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Project Approach in Humanities as a Cognitive Strategy of Modern Engineering Education

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Abstract

During the studying, future engineers must realise the dependence of professional activity on calls of the times, the state policy, human needs and at the same time understand that technologies change different life aspects both of the human and all biosphere. According to this thesis, the authors pay attention to the problem of cognitive strategies creation which allow forming the social responsibility principles of future engineers during their education. In the work the comparative analysis method is used, i.e. theoretical and experimental researches were being simultaneously conducted in this field. The goal is to form the educational method which will allow students getting a bachelor's degree in technologies to understand that the engineer influences the world by manufactured goods. As a result of applying the project educational method in the Philosophy course, students have received necessary social cultural skills: realizing the anthropocentricity of the engineering profession and engineer's responsibility towards society, understanding basic tendencies of social development and forming the strategic view on reality.

1. Introduction

The necessity to rethink engineering education is dictated by the reforms having been conducted in the Russian Federation since last century, particularly in the spheres of economy, science and education. The reforms must be complex, as recorded in the article by V. V. Putin "We Need a New Economy": "Reconstructing our economy has to be started from universities both as the centers of fundamental science and as a professional basis of innovative development" (Putin, 2012). In this article some priority directions are specified for Russia to recover its technological leadership: pharmaceuticals, high-tech chemistry, composite and non-metallic materials, the aviation industry, information and communication technology, nanotechnology, nuclear industry, space. This

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implies that the future of Russia is connected with engineering in the first place and therefore with engineering education. The education system has been reformed several times in Russia in the last decade. The subject of changing in the engineering education is competence which a graduate with a bachelor or master degree in technology must possess. In Russian curricula the competence is divided in common cultural and professional one. The common cultural competence includes the abilities to synthesize, analyze, receive the information; to set goals and to choose the way of achieving them; to carry out one's own activity on the basis of socially accepted moral and legal norms; to analyze the ideological, social and personal importance of the problem; to form and defend own ideological positions; the ability and willingness to understand the driving forces and laws of the historical process and to determine the man's place in the historical process and the political organization of society. The professional competence includes both specific knowledge and skills determined by professional activity: the ability to cooperate and to manage a team, to function in interdisciplinary projects. The structure of higher education in Russia is linear, i.e. the courses which the student will learn in the process of education and the sequence of them are initially known.

This approach allows answering the question: "What must the student know and be able to do having graduated from university?" and actualizes the problem "How to form common cultural competence, professional and social skills through the study of specific subjects?"

In this context, the problems of a modern engineering education in Russia are actively being discussed. Yu. P. Pokholkov, the President of the Association for Engineering Education in Russia, indicates a need for a system of advanced training of specialists paying attention to the professional qualifications and society's willingness to accept new technologies (Pokholkov, 2012). Kirillov N.P. (Kirillov, 2011) draws attention to the methodology of engineering activities: creative thinking and finding new ways to solve problems. From our point of view, his conception continues the model of Physical-Technical Higher Education which was implemented after the Second World War in the Soviet Union (Karlov, 2006), and the idea of G.S. Altshuller, the author of TIPS (Theory of Inventive Problem Solving) (Altshuller, 1989). The research paradigm formed by the ideas of these authors is the following: the engineering profession requires above all creative activity aimed at solving the problems of society. Within this paradigm the aspect formed in the philosophy of technology of XIX-XXI centuries has been selected. Lewis Mumford drew attention to the fact that the primary condition for the creation of the greatest engineering works is Megamachine – a powered systematic social formation. The important aspect for us is the idea of Mumford that creating a large-scale technical object transforming social relationships requires special organization of a team (Mumford, 1972). We also use the institutional approach to scientific and technological activities being developed by Paul R. Josephson (Josephson, 1996), in the context of which the influence of the state, the state ideology on the perception of scientific ideas and the structure of technological objects is justified, thus allowing to talk about technological politics, proletarian science, bourgeois science, etc. Such a paradigm suggests that in the course of training future engineers should realize the dependence of the professional activity on the time requirements, the state orientations, human needs, and at the same time understand that the equipment and technology transform various aspects of life of both people and all biosphere. On the basis of this paradigm, the authors draw attention to the problem of creating cognitive strategies that allow forming social responsibility principles of future engineers during the educational process.

2. The method

We used the method of comparative analysis, i.e. theoretical and experimental researches were simultaneously carried out in this area. A preliminary analysis of students' competence on the understanding of the main tendencies in the development of society and the social importance of the engineering profession was done. When preparing the interview questions, we studied literature in the field of engineering education. Upon completion of the work the initial and obtained results were compared.

