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Professional Culture of the Specialist of the Future

ROLES AND ROLE PREFERENCES OF ENGINEERING POSTGRADUATE STUDENTS

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Abstract

The paper is devoted to analysis of roles and role preferences of postgraduate students, who major in engineering, and how these roles and preferences affect the educational activity. The authors consider key occupational roles of postgraduate students as would-be teaching instructors, who have to share the roles of engineers, researchers and teachers. The paper confirms that the studied roles of the teacher, or instructor, at the engineering university are closely interrelated, but determined by implementation of various activities which require diversity of competencies from a specialist. Every specialist is inclined to one of these roles. Role preferences of university teachers change over time. If at the postgraduate education stage, the leading role attitudes are engineering and researching ones, for experienced professors, which is confirmed by the survey, the priority of educational activity is obvious. Can everyone perform all the roles: scientists, engineers, and teachers? It is obvious that the choice is made not due to external reasons but also according to an inner aptitude. There is no point in making a specialist pursue science if they are not interested or if they "do not succeed". At best, the result will be mediocre. It is pointless as well to make a scientist actively deal with didactic issues. It seems natural to conclude that a higher education institution needs and should welcome specialists guided by different role models. Only within the process of interaction between such specialists, it is possible to increase effectiveness of education and provide training of modern engineering staff.

Keywords: Engineer, postgraduate student, roles, researcher, teaching instructor.

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1. Introduction

Recently, leading economies have been developing high technologies, which are regarded as a prerequisite for further development. The government of the Russian Federation considers as a priority to turn the country to the innovation pathway. Obviously, new assignments and approaches, which are implemented within this pathway, require training specialists of a new format. The existing system of engineering education does not provide this training. According to educationalists, that is the primary cause of the global crisis in engineering education. However, higher education undergoes certain changes aimed at improvement of training engineers whose competence and qualification would be relevant to the time. A leading role in this process will belong to university professors and teaching instructors who now start their occupational activity as novice teachers and postgraduate students. Therefore, studying professional preferences and interests of postgraduate students at engineering universities is of great urgency and importance.

The primary vector of educational reforms recently undertaken by the Russian government is the following: computerization of education relevant to digital economy, expansion of distance learning, increase in significance of foreign language, physical education and scientific research. In the context of the subject under study a key feature of the transitional period is the top priority of scientific research in the university activity and assessment of each teacher's performance. Today university authorities mostly force all the teaching staff to do scientific research, to enhance publication activity in order to improve rankings of their university, institute, department to create the content for distance learning programs.

2. Problem Statement

PhD programs also claim research as a priority. However, postgraduate education can be regarded as preparation for teaching work. Additionally, every postgraduate student is primarily an engineer, most PhD students have engineering experience. Hence a postgraduate student, like a lecturer or a teaching instructor at an engineering university, performs three roles: engineer, researcher and teaching instructor. Acting equally the three roles is assumed impossible, especially in the conditions of growing academic workload. Naturally, a teacher creates his/her own hierarchies of the three roles. The priority role is chosen according to individual abilities and the effect of external incentives, introduced by higher education management.

3. Research Questions

- Balance between postgraduate's working time
- Priority activity

4. Purpose of the Study

The purpose of the given research is to study role preferences of postgraduate students who major in engineering and to analyze their influence upon a type and quality of education.

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5. Research Methods

In order to obtain reliable information, we conducted a survey among 152 postgraduate students and 31 experienced teaching instructors working at Peter the Great St. Petersburg Polytechnic University.

6. Findings

Balance between postgraduate's working time and priority activity. The survey revealed that research activity is not a priority for all postgraduate students. Only a third of respondents (34.21%) marked this activity as the main one. Most respondents (58.55%) prioritize occupational activity. Teaching activity is perceived as key activity only for 7.89%. Consequently, postgraduates' working time is distributed as follows: 55.14% – occupation, 32.10% –research, 12.63% – teaching. The obtained result is not in line with standard views, but, in our opinion, can be explained. Every university teacher is initially an engineer. Engineering activity, rather than academic or research one, is what he/she chose when applying to university, it was based on his/her priorities and interests. Enrolling in the postgraduate program, these priorities do not change either, which proves the fact that research activity is perceived as continuation and evolution of professional interests. Most postgraduate students consider research a temporary stage, necessary to gain higher status. Moreover, they are absolutely ignorant of teaching, because they do not think of it as the main occupational activity in the future (Popova, 2017; Bridgstock et al., 2015; Baruch, 2013; Clark, 1983).

