some cases (Kouchak & Smith, 2020).

The sum of ethical principles and standards that conduct and guide behaviours in the work environment is called professional ethics (Nichols & Weldon, 1997). In other words, it is the set of behaviours and rules that should be followed for any profession at any business branch. These rules are generally the same and valid all over the world, and they are also too serious to be left to personal opinion.

Briefly, the purposes of rules are to prevent mistakes, introduce better services to people, and prepare guidelines in line with a profession's aims. In addition, the aim in applying rules is to develop a moral, just, and proper behavioural model toward society, customers, professions, colleagues, nature, and the environment (Abaté, 2011; Khulief, 2008). The main purpose of professional ethics is to develop a behavioural model for the interpersonal relations in work areas and to limit non-conformist interpersonal behaviours. Engineering ethics is an area of study that emphasizes the idea of professions and involves some unique rules in professions. So, how does one become a good person or engineer in this case (Öztürk et al., 2015)? As a result, engineering ethics must be considered from a global perspective.

How Should Engineers Be Equipped for Solving Ethical Issues?

Work-life is governed by different systems of norms. The system of norms governing and regulating professional engineering behaviours is known as engineering ethics. Four frames of reference exist regarding the effects caused by engineering ethics: individual, professional, social, and sustainable. These can be handled roughly in terms of micro and macro dimensions (Bowen, 2014). While the individual and internal relationships of the engineering profession are considered as micro ethics, macro ethics deals with collective social responsibility and the social sustainability of progressing technology (see Fig. 1; Abaté, 2011; Herkert, 2005; Nichols & Weldon, 1997; Öztürk et al., 2015).

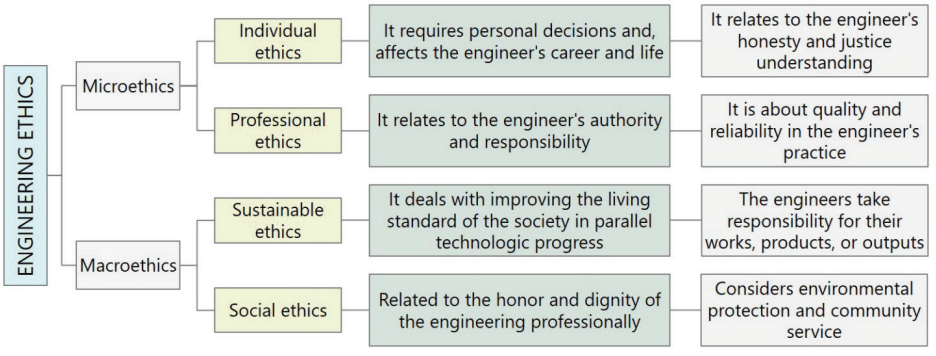

Figure 1. The current framework of engineering ethics.

In its current state, the curriculum of many engineering faculties regarding engineering ethics is generally as an elective class. In addition, most teaching methods in these classes are based on known case studies (Davis & Yadav, 2015; Kelley, 2008). These classes teach by pointing out the subject and explaining historical events involving engineering mistakes such as how the Grenfell Tower fire had formed due to a flammable building exterior, the emission test scandal for Volkswagen's diesel cars involving software designed to misrepresent data, the cases involving exploding Ford Pintos due to a defective fuel system design, the collapse of the Tacoma Narrows Bridge due to miscalculations, the space shuttle Challenger explosion, and the Piper Alpha disaster (Fleddermann, 2012; Wulf, 2004). The history of engineering is filled with such events that will continue to happen (Kouchak & Smith 2020).

The main purpose of the learning technique is to help engineers perform their profession more attentively. Case analysis in the learning technique involves eight

main steps: i) identifying the ethical problem, ii) narrowing the focus, iii) determining relevant facts, iv) making reasonable assumptions, v) undertaking definitional clarification, vi) conducting ethical analysis, vii) reviewing the process, and viii) resolving the ethical problem (Luegenbiehl & Clancy 2017a). The case study approach provides a good view using global to domestic rules. Thus, engineers' opinions can be generalized within an ethical framework. In addition, they can become familiar with similar situations. Undoubtedly, the learning approach enables engineer candidates to discuss and evaluate the problems engineers face (Kelley, 2008; Luegenbiehl & Clancy, 2017b).

