

The Experience of Developing Social Responsibility in the Next Generation of Engineers at Ukrainian Universities

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Abstract. The development of social responsibility of future engineers, who must be able to predict and evaluate the results of their professional activities is a relevant aspect of training specialists at a technical university. The problem is becoming increasingly acute due to the rapid penetration of artificial intelligence into many areas of the socio-economic life of society, in which many researchers and entrepreneurs see not only benefits for mankind, but also threats due to fears of artificial intelligence getting out of human control.

Although there are some disciplines at Ukrainian universities that in varying degrees deal with ethical issues of engineering, many higher schools do not typically consider professional ethics as a compulsory course, so it seems necessary to look for additional methods and techniques for the formation of engineering ethics and social responsibility as its key element in various types of activities.

In 2021–2023, a pedagogical experiment was conducted at Kharkiv National Automobile and Highway University with the aim of selecting and testing a set of methods for developing future engineers' social responsibility. To this end, an

experimental group was formed from students of different specialities (122 students), in which a variety of pedagogical methods were used while studying various disciplines in the format of formal education (discussions, debates, solving dilemmas, projects, case studies, simulations, etc.), informal (round tables, conferences, contests, publishing results of research), and informal education (volunteering, involvement in civil activities), and a control group (120 people), in which these methods were not used.

The following criteria and indicators for assessing the level of development of social responsibility were chosen: 1) a value-based criterion (awareness of social responsibility as a key feature of an engineer's professionalism; 2) pragmatic (skills to navigate in a variety of professional situations and make responsible decisions); 3) reflective (ability to make evaluative judgments, self-esteem).

In the study, we applied a mixture of quantitative and qualitative methods to evaluate the results of the experimental work by the chosen criteria and indicators. The positive impact of the tried-and-tested methods on the development of social responsibility in the next generation of engineers was experimentally proved.

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Promising for further scientific research is the improvement of pedagogical support of ethical skills' formation in technical specialists, as well as a set of methods for diagnosing the socially significant characteristics of technical students.

Keywords: development, future engineer, pedagogical experiment, social responsibility.

I. INTRODUCTION

An important task of higher education institutions that train specialists in technical specialities is the development of social responsibility (SR) in students, which will encourage them in the future to act in the interests of society, predict and evaluate the results and consequences of their actions.

Technology is an integral part of modern culture and civilization, and the traditional technical training has always been largely targeted at the cultivation of the technocratic attitude to the world. But taking into account the bitter experience of the recent past, there is a need to re-evaluate the engineering education from the new, ethical positions, to search for more humane forms of interaction between man and technology as uncontrollability of technology poses great threats to the safety and well-being of humans. One can recall engineering-related failures that resulted in injuries or death of countless people, e.g., levee failures in New Orleans, Chernobyl disaster, Deepwater Horizon oil rig spill, Montana asbestos contamination, Minamata mercury poisoning, Jilin chemical plant explosion, Seveso disaster, interstate bridge collapse in Minnesota. These and many other tragedies undermine confidence in engineers and raise the question of strengthening their SR.

Lately, humanity has faced such a new threat as artificial intelligence, the rapid development of which causes increasing concern among the best minds of the planet, who warn about the possible existential risks that this technology poses. Among the biggest dangers with AI are fraught with the experts mention job losses due to automation, lack of AI transparency and explainability, wealth inequality, social surveillance with AI technology, lack of data privacy, autonomous weapons powered by AI, AI acting beyond humans' control and in a possibly malicious manner [1].

Not long ago, an open letter signed by more than a thousand experts and entrepreneurs came to light, calling for the development of AI technologies, which are already difficult to control, to be put on hold until robust security protocols are developed. It is also worrying that the leading tech giants (Microsoft, Meta, Tesla) involved in AI development are cutting teams that ensure responsible development of their products, although it is precisely these teams that help developers anticipate and eliminate potential risks and problems of a new technology, before new products are in the hands of users [2].

We are unlikely to want to use medicines, vehicles or civil structures if they are made by irresponsible people. As Einstein believed many years ago, the fate of scientific and technical progress depends on the moral principles of its creators, and the ethical and humanistic approach is a priority criterion for this progress.