Role interaction. Dealing with differences and interactions of roles, almost all postgraduate students (except two), all teaching instructors and lecturers are in agreement that, on the one hand, the roles under study have significant differences and require different competencies, but on the other hand, the roles are closely interrelated.

According to postgraduate students, education is most effective when the role of a specialist has a priority in the teacher's activity (41.82%), or a lecturer (teacher) (36.36%), but education is less effective when the teacher has the role of a researcher (21.82%).

Analysis of roles and their effect on education efficiency.

Due to their interrelationship and hierarchy, roles of university teachers can be presented in the form of a priority chain.

1.Engineer-researcher-teacher, engineer-teacher-researcher. The priority of these two role positions is obvious for postgraduate students, as before enrolling in the postgraduate program, they were engineers and dealt in engineering as their occupation. Motivation to enroll in the postgraduate program can be to improve the status (Popova, 2017; Baruch, 2013; Bridgstock et al., 2015; Clark, 1983) or to study some professional issues more profoundly, or to turn to research activity. At the same time, the world practice (Altbach, 2004; Doctoral Studies and Qualifications in Europe and the United States: Status and Prospects, 2004; Prpić et al., 2014; Baruch et al., 2015) and the data of our research show that more than 30% of graduate students do not consider themselves to be scientists and do not associate their further careers with academic activity. Pedagogy as a course of humanities is not interesting for most postgraduate students, it is irrelevant to their engineering attitudes and values. They study pedagogy only as a "must" -course. A teacher-engineer perceives his/her educational task only in terms of educational content.

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This role sequence can be analyzed by the example of engineers who support universities and agree to give lectures or separate classes. Lectures of specialists and experts from companies and industrial institutions are welcomed by universities, and recently this has become common practice. Peculiarities of such education are the following: these lectures are practice-oriented, specialists have excellent knowledge of engineering activity and engineering problems. However, such specialists do not have knowledge and experience of teaching, they are not responsible for the result, education is aimed at solving only specific problems urgent for the institution this specialist is working for. Lectures and classes given by industrial specialists are very important, as they get students acquainted with the real situation in the industry or in their occupation. However, such lectures and classes are really effective only if they are accurately positioned in the context of the educational process and have relevant teaching support, which can compensate, if necessary, some drawbacks.

Research work of postgraduate students is related to writing PhD theses, whose key requirement is practicality. But knowledge that postgraduate students acquire when doing this is rather specific and precise. Research materials can be integrated into education only in amounts relevant to the course. Otherwise, education is based on studying detailed scientific information which can be subjective or irrelevant for postgraduate students. The postgraduate students provided the following responses: their research materials “can be included in the course program”, “only basic elements can be included in the course program” and “the research is rather specialized, it cannot be included in the course program” (36%, 29% and 32% respectively).

The role of teaching is obviously an underdog here. Postgraduate students do not know essentials of didactics and can not use them in practice. They teach traditionally using patterns and approaches of their senior colleagues. The same was passed from generation to generation. Besides, apart from explanations of how to give classes, more experienced teachers force postgraduate students to teach in accordance with the established traditions, hereby preserving outdated teaching techniques. A rather new educational technology adopted by engineering universities has been the practice-oriented approach. This approach is based on cooperation with domestic industrial enterprises and global technological companies, and on adoption of new teaching approaches. The practice-oriented approach allows graduates to be competitive on the labor market, due to obtained knowledge and experience. The approach implies (Karyukina, 2014):

1.perfection of student education: making education more practical; implementation of the context approach; introduction of active and interactive educational technologies;

2.development of practice-oriented education based on cooperation (direct agreements) with domestic companies (with the purpose to train specialists for particular enterprises);

3.development of inter-university cooperation with foreign partners: student exchange, sharing experience in terms of improvement of engineering training.

Modern industry needs independent, creative, proactive, enterprising, and daring professionals who are capable of yielding profit, putting forward and developing ideas, coming up with unconventional solutions, and implementing economically sustainable projects under competition, conflicts and stress. Evaluation of such professionals brings forward their personal competences. Implementation of the practice-oriented approach requires a teacher not only to be expert and shrewd in the given field, which is

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typical for the studied role, but also to possess elaborate psychological and pedagogical competencies, knowledge and skills, as well as experience in applying active teaching methods essential for developing students' personal competencies. Teachers with a prioritized engineer role usually lack such competencies.