Stage 1. According to the authors, the key to achieve a stated goal is realizing by future engineers anthropocentricity of their profession. In this context, a self analysis of the profession subject is a key issue in the cognitive activity of the student. Actualization of the reflection is possible through the gradual involvement of students in the formation of the image of the future. The use of new technology is connected with a significant

degree of uncertainty, as an unambiguous prognosis of its application consequences is practically impossible, but always associated with the questions about what kind of society people want to live and what people should be. In order to determine the image of the future existing among the students, a survey consisting of two parts was conducted. The first part included questions aimed at understanding the basic tendencies in the development of modern society, as set out in the works by P. Drucker (Drucker, 1999), U.Beck (Beck, 2009), D. Bell (Grunwald, 2012). In the second part the issues related to the understanding of the category "social responsibility of the engineer" were presented on the basis of the works by A. Grunwald (Grunwald, 2001), N. Doorn (Weber, 2012), Weber N. Nikol, Strobel J. (Grunwald, 2011).

In the first group of the questions formulating the basic characteristics of the modern society was required. As a hypothesis for the survey it was assumed that the students would indicate the characteristics defined by modern researchers: knowledge as the basis of technological, social and economic development; risk as an integral part of everyday life; sustainable development as a development strategy; information on how to raise public awareness; heterogeneity of social structures. Analysis of the responses shows that about 30% of the students find it difficult to answer this question. This fact is noteworthy since all students have passed the course "Social Studies" as a part of general secondary education which details the following stages of society development: "traditional", "industrial", "post-industrial / information" and, therefore, should have an idea of the possible prospects of social development. Perhaps this was the reason that about 30% of the students paid attention to information technology, but for most students understanding of information technology is limited to the following components: computer, phone, tablet PC. Then, when interviewing the students to specify the role of these technologies in the development of society was attempted. The majority of students do not indicate their industrial application talking about only everyday use: access to the Internet, mobile communications. About 40% of the students used the term "innovative technology" in their responses, but could not explain the meaning of it: could not formulate the characteristics of innovative technology, innovative organization and the innovative university. Perhaps the reason for this is that the term is widely used today as a slogan in the various spheres of the Russian reality: mass media, speeches of politicians, economists and analysts in the field of education, and so on, but the desire to give a rigorous definition of the term "innovation" is present only in the academic community.

In the second group of the questions it was required to specify how the further development of the technology in the next 10 years would influence public life. For this purpose it was necessary to specify which sector of the Russian economy will develop in this period. The answers can also be divided into several groups: about 20% of the students found it difficult to answer this question. Further responses evenly divided: information technology, energy, oil and gas. At the same time, it should be noted that there is no strict regularity between the answers and the direction in which students are taught, but there is a clear focus on the understanding of Russia as a raw state. Further it was required to formulate how the development of these technologies would change the specific elements of society. This question was intended to find out whether students understand that technology and society develop in close relationship providing a reciprocal influence on technical developments, lifestyle, social and personal priorities. The results showed that 90% of the students did not realize the relationship between the development of technology and society.

Next, it was necessary to specify the social functions of the engineer. This issue was focused on finding out whether the students perceived the impact of engineering activity results for the development of various sectors of the economy, changes in the structure of society, the transformation of the spiritual and physiological components of the human being. This question caused the greatest difficulty among the students. Most of them left the question unanswered. Later in the discussion of this question, we concluded that even in the second year, students are well aware of their professional duties, but the issues relating to the way in which technology developed by them influence society and the person do not even exist for students in the course of their education. In our opinion, the issue of engineering social responsibility must be recognized by students at the early stage of their education. To achieve this objective we have used the project method in the study of students getting a bachelor's degree in "engineering and technology" at Tomsk Polytechnic University, the course "Philosophy".

Nowadays higher engineering education in Russia is focused on the Federal State Education Standards (GEF) of Higher Professional Education. One of the points of the GEF is requirements to the results of basic baccalaureate programs acquisition. In our opinion, higher education implies that a person develops in the educational process not only the professional knowledge and skills, but also acquires the general cultural component presented in the GEF by general cultural competence. The analysis of the GEFs in the various technical areas allows selecting their universal, general cultural competence.