One cannot but agree with Rapp's point of view [3], that technology is based on the mechanisms of human culture and values, so the problems of engineering can be solved by improving society, social institutions, democratic mechanisms of control, and education.

II. MATERIALS AND METHODS

Engineering ethics regulates engineering activity through a certain system of norms and values and is formed in students primarily as a result of mastering the content of the subject of professional ethics and gaining an experience of professional morality in a situational learning [4].

In many developed countries, there is an extensive ethical infrastructure, the core of which is ethics committees that work in all spheres of economic and social life, and the costs of creating and maintaining this ethical infrastructure are quickly paid off in the market when interacting with counterparties who want to cooperate with a reliable partner [5].

Leading institutions in the field of professional ethics are presented by the Canadian Centre for Ethics and Corporate Policy, Edmond & Lily Safra Center for Ethics at Harvard University, the Erasmus Centre of Behavioural Ethics at the University of Rotterdam (Netherlands) and the Center for Ethics at the Open University (Great Britain), The Hague Institute for Global Justice, Netherlands, etc. They deal with theoretical issues of professional ethics, hold various events involving businesses, participate in the accreditation of universities, their representatives are included in commissions that approve curricula and courses. The experience of these institutions is worth studying and adopting as common efforts of all countries should be applied to improve the system of ethical education.

The key concept of ethics, both professional and engineering, is responsibility. At present in the literature the term "corporate social responsibility" (CSR) or social responsibility of business is increasingly being used. The social responsibility of business involves the obligation of companies to protect the interests of society, and not just to care for profit [6].

It should be noted that the present war with Russia has a significant impact on the role and development of SR of business in Ukraine. According to a survey [7], about 67% of Ukrainian enterprises have restructured their budgets and added SR as a separate item of the balance sheet budget, thereby ensuring support for the state and the Armed Forces of Ukraine.

Researchers express their views that the development of SR should be fully integrated into the curricula at all levels of engineering education, which will allow informing students about various social and ethical aspects and consequences of their future activities. Some Western universities have already introduced such courses as business and society, business ethics, environmental management, corporate social responsibility, and corporate citizenship. In addition to special courses, such educational tools are used as the introduction of additional modules, holding seminars, conferences, other special events, etc. [8].

But it does not seem to be enough. Among 180 engineering educators in the study by Romkey [9], the average implementation of “I encourage students to consider the potential environmental impact of technology” was 2.49 (where 2 = sometimes and 3 = often on a 1–4 scale).

As Akay claims, it is clear that engineering must go beyond pure technology and address matters that are imbedded in the social and economic fabric of society [10]. Engineering courses should integrate sustainability and socially responsible design agendas throughout the four-year undergraduate curriculum and develop awareness and understanding of socially responsible design and behaviour in the next generation of engineers [11].

In order to form SR in technical students, a pedagogical experiment was conducted at Kharkiv National Automobile and Highway University in 2021–2023 with involving 242 students of different specialities who were divided into two groups, the experimental group (EG, 122 persons) and control group (CG, 120 persons), and 27 teachers of various disciplines. Besides, students and teachers from other Kharkiv universities – O.M. Beketov National University of Urban Economy, National Technical University “Kharkiv Polytechnic Institute” were invited to participate in a number of extracurricular events.

The tasks of the experimental work were 1) to select and test methods to form SR in students within the framework of formal, non-formal and informal education, 2) to compare the indicators of SR of the students from the EG who were exposed to the methods of pedagogical influence, and the CG where no experimental methods were used.

The results of diagnostic measures (surveys, interviews, observations) showed that the understanding of the concept of SR by the students is vague and mostly at an intuitive level. The students themselves explained this by an insufficient attention to ethical issues in the course of studies.

An analysis of more than 40 programmes in various technical specialities [12] showed that they did not practically include disciplines directly related to engineering ethics, though some ethical issues could be raised in the course of studying such programme disciplines as ethics of business relations, ecology, civil defence, labour protection, man-machine interaction, philosophy of engineering and technology, social concepts of sustainable development of transport, traffic safety audit, basics of academic integrity and academic writing and some others.

None of these disciplines offered a holistic approach to the formation of SR of a future specialist, but they might become a favourable basis for the development of this quality if they were supplemented with appropriate content and taught by appropriate methods that we did during the experiment.