However, current problems show that creating business ethics by telling students about historical events inhibits engineering students from making new expansions on the subject. Also, engineering ethics becomes baseless and unprincipled when only coded within current values. Engineers' ethical approaches must require them to prompt beyond the traditional technical discipline due to the many problems that frequently recur. The belief of ethical awareness as a broad vision that comes with experience and seniority has fallen to the wayside in this new learning method (Basart et al., 2015).

So, how can engineer candidates be provided with the ability to adopt an ethical manner? Obviously, before examining the examples related to engineering disasters, teachers need to address more basic and personal ethical problems and present them to their students, and this should start in primary and secondary school. A candidate equipped with basic ethical rules can continue engineering education under ideal conditions during their graduate and post-graduate education (Herkert, 2005; Khulief, 2008). In this way, a culture of ethical behaviour can be created at all stages of engineer candidates' education, thus providing the prerequisite of preparing a good engineer for the industry. The confusion present in teaching how to apply ethical rules can be eliminated by learning new ethical principles (Davis & Yadav, 2015; Kelley, 2008).

How Should the Ethical Problems Today's Engineers Face Be Understood?

Incontrovertibly, a young engineer experiences the most common conflicts between ethical values and commercial earnings after graduation. So teachers' job is not to tell students what to think when they have encountered an ethical problem but to have students learn how to think, to possibly teach something about ethics, and to help students internalize the principles of engineering (Abaté, 2011). In other words, teachers must teach students that they may be blamed or held accountable in the

future. As with most personal developments, the easiest way to gain awareness about ethics is through personal experience or workplace interactions. In this case, ethical learning can easily be said to continue for engineers after graduating. As engineers become more professional, they can progress more easily with regard to ethics alongside getting used to workplace goals. As such, engineers should be able to clearly express ethical concerns to their employers in their workplaces (Smith et al., 2014).

Lifelong Learning Strategies Regarding Engineering Ethics: How Can Sustainability Occur in Ethics Learning?

That different learning strategies such as cognitive or metacognitive learning exist is well known. These strategies aim to have learners' learning capacity be more successful. However, the learning strategy of the future is based on the concepts of permanency and sustainability. Thus, engineer candidates must discover the importance of institutional learning before starting business life.

Alongside this, although the face-to-face learning methodology is still popular, engineers have been forced to adapt to digital learning techniques due in particular to COVID-19 or having not enough time during their teaching periods.

Face-to-face learning has many advantages such as creating a case-study opportunity in the classroom where students can connect or discuss with other candidates from a wide range of backgrounds, spending the day outside of the office. Meanwhile, online learning channels provide various advantages to engineers in all career stages such as 24/7 access to the course, getting post-graduation course updates, and monitoring global world events and social networks.

In this case, developing educators' capacities so as to integrate them into ethical and sustainable engineering courses and placing sustainable thinking and ethical practices in corporate culture and other professional groups may be identified as the initial target (Beder, 1997; Öztürk et al., 2015; Talu et al., 2015). Thus, unethical issues can be reduced or prevented while also achieving great success and sustainability in the work environment. In other words, key competencies should be integrated throughout curricula as well as specific competencies in each engineering discipline (Martínez-Mediano & Lord, 2012).

Improving and Licensing the Standards of Engineering Ethics

A good place to start would be by updating the ethical standards in Turkish Engineering. However, a council must first be established for updating standards. The general

ethical principles that need to be dealt with in all engineering branches need to be rewritten; namely, the principles of professional behaviour should be propounded. Having candidate engineers commit by becoming members of a professional institution after school may support this situation and establish an audit mechanism.

Also, employers have a key role to play on the issue. Engineer candidates can get support to form an ethical culture in the workplace from institutions with organizational memory and highly skilled expertise. This situation can have much more important than regulating ethical behaviours and applying standards or legislation. Of course, the Chamber of Engineers and other professional associations have conducted many studies, congresses, and symposiums on the subject and have surely submitted noteworthy principles. However, just like leaving principles to the conscientious responsibility of the engineer, a body of rules with no legal basis or sanctioning power creates difficulties in establishing ethical order (Nichols & Weldon, 1997; Smith et al., 2014).

