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ETHICIZING SCIENTIFIC ACTIVITY AND MORAL EVOLUTION OF FUTURE ENGINEERS IN THE DIGITIZATION ERA

Abstract

This article presents the relevance and experimental verification of organizational and pedagogical possibilities of ethical scientific activity of the future engineer in the digitalization era, reveals pedagogical conditions: humanity, interdisciplinarity, integrativity, identified and motivated principles of the future engineer's ethical scientific activity as humanistic orientation, subjectivity, mutual understanding, cultural appropriateness, coordination of tradition and innovation, compliance with which improves formation stages principles of personal qualities of the future engineer. The identified pedagogical conditions improve the process of ethical scientific activity of the future engineer taking into account the requirements of modern science and practice in the era of digitalization. The reliability and validity of the results are methodologically proved by the initial research hypotheses; in the volumetric analysis of the given problem at the interdisciplinary level; applying in complex a variety of complementary methods of empirical digital data collection and software processing corresponding to the research problem, objectives, tasks, hypothesis, application of various methods of qualitative and quantitative evaluation and interpretation of results, objective possibility of experimental work replication, nature of significance and sample size of the experimental research data

Keywords: ethics, morality, engineering activity, pedagogical conditions, student, engineering ethics.

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ЭТИЗАЦИЯ НАУЧНОЙ ДЕЯТЕЛЬНОСТИ И НРАВСТВЕННОЕ СТАНОВЛЕНИЕ БУДУЩИХ ИНЖЕНЕРОВ В ЭПОХУ ЦИФРОВИЗАЦИИ

Аннотация

В данной статье представлены акуальность и опытная проверка организационно-педагогических возможностей этизации научной деятельности будущего инженера в эпоху цифровизации, раскрыты педагогические условия: гуманитарность, междисциплинарность, интегративность, идентифицированы и аргументированы принципы этизации будущего инженера в процессе научной деятельности как гуманистической направленности, субъектности, взаимопонимания, культуросообразности, согласованности традиций и инноваций, соблюдение условий которых совершенствует принципы этапов становления личностных качеств будущих инженеров в процессе развития студенческого научного онлайн-общества; Определенным спектром возможностей в этизации личности студента обладает научная деятельность, так как она а) интегральна по своей сути, технологиях и обеспечивая взаимодействие нравственных принципов субъекта; б) обновляет применение гуманитарных технологий, на основе совести,ответственности, взаимопонимания, честности, милосердия инициирование рефлексии собственной научной деятельности субъекта; в) содействует внедрению сущностных аспектов нравственно-личностного развития изучаемых учебных предметов студента. Установленные педагогические условия улучшают процесс этизации научной деятельности будущего инженера учитывая требования современной науки и практики в эпоху цифрофизации. Достоверность и обоснованность полученных результатов методологически обоснована исходными позициями исследования; в обьёмном анализе данной проблемы на междисциплинарном уровне; применяя в совокупности разнообразные взаимодополняющие методы сбора и програмной обработки

эмпирических цифровых данных, соответствующих проблеме изучения, целям, задачам, гипотезе, применением разнообразных методик качественного и количественного оценивания и интерпретацией результатов, объективной возможностью репликации экспериментальной работы, характерностью значимости и объема выборки данных экспериментальной работы

Ключевые слова: этизация, нравственность, инженерная деятельность, педагогические условия, студент, инженерная этика.

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ҒЫЛЫМИ ҚЫЗМЕТТІ ЭТИЗАЦИЯЛАУ ЖӘНЕ ЦИФРЛАНДЫРУ ДӘУІРІНДЕ БОЛАШАҚ ИНЖЕНЕРЛЕРДІҢ АДАМГЕРШІЛІК ҚАЛЫПТАСУЫ