Taking into account the features of SR in engineering (fair operating practices, care for environment, accountability, transparency, ethical behaviour, respect for the rule of law, etc.) the following criteria and

indicators for assessing its levels were chosen: 1) value-based (awareness of social responsibility as an important indicator of an engineer’s professionalism; 2) pragmatic (the formed skills to navigate in a variety of professional situations and make responsible decisions); 3) reflective (the ability to make evaluative judgments, self-esteem).

We distinguished the following levels of awareness of SR: full awareness (students understand the importance of an engineer’s SR, have a clear idea of a professional duty); partial awareness (have a vague idea of the norms of engineering ethics and the social role of the engineering profession; lack of awareness (there is no awareness of the need for responsible performance of professional duties).

The levels of skills necessary for making responsible decisions were defined as: high (a student has fully mastered all groups of skills necessary for socially responsible professional activity; average (a student requires assistance in making responsible decisions); low (a student has not mastered the skills necessary to demonstrate SR in professional activity).

The levels of reflexivity of behaviour were determined as follows: high (a student constantly reflects on his/her own behaviour in the aspect of SR; they are able to adequately analyse professional and ethical situations); average (a student is not always able to adequately analyse professional and ethical situations and make responsible decisions); low (a student does not reflect on his/her own behaviour in terms of SR).

To assess awareness of SR as an important component of the professionalism, responses to open questions of a questionnaire developed by Yemelyanova [13] were used. The formation of professional and ethical skills was revealed with the help of special tasks at the level of recognition, reconstruction, production and creativity, which contained the entire range of possible human patterns of behaviour and were expressed quantitatively [14], [15]. The indicator of reflexivity of behaviour was established using Rotter’s questionnaire for determining the level of subjective control [16] that characterizes a person’s tendency to attribute responsibility for events in life to external forces or to their own abilities and efforts.

In the experimental work we tried and tested numerous methods and techniques of active learning, which contributed to the formation of professionally responsible engineer [17].

In modern pedagogical literature, three types of education are distinguished – formal, non-formal and informal, each in its own way affects the process of organizing education and self-learning. Formal education is regulated by the programs of educational institutions, non-formal education covers various alternative measures and resources additional to the system of formal education, informal education is the least structured and organized by people themselves according to their plans.

Within the framework of formal education, SR was developed in students of the EG during lectures and practical hours while discussing issues of responsibility for the environment, the country, the results of professional activity, etc., e.g. What is a professional

duty? What is professional integrity?, Responsible people: what they are like, What can be done to improve the behaviour of road users? What are the dangers of driving under drugs or alcohol? What is more effective, advertising campaigns or stricter laws? What can be done to help people understand the risks and develop safer habits?

The students were shown videos on acute environmental problems, such as *The Human Element* (2019), *Before the Flood* (2016), *Chasing Coral* (2017), *Racing Extinction* (2015), *The Ivory Game* (2016), *Life after people* (2010), *Catching the Sun* (2015), *Home* (2009), *Extinction: the Facts* (2020), *The Day after Tomorrow* (2004), etc. The students were also suggested to watch *Oppenheimer* (2023) – a biopic about an atomic bomb pioneer Robert Oppenheimer. After watching the films, the students were asked to discuss the issues raised from the point of view of SR of technical specialists, analyse social values and destructive consequences of irresponsible attitude to the planet and its inhabitants.

The following legal and ethical questions about artificial intelligence (AI) could start highly controversial and even philosophic discussions: At what point is a machine truly intelligent? If an AI injures or kills a human, who is to blame? The manufacturer, the owner, or the AI itself? Would you be comfortable seeing an “AI Doctor” or an “AI Nurse”? Would you feel safe in a plane that was being piloted by an AI-powered system? What are the geopolitical implications of AI? etc.

Critical thinking skills were developed while solving ethical dilemmas of the robotic future: Robots in upbringing and education: parents or machine? Drones: protection or surveillance? Robots and personal affection: is it possible? Determining the boundaries of the machine responsibility: who is responsible for the accident? Privacy: to trust or not to trust our personal data to AI? Medicine: who is more likely to cure?