We list those that may be generated in the course "Philosophy" acquisition: to generalize, analyze, acquire information, to set goals and to choose the way of achieving them; carry out its activities on the basis of socially accepted moral and legal norms; to analyze the ideological, social and personal importance of the problem; independently form and defend their own ideological positions; the ability and willingness to understand the driving forces and laws of the historical process and to determine the man's place in history and political organization of society. In accordance with this competence, the following functions of the course "Philosophy" in the preparation of bachelors can be formulated as:

- Worldview – defining the view of the world, problematization of various forms of the world view, the sources of its formation, actualization of the individual's role in the process of creating own philosophical orientation;
- Prognostic – realizing the consequences of the decisions being made for the individual, family, organization, government and society as a whole;
- Social – problematization of personal social responsibility focusing on the philosophical ideas of civil society and the welfare state;
- Educational – actualization of the categories "experience" and "historical experience", the formation of ideas about society and history as a natural phenomenon, obeying the cause-effect relationships.

Having defined the functions of the course "Philosophy", which is studied by all students getting bachelor's degree at Tomsk Polytechnic University, we have formulated its purpose under this semester: forming reflection of the conditions for the development of technology, the goals of the technological development, effects and conditions of technology application, saving and recycling. It is advisable to raise the question: "How is it possible to implement these functions within a semester course?". The total number of the course is 96 hours, including 32 classes (16 – lectures, 16 - practical training) and 64 hours - the time allocated to individual work of students. Accordingly, it is necessary to search for methods to update the students' independent work. To this end, the Department of Philosophy traditionally use standard approaches: homework for practical lessons, preparation for test control, individual tasks for the conference week with the use of Power Point, training for the Olympics in philosophy, preparing articles for conferences. But it should be noted the problems faced by the teacher using the above methods:

1. Preparing homework often results in copying texts from any (often untested) Internet source even without preliminary reading. In such a variant, a practical lesson does not achieve its objectives: understanding of the acquired knowledge, actualization personal ethical and aesthetic components of worldview;

2. Preparing for the test control often results in "downloading" cheat sheets in a cell phone or printing them;

3. The experience of the conference week has left a number of problems, the main is that for 2 hours and at the same time it is necessary to develop and test competence in a class of 60-80 people;

4. Olympiad in philosophy is carried out only in the spring semester, so students who study a course in the fall semester do not actually have the opportunity to participate. In addition, classrooms do not allow the classroom to seat all who wish to participate in the Olympiad, that is why no more than 10-12 people from each institution take part in it;

5. Preparation and participation in the student's conference undoubtedly provides a good experience of reading philosophical texts, concentration on the problem, logical reasoning, discussions, but focused only on students with high motivation.

6. In addition, it is necessary to pay attention to the substantive problem: students studying humanities at university often tell that the content of these subjects is not relevant to their future profession, which means that the humanitarian cycle is a waste of time.

One of the ways to solve the identified problems is the task oriented towards all students and required to perform. In the fall semester 2013 the students were asked to perform a creative task on the theme "Social assessment technologies." At the beginning of the semester they had to unite in their own micro-groups of 2 -3 person and choose some modern technology. It is noted that the chosen technology must be relevant to the profession which students are getting at the university. The final version of the paper must have the following sections: introduction including the problem, the relevance of the problem in the present, brief overview of the solving problem; the main part containing the items on the basis of which the selected technology will be evaluated. Students were offered the following issues: mechanisms of technology influence on the environment; the technology effects on the human or society; factors that affect the development of technology (economic, political, geopolitical, etc). In conclusion, the findings have to be presented in accordance with the criteria laid down. In addition to the text, at the end of the course, students were required to submit:

1 A presentation of 10-12 slides accompanied by a report, which must be made at the last session.

2 A folder which had to contain: the problem, the urgency of the problems, materials for the social assessment of the technology (2-3 variants) with comments, cuttings or synopsis of 5-7 articles on the topic with comments, cuttings / synopsis of 3 -5 textbooks on the subject with comments, 1 comment to philosophical texts, links to video / audio resources with comments (2-3), a brief glossary topic (no more than 10 terms), with links to sources (encyclopedia).

Important terms: all comments must be written by hand. Comments attached to the text (stapler, paper clips, written on a single sheet, etc.). Articles and textbooks should be provided with the output data and the page numbers.

It should be noted that the preparation of this type of work is new for students especially in content, and therefore requires significant time investment both by students and by the teacher. Students need to learn a significant amount of new literature and supplement purely professional or consumer understanding of technology by the principle of reasonable concern (Grunwald, 2011), i.e. to identify the rational aspects of the risk from the implementation of the technology being developed for the environment, human society and the economy. Formation of this principle requires the students to understand, on the one hand, technology at the professional level and on the other hand, probable and known effects of the use of technology. Complexity of the work requires frequent consultations with teachers both of humanities and technical subjects, what provides interdisciplinary character of the project.