Аннотация

Бұл мақалада цифрландыру дәуірінде болашақ инженердің ғылыми қызметін этикаландырудың ұйымдастырушылық-педагогикалық мүмкіндіктерін ұқыптылық пен тәжірибелік тексеру ұсынылған, педагогикалық жағдайлар ашылған: гуманитарлық, пәнаралық, интегративтілік, гуманистік бағыт, субъективтілік, өзара түсіністік, мәдениеттілік, дәстүрлер мен инновациялардың үйлесімділігі, болашақ инженерді ғылыми қызмет процесінде этилизациялау принциптері анықталған және негізделген. студенттердің ғылыми онлайн - қоғамын дамыту процесінде болашақ инженерлердің жеке қасиеттерін қалыптастыру кезеңдерінің принциптерін жетілдіретін жағдайлар; студенттің этизациялауда көтерудің анықталатын спектрі ғылыми коммутацияға ие, өйткені ол а) өзінің мәні, технологиясы бойынша интегралдық және тең емес принципті кіреберістердің өзара әрекеттесуін қамтамасыз етеді; б) гуманитарлық технологияларды қолдана отырып, ар-ождан,ашықтық, өзара түсіністік, адалдық, субъектінің жеке ғылыми анықтамасының рефлексиясын бастауға мейірімділік негіздеріне жаңартылады; в) байланысты аспектілерді енгізуге ықпал етеді студент игерген оқу пәндері деңгейінде тұлғалардың адамгершілік өмір сүруі. Қазіргі ғылымдарға мұқтаж және цифрлық дәуірдегі практиканы қажет ететін болашақ инженердің ғылыми бағытын этикаландырудың инвестициялық процесінің белгіленген педагогикалық шарттылығы. Зерттеудің алынған әдіснамалық негізделген бастапқы ережелерінің сенімділігі мен негізділігі; пәнаралық деңгейде бұл мәселелелерын жалпы талдауда; жие қолданылатын зерттелген, тұтас, анықтайтын, гипотезалардың эмпирикалық сандарын, сапалық және сандық бағалау мен нәтижелерді интерпретациялаудың әртараптандырылған әдістерін, объективті түрде бағаланатын және түсіндірілетін, тәуелді мәселелердің эмпирикалық сандарын жинаудың және бағдарламалық өңдеудің әртараптандырылған толықтырушы әдістері пайдалану жұмыстары репликациясының қозғалғыштығы, таңдалған даттық пайдалану жұмыстарының маңыздылығы мен көлемінің сипаттамасы.

Түйін сөздер: этилизация, адамгершілік, инженерлік қызмет, педагогикалық шарттар, студент, инженерлік этика.

Introduction. The significance of the research is due to a priority process of modern society's digitalization. Digital environment acts as a means of obtaining information, is a accelerator of scientific and technological progress, aimed at improving technological processes in the production, optimization in the industrial sphere and development of innovative products for the new generation [1]. Information resources are universally integrated into the system of higher technical education as a prerequisite for becoming a twenty-first century engineer.

Digitalization as one of the stages of scientific and technological progress should not cause the loss of values, the main of which are education and science. Transformational changes are inevitable, but it is necessary to preserve moral values and develop new ethical rules related to the development of the Internet and its penetration into the political, social and educational spheres of public life. The transition to the digital economy must be consistent and ethical in terms of "embedding" digitalization into the processes of modern society.

The ethicalization of engineering innovation is becoming increasingly important. Technology tools in academic institutions should have an impact on the creation of an understanding of the world, the upbringing

of an engineer's personality, the development of a correct understanding of the scientific worldview, the focus of the philosophical and pedagogical communities on the axiological component in educational and engineering activities, the ethical and aestheticization of education[2].

The problem of digital transformation of future engineers' development is highlighted in regulatory and legal documents: "Digital Economy of the Russian Federation", in the framework of the program "Digital Kazakhstan"[3]. The issues of modern professional education are presented in the works: D.Thompson, M.D. Thomas, E.Yu. Zakirova, J.L. Liberman, A.Miridonov, V.I. Khabarov and I.S. Volegzhanina. [3,4,5]

The ethical and moral development issues of a future engineer's personality should be considered from the position of available theoretical psychological and pedagogical research. In this case the works of B.G. Ananyev, V.P. Bezdukhov, A.A. Bodalev, L.I. Bozhovich, L.Kolberg, T.K. Poznyakova, N.P. Shityakova, P.M. Yakobson can be generally recognized.