The students were suggested to perform an online “Environmental awareness quiz” [18] with a subsequent discussion which included the following multiple choice questions: What is the cause of climate change? How much waste do humans produce every year? What’s the most effective way to reduce CO₂ emissions? Whose responsibility is it to make sure we reduce the amount of energy used?, etc.

In order to teach students to make a moral choice, a business game “Technique for eliminating deadlock situations” was held to help students to find new ethically acceptable decisions.

The students were divided into several “road construction companies”, which had to lay a road, taking into account a number of factors: the topography of the area, the location of settlements, possible deductions to the local budget, damage to the environment. After the “companies” made their decisions, the teacher deliberately drew a card with a set of “force majeure circumstances” and announced some unexpected event, e.g., a flood destroyed a bridge, and one of the companies must urgently repair it. The affected “companies” were forced to make amendments to their calculations and

choose priorities – profit, people, environment, that required students' critical thinking responsive solutions.

The students carried out a project that involved analysing the advantages and disadvantages of different modes of transportation, assessing factors such as safety, pollution, congestion, noise, health and community well-being.

The advantage of the case study method is that students learn to work in a team, analyse various life situations and look for the most suitable solutions. An example is the case study developed by Raicu (2018), which we adapted to our conditions [19]: the students had to decide whether their company/team should enter into a contract with the city to create a controversial product by analysing what ethical issues its designers/developers need to address, and what moral values potentially conflict with each other.

Another efficient tool to accustom students to responsible behaviour is the training practice, which enables students to feel involvement in the real professional activity by performing the duties of a specialist's assistant and to realize their social role.

As part of non-formal education, such events as essay contests, round tables, conferences, and the publication of the results of research were organized. Topics for essays included the following: What are the biggest challenges in mechanical engineering? The city of the future. What scares you the most about AI? What are the potential benefits of AI? List as many as ways or applications of AI as you can. What are some future uses of AI? etc. A “Road safety” video competition was held to encourage students to conduct surveys of local roads and proposed measures to improve road safety (for example, road markings, installation of speed cameras, regular police patrols).

Round tables as a form of public discussion of some problems were held on the following topics: The city of the future; Alternative energy sources; Will virtual reality become a primary form of entertainment and communication in the future?; What kind of regulations should be in place to control the development of AI?; The jobs that can't be automated; How long will it be before self-driving cars are common on the roads?

A student conference is an annual event organized by almost all universities of Ukraine. The students of the EG presented the results of their mini-research acquiring the skills of public presentation on various urgent topics: The pros and cons of AI's effects on jobs; Does technology make society lazy?; What is the future of transportation?; The Internet to learn English; Will the increasing dependence on technology lead to a loss of critical thinking skills in individuals? etc. Even in war conditions the students continued to take an active part in research work. The best reports were published in the collection of students' scientific papers “Students. Science. Foreign language”, which since 2008 has been published annually at the university.

Informal education includes, firstly, student self-government, which deepens the initiative of student groups in the organization of various types of activities. An important direction of student self-government today

is volunteering, which during the full-scale war in Ukraine has taken various forms and contributed to the national resistance to the Russian invaders in different ways [20]. In particular, many volunteers are helping the Ukrainian military, providing important support in the form of weapons, special equipment, transport, means of communication, training, etc.

The students-volunteers from the EG also took part in collecting donations to support military and humanitarian organizations that provided assistance to those affected by the conflict, in particular, internally displaced persons. This aid included food, clothing, shelter, medical care and other essentials. They met with the participants in the hostilities – war heroes, took part in the celebration of "Day of the Defender of Ukraine", "Day of the Ukrainian Cossacks", etc.

III. RESULTS AND DISCUSSION

At the control stage of the experiment we determined the indicators of the dynamics of SR development by the specified criteria. The successful formation of SR in students is largely determined by the awareness of social responsibility as an important component of the professionalism of a modern engineer. Therefore, we

consider a significant increase in the number of students in the EG, who have a high level of awareness of the importance of SR an important result of the experimental work (Table I).

We believe that such changes occurred due to extensive work by teachers of social, humanitarian and special disciplines, and organizers of training practice as they provided an opportunity for each student to check their readiness for a responsible attitude to functional duties, the degree of professional competence, identify shortcomings and outline ways of professional self-improvement.