Alright, solving the problem with laws, regulations, and directives is impossible. Regulating ethical behavior is a complex issue. Defining the boundaries of ethical rules is often an unclear and unique topic. Perhaps many studies can be carried out on enforcing laws, creating awareness of social responsibility, dealing with the loss of self-confidence caused by social exclusion, or the conscientious pressure an engineer's religious doctrine has. These studies' main purpose should be to guide engineers (Khulief, 2008; Nichols & Weldon, 1997). Therefore, the fact that talented engineers are increasingly more concerned with their status than any problems that occur or the health and peace of society is a noticeable regret.

Licensing is important to increase the reputation of the profession. The main purpose here is not to license the situation. For example, doctors are licensed not for their protection or to increase their status but to be able to monitor the prescriptions they write, the operations they perform, and the illnesses they diagnose (Kouchak & Smith, 2020; Talu et al., 2015). Apart from the rare exception, those in the engineering field must be licensed and registered and must keep records. In other words, associations or governments must keep engineers' registration files. Perhaps the first step should be to have engineers sign a statement of compliance or verbally vow to comply with ethical principles before starting their careers. However, this by itself will never be enough.

Now, imagine that many legal regulations and systems exist regarding ethical principles. Written resources are present, but there is no police or courts, and no-

body gets punished. In such a case, can one say that laws or legal regulations exist? Can engineers protect society in this way? Thus, new-generation employment models need to be developed.

How Should Engineering Ethics Instruction Be Presented to Students and Evaluated?

Students do not take time to consider unevaluated things seriously. At the same time, evaluations can easily become dull. Engineering candidates should be given the keys to enable their ability to think, discuss, and evaluate critically and thus solve the problems they face (Talu et al., 2015).

The first questions to ask are:

- Who will do the teaching work; how and when will it be done?
- Who will do the evaluation work; how and when will it be done?
- Who will do the accreditation; how will it be done?

Higher education centres and private education institutions should provide engineering candidates with ethics courses before graduation. These courses must be given by experts (Talu et al., 2015), as previous experience has shown that courses on things such as entrepreneurship, project management, and occupational health and safety do not have the expected impact when taught by non-experts.

This study conducts a questionnaire with engineering students at Ataturk University. A total of 154 students responded to the questionnaire, all of whom were third (8%) or fourth-year (92%) students. The gender distribution of the participants is 77% male and 23% female. The majority of the study's participants are students studying in mechanical, electrical-electronics, computer, industrial, or civil engineering departments. Figure 2 shows students' backgrounds and their area of residence in Turkey.

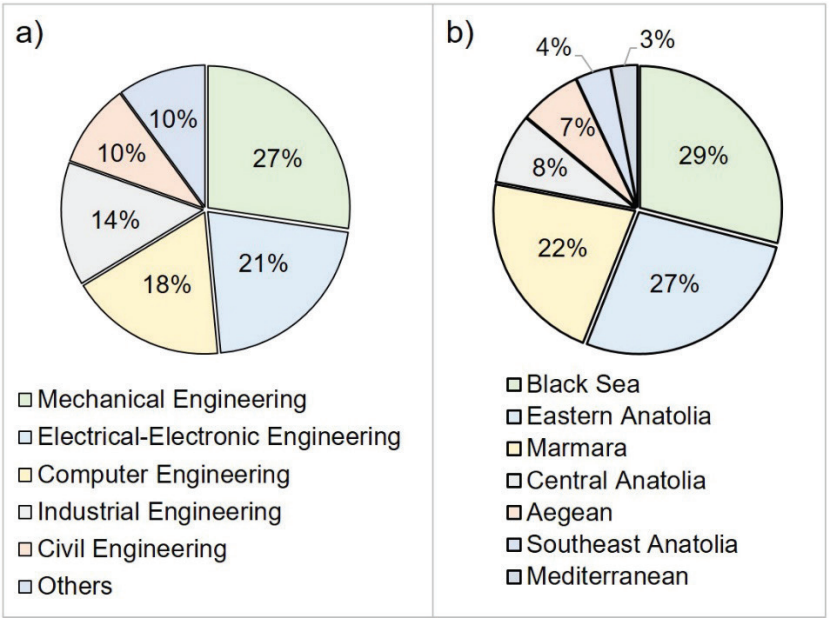

Figure 2. Student backgrounds (%): a) department b) region

Figure 3 shows that the majority of students agree that ethical problems and their content increase and change with the development of technology in the industry. Over 75% chose "agree" or "strongly agree" for these questions. These results show engineering students to be aware that they will face more ethical problems after graduation.