The activity role in personality development is characterized in the works of such prominent scientists and pedagogues as V. Davydov, E.Zair-Bek, L.Zankov, I.Kolesnikov, A.Ksenofontova, S.Raschetina, A. Tryapitsyn, N.Chekalev, G.Schukina.

The problem of the research is the basis of the content, technology of scientific activity organization as an aspect of future engineer's scientific activity ethicization in the conditions of digitalization. The main thesis of the research is: scientific activity as a high school educational sphere, which prevents selection of student's activity, creates preconditions for formation of a human fund new quality, the instrument of which is the natural moral development of a future engineer's personality in this process.

Objectives of the research: to identify the possibilities of ethical scientific activity in the moral formation of the future engineer in the era of digitalization.

The article structure consists of the introduction, the main part, the conclusion, the list of references.

Materials and Methods. Hypothetical reading material examination, goal-oriented instructive observing, survey study, testing, demonstrative experimenting.

The reliability and validity of the results obtained is ensured by the methodological legitimacy of the beginning positions of the study; a comprehensive examination of the issue at the interdisciplinary level; the the utilize of a combination of different complementary strategies of collecting and handling observational material adequate to the problem under study, goals, objectives, hypothesis, the use of various methods of quantitative and qualitative assessment and interpretation of results, the possibility of repeating experimental work, the representativeness of the test estimate and the importance of test information affirming the most conclusions of the research.

Results and Discussion. The content of the future engineer's moral formation process in scientific activity consists of the following:

– systems of creative and developing activities (axiological analysis, writing philosophical and ethical essays, comparative analysis of critical articles, watching TV programs, exchange of opinions, dialogues, discussion of specific problems);

– methods, modern humanitarian technologies (conversations, problem influence, heuristic, research);

– online forms of interaction (tele-bridges, virtual battles on philosophical and moral topics, media exhibitions, scientific and practical conferences, workshops, scientific seminars on digital platforms);

– changing characteristics of intercultural interaction (Internet projects, forums, multimedia projects, electronic portfolio technology, website creation);

– the use of communicative-value technologies (the role of position in games in philosophical online cafes, games staging moral and ethical situations contained in the academic subjects-sections of the educational spiritual and moral description of E.N. Goncharova), having personal significance for students, their reflection.

The educational information system is built with the expectation of complicating the characteristics of cognitive activity (extracts from philosophical, scientific, artistic, social literature, periodicals in libraries of free choice, developed system of tasks, assignments). The knowledge obtained by the student independently in the scientific engineering activity enhanced the education content at the level of academic subjects learnt by the student, which made possible joint reflection of the student with the teacher also on moral and ethical problems, which enlightened their positions in relation to kindness and cruelty, honor, dignity, conscience, responsibility, politeness and mercy.

The second educational object - implementation of modern creative humanitarian technologies, which lead students to the understanding that knowledge of moral norms, justice, values substantiates the moral choice, and values " enlighten this choice" (V.P. Bezdukhov) – expand the possibilities of shifting motivation to the goal and stimulated self-assessment of personal achievements of the student, indicating the effectiveness in his moral development.

And, finally, the third educational object - enriching the university with axiological implications of the future engineer's scientific activity, expanding the student's learning opportunities in pedagogical and social situations of moral-spiritual content solutions, allowing the student to proceed from the factual level of acquisition, moral content, enabling the student to move from factual moral content to philosophical, appealing to self-knowledge and action. Revealing the value priorities of the time, finding a benchmark that could serve as a moral reference point for the future engineer, capable of axiological characterization of the cultural, historical and educational situation in Russia and Kazakhstan [6]. The students of the experimental groups became the organizers of an online meeting of future engineers. The topics were different: "Why do they think spiritual and moral ideals are exhausted today: love for the Motherland, mercy, justice, honor, dignity?", "How can we revive cultural and moral ideals?"

The study confirms that the use of scientific activities, socio-pedagogical practices in axiological implications contributes to the future engineer's moral formation. The result is the worldview maturity, educated future engineers' assimilation of moral values.

We have found that the student's ability for choosing information of moral content, humanitarian activity, scientific activity is formed by positive, deep, constant motives of the student's moral formation as a future engineer.