The formation of the skills of socially responsible behaviour was achieved thanks to supplementing the content of social and humanitarian disciplines with knowledge of a professional and moral nature, active and interactive forms and methods of learning (round table, discussion of ethical situations, solutions of moral dilemmas, brainstorming, case analysis; simulation of professional situations, etc.). The dynamics of development of SR skills is shown in Table II.

Based on [16], we also determined the indicators of the dynamics of future engineers' reflexivity (Fig. 1).

TABLE I DYNAMICS OF AWARENESS OF SOCIAL RESPONSIBILITY (%)

Feature	E (122)		C (120)	
	Before experiment	After experiment	Ascertaining data	Control data
Full awareness	11.0	83.2	15.9	19.0
Partial awareness	60.0	14.8	43.8	71.4
Lack of awareness	29.0	2.0	40.3	9.6

TABLE II DYNAMICS OF FORMATION OF SOCIALLY RESPONSIBLE SKILLS(%)

Level of development	E (122)		C (120)	
	Before experiment	After experiment	Ascertaining data	Control data
High	5.9	62.0	4.4	23.1
Average	61.5	37.5	59.1	63.8
Low	32.6	0.5	36.5	13.1

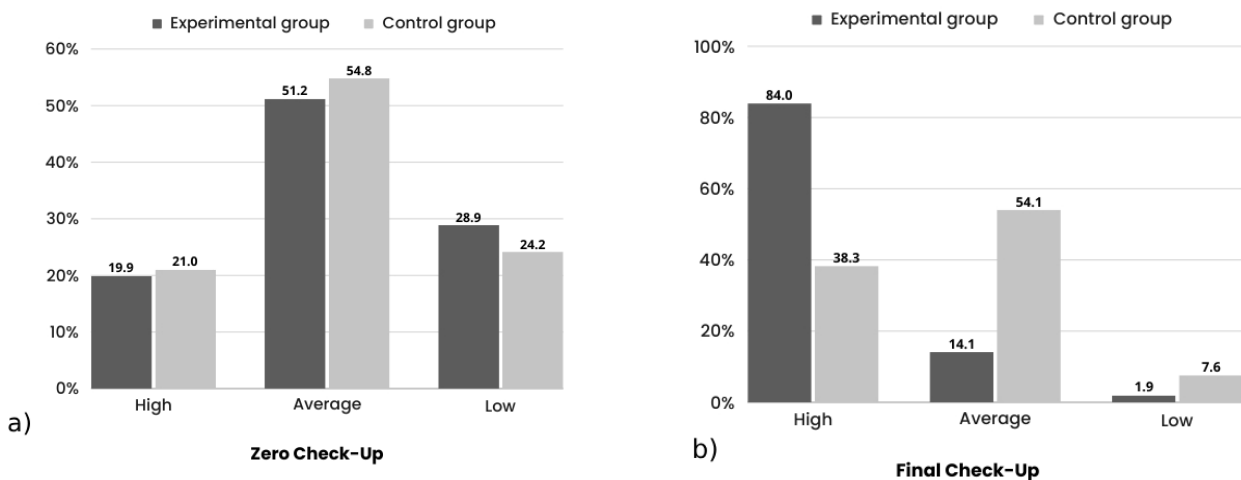


Fig. 1 Trends in the development of the reflexive behaviour

In the course of the experiment with the regular involvement of students in various practices of the ethical nature (participation in contests of essays on ethical topics, round tables, discussions of acute socio-ethical problems, case studies, etc.), the following results were obtained: the number of students with a high level of reflexive behaviour increased by 64.1% (EG), compared to 17.3% (CG), which indicates a significant impact of the applied methods on the students' ability to analyse professional situations and make responsible judgments.

The reliability of the results of the experimental work was proved by the means of mathematical statistics (the change in the statistical characteristics of the experimental and control samples was analysed by the criteria of significance) [21], which confirmed that changes in the levels of indicators of future engineers' SR are statistically significant.