Among the advantages of this role are the ability to provide students with thorough academic schooling and a profound insight into the conceptual facets of the profession, as well as a skilful approach to practical learning. Meanwhile, the disadvantages include a narrow range of didactic means, incomprehension of psychological and pedagogical features of a teacher's job, inability to develop students' communicative, team, and other highly-demanded personal competencies. Other shortcomings are the insufficient regard to social and ethical aspects of engineering as well as the inability to innovate education and a lack of interest in it.

2. Researcher - engineer - teacher.

Significance of the scientific approach to education is undeniable. The scientific research approach to teaching, application of cutting-edge scientific advances, scientific relevance, and viability of the educational material have always been regarded as an indispensable element of higher education. The current level of technological advance demands the use of scientific knowledge as a keystone of scientific and technical progress. Technology used to be comprised of mainly empirical knowledge accumulated in the instruments of labour, while today it tends to integrate scientific knowledge instead. Nowadays all crucial achievements in technology are based on fundamental scientific discoveries (Medunetskiy & Silaeva, 2016). Mere empirical means are insufficient for creating such technical equipment as nuclear reactors, lasers, computers, etc., since their construction requires thorough preliminary research of physical, chemical, and other phenomena and processes underlying their operation principles.

Scientist has seized to be an exceptional job and it turned into mass profession. Scientific research used to be more individual in general, while nowadays it is becoming more collective, since it usually needs to be performed by a numerous group of scientists. The social dependence of science grows with its social significance. "For the first time in history", writes Bernal, "science and scientists have been involved directly and overtly in the major economic, industrial, and military developments of their time" (Bernal, 1956). The past century's exception today has turned into a rule. The correlation between engineering and science has changed dramatically over the years. According to Bernal, science became, fully consciously and immediately, what it had long been unconsciously and incidentally—an essential part of production (Negodaev, 2003). Science should now be a step ahead of technology and practice, which has become an indispensable condition of the technological progress and, consequently, production. The role of scientific research in education is growing and becoming crucial. Requirements to introduce a strong scientific component in universities is becoming more and more demanding.

The reviewed role position puts scientific activities above all. The majority of postgraduate students dedicate a bit more than a third of their time to it on average. For those committed to science as the main activity, it occupies from 60% to 100% of time. A teaching instructor with this prioritized role is mainly involved in academic pursuits and usually makes visible progress in them. Such an educator dedicates a considerable amount of time to publications, scientific conferences, and other science-oriented events. This role model is regarded as the principal one and is widely supported in Russian universities.

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The primary engineering component (role) in this context makes the basis for scientific activities, but it can gradually recede in the case of retargeting. Meanwhile, active independent scientific research fulfilled by postgraduates is often temporary and is aimed exclusively at writing their theses and at solving specific narrow-focused problems (Balabanov et al., 2003). When the role turns to a teaching instructor with an academic degree, the approach to the scientific research alters. A survey of experienced teachers has revealed that this role position is a prioritized one: it is ranked the second after the pedagogical function and undergoes certain changes. While postgraduate students carry out research on their own, experienced teachers mainly supervise research conducted by students or postgraduates. Therefore, their scientific activities take substantially less time and occupy about 21% of the working hours balance. Nonetheless, educational work and, associated with it, self-improvement rank last in this role position, since an educator lacks time for it – similar to the previous role model.

Among advantages of this role model are its capacity to provide students with thorough theoretical and scientific schooling, profound mastering of the conceptual facets of the profession, a scientific approach to presenting material and practice. The disadvantages coincide with those of the previous model: the risk of a narrow approach to scientific subjects, limited didactic schemes, incomprehension of psychological and pedagogical specifics of the educational activities, inability to develop communicative and team competencies, which are in high demand in the modern scientific community, low level of consideration of social and ethical aspects of engineering, inability of innovations in the educational sphere.

3. Teacher - researcher - engineer, teacher- engineer - researcher

This role model, in our opinion, suits most the position of a technical university teacher and is coherent with his or her status and professional objectives. A university teacher should first of all ensure proper schooling of graduates, which requires solid knowledge of both engineering and scientific fields. However, the approach of an engineering lecturer, or teaching instructor to them is different. According to the modern requirements to education, a teacher, rather than communicating a certain amount of information to students, is supposed to teach them to extract and process necessary information, to master the skills of self-education, and cultivate the urge for lifetime learning. A modern teacher’s function is to develop and to implement techniques and methods aimed at achieving pedagogical and psychological objectives in the framework of engineering schooling, at developing soft competencies, at moulding engineer’s personality, and at educating a worthy citizen of the country.