Engineering ethics involves the formation of moral values through the mastery of scientific activity under the national and universal prism. The formation of a higher level of self-awareness, ability to conceptual thinking, integrated vision of the world, embodiment of value conceptions in their own creative activities, bringing together life in a team, and self-expression in interaction with the cultural and human world is an important task at the present stage of development [7].

Engineers, in carrying out their professional duties, must put the safety, health, and welfare of citizens first.These issues are defined by engineering ethics and address the impact of technological development on people and their way of life less prominently than the impact on nature. Nevertheless, it is significant. Uncontrollable changes in nature have become one of the most thoroughly studied subjects when it became clear that man and nature have not had time to adapt to the rapid development of technological civilization [8]. Unexpectedly for many it turned out that engineering, scientific knowledge and technology have a significant impact on nature and man, changing them. In order for technology not to destroy and cripple mankind, people need to understand both the nature of technology and the consequences of technological development. However, it is impossible to solve this problem without an integrated humanitarian and legal education.

The important thing in the experimental groups was the change in organization methods of future engineers' scientific activity: their democratization, problem-based approach, transition to pedagogy of cooperation, humanitarian technologies.

Pedagogy of cooperation implied a creative dialogue between a teacher and a student in the process of moral evolution, a joint search for knowledge. In these cases the teacher was not just a transporter of knowledge, but a creative organizer of thought and research activity. In our collaborative work we tried to work so that communication with students would awaken in everyone the need for independent thinking, respect towards others, and respect towards oneself, one's opinion and views [9].

For example, in the experimental groups discussions on the moral conflict solution (Volkova M.V.) were tested, as a result of which a strong positive dynamics was observed for most indicators. Positive and critical, negative statements of students and discussions developed dialectically. The emotionally intense form of conversation activated the thought process of each participant. The movement toward truth went not only from one thesis to another, but also from student to student; there was interest in the personality of the opponent. The polemic in the discussion was strong in the sense of interest, cooperation, and competition. In the process of polemics the student revealed himself, showed his personal and civic qualities. It was noted that the students' knowledge about the essence of spiritual and moral formation, methods of self-recovery, obtained and assimilated as a result of the struggle of different points of tension, acquired a strong character, and later, tested in practice, transformed into moral convictions [10].

At the meetings of the student scientific society, problem-reflexive polylogue and positional discussion were used as the main methods. Preparing and conducting a polylogue process: step-by-step development of pedagogical problems, where each student structures the problem independently; step-by-step ideas on how to solve these problems; the stage of collective discussion of these problems. Through the "prohibition to repeat ideas" each participant achieved the effect of maximum understanding of alternative solutions and developed a personal and meaningful position. The peculiarity of positional discussion was that it allowed not only to form a data bank on the possibilities of solving typical moral problems, but also provided a process of their critical analysis [11].

Some students in the experimental groups created a project for the solution of a moral problem and its argumentation. Criticism of the proposed solution tasks was allowed, because at the end of the group discussing, only one of the developed options was to be brought up for discussion. The other group made all the alternative solutions to the problems, and the third group analyzed and searched for constructive solutions in the presented projects, synthesized them and searched for compromise solutions of the problems. Then the groups switched roles in a circle, and the whole cycle was repeated again. The essence of such project works was the further analysis of the proposed objectives. The students appreciated the adequate methods of organizing scientific activities.

We had taken into account the risky negative consequences of a one-sided rationalistic orientation of the personality, the so-called ethical intellectualism. Unformed emotions can lead to an impoverished culture of feelings, a "partial" perception of the world, a manifestation of which is mental apathy and indifference: there may be a gap between the level of knowledge and motivation. Knowledge can be viewed as a self-sufficient value regardless of its humanistic function. Developed intelligence can be combined with moral uncultivation.

To obtain such ethical knowledge and characteristics, the convergence of prospective and desirable, it is necessary to expand the framework of university socialization of students, to disable the possibility of public self-affirmation, that is, the use of their knowledge, skills and abilities. , competence in socially useful deeds. So, we decided to more widely introduce the practice of writing extensive essays. Students became more convinced of the usefulness and necessity of their efforts and opinions. To create such a contradiction in the process of moral formation, we sought a harmonious combination of knowledge and moral experiences, harmonization of thoughts and feelings, remembering that these are complementary structural components of the spiritual and moral personality type. In extracurricular research activities we used tasks and exercises, business games, exercises, writing essays on the problems studied; "Express your opinion", short written answers of students to the actual question, which requires students to express their own position.