In general, by the set of indicators we would divide all the students into those who demonstrate a willingness to take responsibility for their actions, act in extreme conditions, look for new ways of solving educational and professional tasks, emotional stability, stress resistance, endurance, a high degree of self-control; those who are characterized by readiness to perform tasks, but only according to the pattern, they negatively evaluate production situations in which their behaviour is not clearly regulated by normative documents; and those who are characterized by uncertainty of their social and professional position, indifferent attitude to the fulfilment of their future professional duties; formal compliance with requirements, instructions and rules of conduct. We found out that the first group of students can be quantitatively and qualitatively improved when students are suggested to consider real-life scenarios or emergency situations that teach them responsibility and develop a high level of understanding of issues of sustainable community development.

We support the idea of the need to develop holistic engineers who are able to solve the complex social problems of the future that calls for a rethinking of engineering education to include greater interaction with the public and industrial partners, more diverse teaching methods, and increased attention to engineering problems.

At the same time, we experienced a lack of a systematic approach to the development of SR in students, a clear inventory of methods and techniques that can be used within specific disciplines, a description of practical experience in this area of engineering education, therefore we believe promising for further scientific research is the development of methodological support for the formation of ethical skills of future engineers, as well as a set of methods for diagnosing the socially significant characteristics of technical students.

CONCLUSIONS

The development of technology and especially such a field as artificial intelligence makes new demands on the morality of a scientist and engineer. Almost every

day we learn about the emergence of new computer programs that surpass the mental abilities and creative capabilities of humans: they generate texts, sing, draw, and make medical diagnoses.

The improvement of technology and smart machines is inevitable, as is the fact of their undeniable impact on society, economy and relationships between people in the future. Therefore, more and more urgent calls are heard to consider the ethical principles of engineering and AI development, making sure that technology is developed in a direction that is safe for people.

These problems pose significant challenges for higher education institutions of a technical profile, because they are the ones that can and should train responsible engineers of the future, who will be ready to take responsibility for their actions, strive to improve production, be aware of the interests and needs of society.

The experience of Ukrainian universities shows that the regular involvement of students in activities that improve their organizational, evaluative, analytical abilities and affect their emotional sphere contributes to the development of their moral qualities and forms responsible engineers of the future generation.

REFERENCES

- [1] M. Cheng-Tek Tai, "The impact of artificial intelligence on human society and bioethicsm" *Tzu Chi Medical Journal*, vol. 32(4), pp. 339-343, Aug. 2020, doi: 10.4103/tcmj.tcmj_71_20
- [2] V. Glinka, "Artificial intelligence as a threat" [Штучний інтелект як загроза]. *Forbes Digital*. April 2023 [Online]. Available: <https://forbes.ua/innovations/shtuchniy-intelekt-yak-sira-zona-problemi-ta-rishennya-regulyuvannya-instrumentiv-na-osnovi-shi-03042023-12810>. [Accessed: September 16, 2023].
- [3] G. Ya. Mamalui, *Philosophical alternatives of the 20th century: Lectures on the course "History of Philosophy"* [Філософські альтернативи ХХ століття: Лекції по курсу "Історія філософії"]. Kharkiv: KhDAK, 2002.
- [4] O. M. Lapuzina, "Formation of professional ethics in future engineers based on situational learning," [Формування професійної етики у майбутніх інженерів на основі ситуаційного навчання], PhD thesis, Vinnitsia: VDPU, 2006.
- [5] P. Brey, "Research Ethics Guidelines for the Engineering Sciences and Computer and Information Sciences," in *The International Library of Ethics, Law and Technology*, Vol. 23, K. Laas, M. Davis, and E. Hildt Eds., Springer, 2022, pp. 15-34. https://doi.org/10.1007/978-3-030-86201-5_2
- [6] D. S. Bukreeva and K. V. Denisenko, *Social responsibility of business as a basis for ensuring business activity of enterprises: European integration aspect* [Соціальна відповідальність бізнесу як основа забезпечення ділової активності підприємств: євроінтеграційний аспект], *Economy and society*, vol. 38, 2022 [Online]. Available: <https://economyandsociety.in.ua/index.php/journal/article/view/1316>. [Accessed: Oct., 4, 2023], <https://doi.org/10.32782/2524-0072/2022-38-52>
- [7] E. P. Buryi and G. P. Zhaldak, *Corporate social responsibility in war conditions* [Корпоративна соціальна відповідальність в умовах війни], IV International scientific and practical conference *Business, Innovations, Management: Problems and Trends*, April 23, 2023, Kyiv: NTU "Kyiv Polytechnic Institute".
- [8] P. Adamek, "Corporate Social Responsibility Education in the Czech Republic," *Procedia – Social and Behavioral Sciences*, vol. 106, pp. 730-738, 2013.
- [9] L. Romkey, *Engineering, society and the environment in the teaching goals and practices of engineering instructors*. *Proc. of*