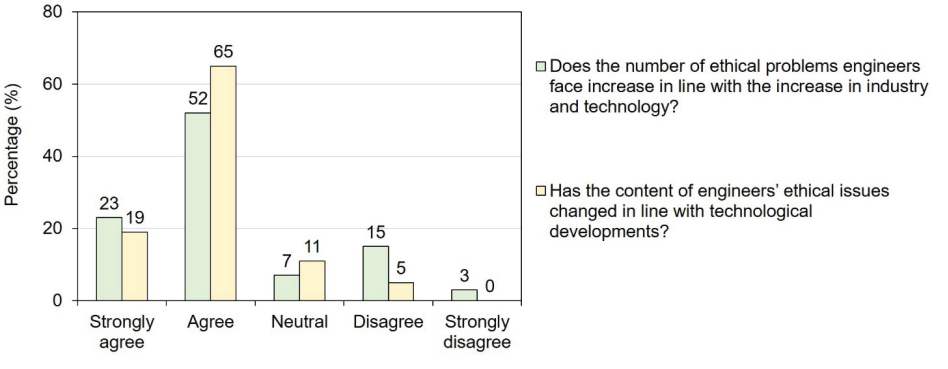

Figure 3. Students' general approach toward ethics and technological progress and their levels of understanding.

Undoubtedly, knowledge about ethical rules in engineering is also important for an engineer candidate. As such, this competence allows the spectrum of engineers' varied roles to integrate in the workplace while performing engineering services (Harun et al., 2016). The survey showed more than half of the students to have not encountered engineering ethics during their education; only 14% had attended a conference/symposium or workshop on the issue (Fig. 4a). Figure 4b shows students' level of knowledge regarding the rules of engineering ethics in their profession. Surprisingly, 62% answered they agree or strongly agree to know these rules. Even so, 38% of them do not know/agree (or are neutral) about their profession's rules on engineering ethics. Also, earlier studies have stated students to claim understanding the topic when in reality they did not (Falcone et al., 2013).

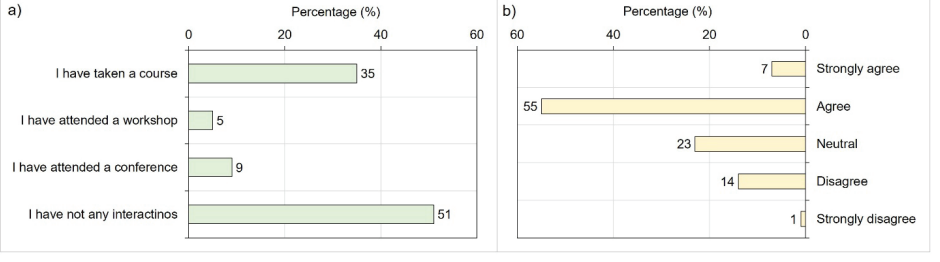

Figure 4. The levels of a) students' interaction with engineering ethics during their education and b) knowledge of their profession's ethics rules.

Universities apparently need to make radical changes to the engineering curriculum and to add compulsory engineering ethics courses rather than being elective. Perhaps engineer candidates who've not undergone proper ethics courses will not be allowed to work in the industry in the near future.

Apart from conventional learning, Maalouf (2019) proposed a method for increasing engineering candidates' ethical awareness during their education. In this method, a freshman student is paired with a senior student and then sent to a community-based organization for an internship. This study investigated the possible impacts education, experience, and gender interactions have on the ethical responsibilities of academic institutions and the workplace. The results revealed individual ethical values to be influenced by students' academic levels and by the amount of time spent at the workplace. Kirkman (2017) proposed a problem-based learning technique for engineering ethics courses in which students are divided into different work groups and start working on open-ended problem