While working on their essays, students focused on issues directly related to university life. For example, the essay "Moral Guidelines for Future Engineers of the XX and XXI Centuries. What have we inherited and what have we lost?" was offered to students of all levels to write. We received 247 jobs. We held a students' conference for an open exchange of opinions. Students in the experimental groups participated in it in total. According to the jury, which consisted of professors and students of humanities and science and mathematics disciplines, their arguments were evidence-based. They described in their readings historical, literary sources, the data of specific sociological research, showed changes in mindset, analysis, comparison of facts, reporting, summarizing, problem solving.

It was noted that the moral formation of future engineers in scientific activity occurs most intensively, if the communication is socially directed, connected with the implementation of socio-political, educational, educational functions; with production or research activities, and is personally oriented. Each of these facets of interpersonal communication in the experimental groups was important in its own way. And if any facet in one story or another was under-expressed, that level of moral and spiritual development was below the proper level for students in that group. For example, the inability to respect another's opinion, humiliation of another's dignity, inability to overcome conflict situations, indifferent attitude to the behavioral and communication culture had a negative impact on the quality of the process under study.

The beneficence of moral and psychological atmosphere depended on the cohesion of the experimental groups team, moral and personal communication of its members, expressed in their mutual respect, self-assistance, mutual need, in close psychological communication, interaction and mutual influence on each other. In the scientific activities of future engineers this was reflected in the collaborative emotional attitude, experience community, a sense of mutual interest, attention to the successes and failures in the overall affairs. The condition of a goodwill, ease of relaxation determined the success of the action, conference, roundtable, discussion, stimulated students' interest in the problems discussed, intensified their learning, encouraged their own frank deception of opinions, further united the team on the basis of common scientific interests, fostered respect for others' opinions, helped students' self-assertion, strengthened their faith in their own strength. All of this benefited the moral growth of the students in the experimental groups.

The control group showed indifference, passivity, incongruence to fellow students, smiles, scattered atmosphere of spiritual saturation, positive moral tone-evidence characterizing groups with unstable, unfavorable moral and psychological climate, not capable of moral and spiritual development of the student in this group.

Diagnostic data showed changes in the spiritual and moral attitudes of students in the experimental groups. This was due to the fact that extracurricular activities in these groups were put not only on learning, but also on the search for independent moral decisions, the development of their own beliefs in situations of free choice, engendered by spiritual and moral activity, and the enhancement of humanitarian relations.

During the academic year 2020/21 we conducted a pilot study among the students of the Orenburg State Pedagogical University, K.Zhubanov Aktobe Regional University, Zhangir Khan University. We have questioned the students of 1-4 years on different faculties.

The choice of universities was determined by the following: Kazakhstan and Russia are building democratic communities; there are processes of reforms and modernization of education in universities; there are problems of moral development of students in every university; there is an active communication between students and teachers of different faculties and on this basis there is an exchange of information; wide range of university specialties stipulates development of diverse interests of students. The respondents' contingent according to the main characteristics turned out to be relatively homogeneous in each university. The majority of them are students from 17 to 25 years old. This allowed us to impart the extracurricular scientific activity as a factor of moral formation of the future engineer's personality.

The research tools were developed in accordance with the developed criteria and indicators of the student's moral formation (Table 1). The criteria were structural components of moral activity: moral goal-setting, moral motivation, choice of resources, effect of action or inaction, result, consequence.

The research working hypotheses are as follows: first, the moral formation of the future engineer is a process including the increasing deepening of personal aspects of the student: interiorization of the purpose, principles, content of the moral world and its values, assimilation of which forms the student's moral environment, connecting him with the moral practice, covering behavior and moral consciousness.