- the American Society for Engineering Education (ASEE) Annual Conference and Exposition, June 14-17, 2015, Seattle: WA, 2015.
- [10] A. Akay, "The renaissance engineer: educating engineers in a post-9/11 world," *European Journal of Engineering Education*, vol. 28(2), pp. 145-150, 2003.
- [11] I. De Vere, K. Bissett Johnson and C. Thong, *Educating the responsible engineer: socially responsible design and sustainability in the curriculum*. International conference on engineering and product design education, September 10-11, 2009, University of Brighton, UK, 2009.
- [12] Catalog of educational programs [Каталог освітніх програм], 2021 [Online]. Available: <https://www.khadi.kharkov.ua/education/katalog-osvitnikh-program/>. [Accessed: Oct. 25, 2021].
- [13] T. P. Emelianova, Professional responsibility in the everyday consciousness of energy engineering students [Професійна відповідальність в об'язковому свідомості студентів-енергетиків]. *Information humanitarian portal "Knowledge. Understanding. Skills"*, vol. 2, 2013 [Online]. Available: http://www.zpu-journal.ru/e-zpu/2013/2/Emelianova_Professional-Responsibility-Students/. [Accessed: June 14, 2021].
- [14] S. Philbin, *Engineering Education: Research and Professional Skills Development*. American Society for Engineering Management (ASEM) International Annual Conference. Oct. 5-8, 2022, American Society for Engineering Management, Tampa, FL, 2022.
- [15] N. E. Adams, "Bloom's taxonomy of cognitive learning objectives," *Journal of the Medical Library Association*, vol. 103(3), pp. 152-153, 2015.
- [16] J. Rotter, "Generalized expectancies for internal versus external control of reinforcement," *Psychological Monographs*, vol. 80 (1), pp. 1-28, 1966. [Online]. Available: <https://pubmed.ncbi.nlm.nih.gov/5340840/>. [Accessed: November 13, 2021].
- [17] G. S. Sozykina, O. V. Popova and N. V. Saienko, *Social responsibility of future engineers in the automobile and road industry: pedagogical aspect: monograph* [Соціальна відповідальність майбутніх інженерів автомобільно-дорожньої галузі: педагогічний аспект: монографія]. Kharkiv: KhNAHU, 2020.
- [18] Environmental awareness quiz [Online]. Available: <https://www.ideagen.com/solutions/elearning-content/workrite/environmental-awareness-quiz>. [Accessed: March 18, 2022].
- [19] I. Raicu, *Surveillance, Safety, and Smart Cities. An Ethics Case Study*, 2018 [Online]. Available: <https://www.scu.edu/ethics-in-technology-practice/case-studies/surveillance-safety-and-smart-cities/>. [Accessed : Jan. 14, 2022].
- [20] O. Reznik, *Involvement of Ukrainians in volunteer activities during a full-scale war* [Залученість українців до волонтерської діяльності під час повномасштабної війни]. Iiko Kucheriv Foundation for Democratic Initiatives, April 26, 2023. [Online]. Available: <https://dif.org.ua/article/oleksandr-reznik-zaluchenist-ukraintiv-do-volonterskoi-diyalnosti-pid-chas-povnomasshtabnoi-viyni>. [Accessed: Nov. 15, 2023].
- [21] T. G. Kryvorot, "Non-parametric methods of mathematical statistics for evaluating the effectiveness of pedagogical innovations [Непараметричні методи математичної статистики для оцінювання ефективності педагогічних нововведень]," *Pedagogy of creative personality formation in higher and secondary schools*, vol. 32, pp. 288-295, 2013.