situations. In other words, the lecturer doesn't select a problem for the students; instead, the students focus on understanding and conducting class discussions or offer short (10- to 15-minute) lectures to help them focus on what is most important. The first part of the course aims to establish a baseline understanding of the students' ethical development level up to that point. The second and third parts of the course are completed through a structured process in which students ask questions and generate options. The purpose here is to provide students with some of the basic tools of ethical inquiry as well as enough ethics theory. Perhaps a video-based assessment can be made? Similar examples were implemented in the UK (Fox, 2018), where students were divided into small groups in this learning method and recorded a 5-minute video on an ethical topic of their choice. Next, the students observed the attitudes in the classroom and discussed this ethical problem. Thus, the students were able to see the character they will have in the future and had the chance to take a different approach to ethical problems. This is very effective for the new generation as it can reveal their constructiveness and contribute to their enjoyment of ethical lectures. Perhaps in this way engineering candidates can gain well-disciplined behaviours and learn to take responsibility in the face of unethical problems. Lecturers giving homework and study topics to engineering candidates related to the real world during their education must be said again to be very important for them in terms of how they adopt/recognize their future roles (Khulief, 2008; Smith et al., 2014). Students should be taught before they graduate about the social, environmental, and economic impacts of decisions made on ethical issues.

However, the real work starts after they get their engineering degree. Although many institutions deal with ethical issues in Turkey, these institutions and organizations generally deal with the ethical principles of the manager or organization (Öztürk et al., 2015; Talu et al., 2015). Increasing the number of individuals or professional organizations that investigate and analyse ethical behaviour would be appropriate. This work can be started by establishing Professional Engineering Centres, a National Engineering Ethics Institute, or an Interdisciplinary Ethics Application and Research Centre. Perhaps best of all would be to accept ethics in engineering as a scientific discipline and place it among the education branches. For example, all this can be coordinated by the Republic of Turkey's Board of Ethics for Civil Servants (see Fig. 5). This council could also prepare Turkey's Standards for Professional Engineering Competence, as is encountered in developed countries (Engineering Council-UK, 2020). The engineering councils for each engineering discipline can help identify, monitor, and protect engineers with internationally

recognized professional competencies and commitments. The issues of registering and monitoring ethical rules should also be supported by professional associations such as the Chamber of Engineers.

Figure 5. Proposed institutions to establish and their relationship with the main institution for preparing the Republic of Turkey's Standards for Professional Engineering Competences

Engineers who've been evaluated according to these standards will possess a record and receive a title regarding their qualifications. However, each engineering branch having professional organizations is not enough. Having organizations monitor their engineers regarding their profession is necessary for keeping their skills at a high level, for the health and well-being of the community, for protecting the environment, and for determining whether they use their talents in line with economic behavioural principles (Talu et al., 2015). The engineers' national registration records on these councils will increase faith in the engineer both domestically and internationally. Similar examples can be found in different communities (Engineering Council-UK, 2020). The main goal is to have engineers gain the ability to report improper works.

Ethical Problems of the New Generation of Engineers: Big-Data

Nowadays, software and interactive data transfers have spread to all areas of life. Therefore, teaching engineer candidates ethical principles on big data, data privacy, and cyber security is also very important. Industry 4.0, which emerged with the development of artificial intelligence systems and machine learning, offers more autonomous and smarter systems that interact with people. This has led to discussions on the ethical principles between engineering and artificial intelligence systems on issues related to the design, development, operation, and maintenance of

industrial systems (Feng et al., 2019). Real-time storage, analysis, and processing of personal or professional data with the construction of sophisticated tools has radically changed the world because such systems have formed autonomously, and most of them have uncontrolled or semi-controlled environs (Hadlington, 2017; Hand, 2018). Also, the systems engineers design are daily becoming more complex and more dependent on digitalization. So, then how does one control these systems ethically? Feng et al. (2019) said that these challenges and problems need to be faced and solved in a timely and effective way in order to not get stuck in a predicament. In fact, knowing with absolute confidence that such questions or which actions are correct or harmful is impossible. Doing nothing means doing something, and unpredictable things can have negative results. In this case, staying in the best known spot is perhaps best (Kouchak & Smith, 2020). Consequently, if experts cannot propose effective implementation strategies, mankind's developments will certainly negatively affect the hidden danger.

What Are the Most Important Points and Steps to Take for the Future in Engineering Ethics?