Among particularities of engineering in the past decades the experts point out the increasing significance of ethical and social responsibility of an engineer. The role of the so-called human factor in the conditions of growing technological power and exhaustion of nature’s ability to self-purifying and absorbing industrial waste is aggravated with real risk of global technogenic and ecological disasters. The past years have seen a considerable rise in significance of shaping social responsibility in the process of education and assuming one’s role in socially important issues involved in teaching an engineer and, thus, in the range of an educator’s objectives. The teacher himself or herself also has to comply with the requirements of socialization. It resonates with the stand of Slastenin (2002), who defines a bit different range of roles and requires a teacher to overcome the disconnection between a teacher-personality, teacher-citizen, teacher-expert and integrate individual and professional traits of an educator.

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The approach to the scientific research in the observed model has its particulars. A teacher is supposed to constantly monitor the state of science to a much larger scale than a narrow research requires. The objective here is to summarize and systematize this information in order to broaden students' scientific horizons as well as to develop skills of carrying out scientific research, rather than to merely involve them in the process or even force to participate, which is currently a usual practice.

Teaching itself is scientific research and a creative activity. Pedagogical creativity is a search for and encounter of new findings in teaching, new discoveries, and new ways of solving pedagogical problems. These ways can already be known and described but yet unused by a teacher in his or her practice. Their implementation requires adapting to conditions and personalities of each teacher, which makes them individually-oriented. On a higher level of creativity new methods and approaches to education are developed. All the above does not exclude a similar search for new scientific ideas and their elaboration by students in the engineering field.

Merits of this role model, in our opinion, are its unprecedented capacity of ensuring real improvement of the professional schooling, since it enables successfully implementing and using new innovation approaches to teaching engineers, including distance learning and practice-oriented techniques. Another advantage is the ability to properly and purposefully apply the scientific approach to education, efficiently address the issues involved in shaping professional and personal competencies. It is illustrated by the conducted survey: even among novice teachers up to 48% believe that the role position of a teacher is the leading role in improving engineers' training, while 28% name the position of an expert (specialist) the main one, and 24% consider the role of a researcher to be the keystone. Among the drawbacks there can be possible a lack of thorough attention to cutting-edge scientific advances and teacher's own scientific research (Akopova & Chernyavskaya, 2014; Razinkina et al., 2018).

7. Conclusion

Analyzing activity characteristics of postgraduates – future lecturers or teaching instructors in engineering, one should take into account the hierarchy of role preferences. Engineering, scientific, and pedagogical activities are, in fact, different kinds of activities, demanding different competences and different levels of training from a specialist. Negodaev (2003), in this connection, notes that "The direction of thought of a scientist and an engineer during the process of their professional activity is also different. If a scientist goes from analyzing objective reality to forming scientific concepts, laws, and theories, an engineer – from the ideal model, based on scientific knowledge, to its tangible embodiment. Moreover, if a scientist has an opportunity to examine technical means analytically, an engineer should have a synthetic mind, see a multiform object of their activity as a whole, in all its links with other factors: economic, organizational, ergonomic, environmental, etc. (Negodaev, 2003). Teacher's way of thinking, however, should be focused on the problems of systematization and classification, generalization and structuration, comparison and identification of interrelations between objects and phenomena as well as of other trends in thinking of various scientists and scientific schools. It should be directed at analyzing new information in the context of delivering it to students, at developing methods and techniques which will assure its effective learning by the students,

Role preferences of university teachers change over time. If at the postgraduate education stage, the leading role attitudes are engineering and researching ones, for experienced professors, which is confirmed by the survey, the priority of educational activity is obvious.

Is the choice of one or another role model of an activity the result of rational thinking of a professor? Can everyone perform all the roles: scientists, engineers, and teachers? It is obvious that the choice is made not due to external reasons but also according to an inner aptitude. There is no point in making a specialist pursue science if they are not interested or if they "do not succeed". At best, the result will be mediocre. It is pointless as well to make a scientist actively deal with didactic issues. Many years of educational experience shows that prominent scientists rarely become good teachers, and on the contrary, a good teacher can rarely reach scientific heights. It seems natural to conclude that a higher education institution needs and should welcome specialists guided by different role models. Only within the process of interaction between such specialists, it is possible to increase effectiveness of education and provide comprehensive and diverse training of modern engineering staff (Alexankov, Trostinskaya, & Pokrovskaia, 2018; Klochkova, Volgina, Dementyev, & Klochkov, 2016).

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