During the presentation of the final work, the students had to pay attention to the social causes which demanded the establishment of a specific technology; risks that are possible in connection with its use and further development in relation to the present way of the future; possibilities of risk reduction.

Stage 2. In the middle of each semester at Tomsk Polytechnic University a conference week is held during which students are required to demonstrate the knowledge and skills acquired in the course of training. Students studying the course "Philosophy" were offered to prepare a short report on the theme "20 years" in groups of 4-5 people. The report was to meet the following requirements: the created image of the future was to be used as a "working" for the final version of the creative task. The report had to conform to the following structure: the concept of ideal reality, an indication of the way in which technology and people would change (outlook, physiology); how the principles of social stratification, the relationship between people, the field of scientific knowledge and technology would change; the indication of problematic issues in the proposed reality; the ways of achieving the ideal reality. The presentation of the project took place in the dialogue: after a brief report members of the group had to answer questions and criticisms. The submitted works were evaluated by the students themselves on the basis of substantive idea, report compliance requirements, methods of presentation, answers to questions.

Stage 3. Upon completing the course of philosophy, the students were proposed with three sets of questions to which they had already answered at the beginning of the semester once again. It should be noted

positive dynamics during the second response. Answering the question about the characteristics of modern society more than 50% of the students paid attention to the risk as an integral component of it, knowledge as a necessary precondition for the development, consumption as the main cause of risks and conflicts of modern times, the sustainable development of the ideal of modernity. When determining the activity of the engineer as the activity aimed at the creation of innovations, the students explained the term "innovation" in the following way: the creation and use of new technology and processes; development and use of new raw materials; consistent use of products with new features and characteristics that meets the contemporary tendencies shown, for example, in The Measurement of Scientific and Technological Activities. (Eurostat, 2005) Determining the industries that are going to be developed in Russia in the next 10 years, the students almost did not change their first responses: 85% of the students named the oil, gas industry, information technology and energy; 10% identified the cognitive technologies and microelectronics, 5% did not answer. The number of students who found it difficult to answer to this question reduced, but the idea of state development strategy as a raw state has not changed. At the same time the following components of social life that are affected by engineering activity were identified: health, living and working conditions, the methods and principles of communication between people. Upon completing the course social responsibility of the engineer was considered in the following aspects: the responsibility to colleagues in the context of administrative and cooperative activity of the engineer; responsibility to society for the quality of the product produced in the context of professional activity; responsibility to the ecosystem of the impact of the production process, the production and disposal of products on the nature in the context of sustainable development. We have deliberately selected aspects of social responsibility, which we did not pay students' attention to at the beginning of the course suggesting that in the philosophy course students should learn how to formulate the problems associated with the relation of the world-people. Responsibility to colleagues was identified by only 4% of the students, responsibility for the quality of the final product was defined by 83% of the students, the responsibility for the impact of the manufacturing process on the ecosystem is realized by 93% of the students, responsibility for the disposal of products – by 53% of the students.

3. Conclusion

The proposed form of work allows establishing the interpersonal interaction between a teacher and students, between students themselves about the organization of work on the task. During carrying out the work the studying principles of scientific activity takes place. As such, the work with primary sources, the formulation of the problem, goals and objectives of the study can be designated. The process of selecting a topic allows actualizing the student's reflective work, understanding of the world which becomes clearer in accordance with the existing philosophical traditions. The need to actualize the theme in the present, to formulate the problem and offer their own versions of its solution allows students to pay attention to a strategic vision for the future, and not only to the "common sense", which stops on immediate problems. The students have showed positive dynamics in realizing the anthropocentricity of engineering profession and engineering responsibility to society. But in most cases the responsibility is recognized in the traditional sense: product quality and impacts on the ecosystem. It is necessary to continue the study of topics related to the personal responsibility of the engineer to the team and understanding of the concept of sustainable development. There is a positive tendency in the formation of deliberate vision of the future students. But we should also note a serious contradiction – realizing the impact on the surrounding world and understanding of the future of Russia as a raw state. Perhaps in the present the question about the development strategy of a particular state is not appropriate, because students tend to be cosmopolitan and often express a desire to live in other states in the future. On the other hand, the state investment in education, of course, has to be justified primarily by the contribution of students with bachelor's or master's degrees in the development of national engineering industries. The realizing by students that a key aspect in the development of the future is the engineering idea, as well as an understanding of the principle of sustainable development requires further work.

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