Undoubtedly, the basic principle of ethical rules is to be in accordance with general morality. In other words, scientific or professional ethics must not contradict general moral standards! Therefore, the second most important principle of professional ethics is to be a role model for one's colleagues. Professional engineers have a responsibility toward their co-workers, executives, subordinates, colleagues, and even the entire society (Herkert, 2005; Khulief, 2008). This role will help students develop self-confidence while being active in the engineering profession. Society must know that no engineers are unsuccessful or not in compliance with the standards. Having engineers with ethics graduate is important for the development of a happy, healthy, and peaceful life. Of course, they must also accept their responsibilities. Considering ethical issues while determining Turkey's developmental goals is very important in terms of developing an intellectual perspective on these issues. In addition, this brings ethical practices to the forefront and contributes to the subject (Bowen, 2014; Nichols & Weldon, 1997).

Conclusion

Many frequently repeated problems in the field of engineering have shown teaching ethics in engineering using traditional methods to be baseless and inadequate. A person must be good before becoming a good engineer. Therefore, engineer

candidates should be equipped with basic rules of ethics starting in primary school. This may allow future engineers to continue their education under ideal conditions during graduate and post-graduate education. Engineers do the works of the world; but humans appear to still be unaware of the global challenges and responsibilities. So how does one ensure that engineer candidates take ethical rules and the related educational activities seriously? This study has presented a discussion about the issue.

Engineering rules of ethics are generally valid all over the world, and this is too serious to be left to personal opinion. Thus, engineering ethics must be considered from a global perspective. Undoubtedly, the case-study learning approach enables engineer candidates to discuss and evaluate the ethical problems they face. Namely, ethical awareness can be said to encompass a broad vision that comes with experience and seniority. However, today's problems show the formation of business ethics by telling students about historical events inhibits engineering students from making new expansions on the subject.

The learning strategy of the future is based on the concepts of permanency and sustainability. As such, a teacher's job is not just to tell students what to think when they encounter an ethical problem, but also to perhaps teach something about ethics and help them internalize the principles of engineering. Ethics-based courses must be instructed and evaluated by experts. Professional engineers have a responsibility as role models for engineer candidates. Apart from conventional education, having students take responsibility and adapt their skills can be done using video-based assessments. Lecturers who give homework and have engineering candidates study topics related to the real world during their education must again be said to be very important for these candidates in terms of how they adapt to and recognize their future roles. Online learning channels provide various advantages to engineers throughout their career, such as 24/7 course access, getting course updates after graduation, and monitoring global events and social networks. Students should be taught about the social, environmental, and economic impacts of making decisions about ethical issues before they graduate. Therefore, universities must make radical changes to the engineering curriculum and must add engineering ethics courses that are compulsory rather than elective.

Nowadays, talented engineers are regretfully noticed to be concerned more about their status than the problems and experiences that have arisen or increasing the health and peace of society. At this point, engineers must submit a declaration of their conformance to ethical principles orally and in writing before starting

their careers; also, whatever they do in the engineering field must be registered and licensed. Maybe engineer candidates who have not undergone proper ethics courses will not be allowed to work in the industry in the near future.

This study conducted a questionnaire with engineering students in Ataturk University. The survey results show the majority of students to agree that ethical problems and their contents have increased and changed with the increases in technological developments in the industry. Also, engineering students are aware they will face more ethical problems after graduation. While Industry 4.0, which emerged with the development of artificial intelligence systems and machine learning, offers more autonomous and smarter systems that interact with people, it has also led to the discussion on the ethical principles in engineering and in artificial intelligence systems. Thus, ethics rules must be revised in parallel with technological developments. In addition, engineering ethics should be accepted as a scientific discipline and placed among the education branches. For this purpose, Professional Engineering Centres, a National Engineering Ethics Institute, and an Interdisciplinary Ethics Application and Research Centre can be established for determining the Republic of Turkey's Professional Engineering Standards. Engineers who've been evaluated according to these standards will possess a record and received a title for their department. Having national registration records of engineers in councils will increase faith in engineers both domestically and abroad.

One should not forget that no unsuccessful engineer exists when engineers do not comply with standards. Having engineers graduate with a sense of ethics is important for the development of a happy, healthy, and peaceful life. Of course, they must also accept their responsibilities.

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