Table 1.Criteria and level indicators of moral formation of student's personality in scientific activity of future engineers

Significant (High) Level	Conscious (Medium) Level	Critical (Low) Level
Motivation and evaluation criteria Indicators: the student's strive for moral perfection, expressed by a constant wish to master ways of acquiring experience in moral attitudes toward the world, oneself, the Other		
Positive, stable, permanent reasons	Situational, superficial reasons	Persistent negative attitudes toward the process of moral evolution
Cognitive Criteria Indicators: *The student knows:* – The essence of the concepts of "responsibility", "morality", "moral formation of the personality", the possibilities of scientific activity in the moral formation of the future engineer; *Aware of:* – values (education, good, duty, dignity, honor, mercy, freedom, conscience, justice) as a form of motive and content of the moral formation of the individual; - values orientation; – the principles of organizing the moral space of the future engineer; – ways of self-improvement, self-realization		
Basic, in-depth, comprehensive, solid knowledge	Comprehensive, solid knowledge of some problems	Partial Notions
Performance criteria Indicators: *The student is able to*: be responsible for the decisions made; determine the strategy and ways to achieve the goal on the basis of moral choice. The student is able to: analyze moral situations; find moral ways to overcome contradictions in scientific activity; build relationships with others on the principle of respect for the person; be tolerant to the opinion of others; respect the opinion of the other and engage in dialogue; resolve conflicts through dialogue; oppose malice, immorality; demands in learning, work to oneself.		
The skills have a creative character	Reproductive skills	Individual skills at the level of individual techniques and actions

At the same time there is a realization and choice of a deed motive, justification of a behavior behavioral intent for oneself and in facing others from the positions of socially and personally significant values, awareness of the criteria of right and wrong, which provide orientation to behaviors, adequate to the content of these values. The result of the process is the consolidation of a system of values in human relations to the world, to others, to oneself; a special perception of life, "the priority of complex over simple, high over low, developed over undeveloped", conscience, constant evaluation of own actions and oneself as an actor from the position of morality.

Conclusion. Thus, according to the systematization and analysis of research results, it is necessary to assume the necessity of changing the direction of modern engineer training, focusing on the ethicization of engineering activity in the process of science and production integration. In the process of implementation of ethical scientific activity of future engineers the following skills are formed: independent research work, creativity and initiative, teamwork, work with scientific literature, critical evaluation and reflection, managerial skill of activity planning, time, consequences forecasting.

Engineers, in carrying out their professional responsibilities, must put the safety, health, and welfare of citizens first. These issues are defined by engineering ethics, affecting the impact of technological development on people and their way of life less prominently than the impact on nature. Nevertheless, it is significant. Uncontrollable changes in nature have become one of the most closely studied subjects when it became clear that man and nature lack the time to adapt to the rapid development of technological civilization. Unexpectedly for many people it turned out that engineering, scientific knowledge and technology have a significant impact on nature and man, changing them. In order for technology not to destroy and cripple mankind, people need to understand both the nature of technology and the consequences of technological development. However, it is impossible to solve this problem without a comprehensive humanitarian and legal education.

Technique manifests the humanitarian nature of the engineer, reveals the hidden existence of man in the world of images, schemes, rhythms and meanings, that is why it is so important to focus not only on cognitive procedures, but also on the axiological aspect of technology assessment, where the highest human capabilities and patterns of behavior are the model of devotion to the truth. The addition of information from philosophy, psychology, finance, technological craftsmanship, and biomechanics to engineering skills broadens the influence of technological activity on social and moral life. Simultaneously, technological advancement creates plenty of new issues that necessitate an unique approach to ethics in order to avoid risky circumstances.

1. The number of people who have received secondary effects from technical activities is increasing.

2. The destruction of the natural system under the influence of human activity continues to grow, becoming global in scope.

3. Deterioration of medical-biological and ecological situation actualizes the problem of responsibility for nonborn generations.

4. Human beings are increasingly subjected to manipulations of the social and medical-pharmacological type. As a consequence of this experience, the ethical problems of research are becoming more and more acute.

5. As a result of interfering with the genetic code, humans are in danger of becoming "objects of technology".

It is worth emphasizing that there are certain risks in the implementation of scientific activities of future engineers in the boundless flow of information that fills cyberspace. It is necessary to teach not only to professionally conduct scientific search and navigate in the digital environment, but also to foresee the possible results of their activities, to bear responsibility, eliminating negative consequences.

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