Mentoring as an effective way to train and develop postgraduates in engineering

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Abstract. The article defines the relevance of mentoring in the postgraduate stage of engineering education, the importance and necessity of mentoring for training and progress of young scientists and postgraduates in higher educational institutions and organizations of the Russian Academy of Sciences. The creation of the mentor register in institutions of higher education and research organizations in order to turn them further into scientific schools. The results of the studies conducted in management mentoring of promising young researchers both in Russia and abroad are considered. «The mentoring program» in the institution of higher education is proposed.

Nowadays the system of higher vocational education, including postgraduate education, is undergoing great changes. The Federal law « On Higher and Postgraduate Vocational Education » became invalid in September 1, 2013 due to the application of the Law «On Education» dated back to December 29, 2012 № 273-FL. In 2017, significant changes in this sphere took place, for example, the duration of full-time postgraduate training was increased from 3 years to 4 years, and the duration of postgraduate training in correspondence was increased from 4 years to 5 years. There is little information about postgraduate and doctoral studies, about writing the thesis in the Law «On education». At the moment these issues are only under discussion and consideration, as a result, changes are constantly taking place and are being regulated with the help of normative acts of the Ministry of Education and Science, local regulations, etc. We consider some of them, including: the Federal law dated back to August 23, 1996 № 127-FL « On Science and State Scientific and Technical Policy », the Law «On Education» dated back to December 29, 2012 № 273-FL, orders and letters of the Ministry of education and other normative documents in the educational field for the past two years.

The above-mentioned documents introduce indicators for improving the performance of scientific organizations on the basis of which the Dissertation Councils have been created. The deadline for these changes is quite short but rather strict. It is planned to expand the list of Universities that have the right to award their own degrees, to introduce the mandatory defense for postgraduate students, to reduce the list of journals of the Higher Attestation Commission, along with the gradual introduction of obligatory publications in the journals of foreign citation indexes. At the same time, the level of requirements for postgraduate degree seekers rises, and the value of academic degrees increases. Thus, the system of awarding academic degrees is being reformatted.

The requirements for the members of the Dissertation Councils are being tightened. The Order of the Ministry of Education and Science of the Russian Federation dated to November 10, 2017 № 1093 «On
approval of the Regulations on the Council for the defense of dissertations in seek for the degree of Candidate of Sciences, for the degree of Doctor of Sciences» establishes new rules for Dissertation Councils, which significantly increase the responsibility of scientific supervisors for the quality of a postgraduate's thesis. On the one hand, such a decision will motivate a significant number of scientific supervisors (consultants) to perform their duties better, on the other hand, it will complicate the selection of a specialist who would agree to be a scientific supervisor (a consultant) and take a certain risk for the quality of the thesis.

We will analyze the scientists who are engaged in the research and development in the field of higher education, see figures 1 - 5 [1].

![Figure 1](image1.png)

**Figure 1.** The number of staff, engaged in the research and development, in total and in the field of higher education.

![Figure 2](image2.png)

**Figure 2.** The number of researchers in technical sciences.
Figure 3. The number of Candidates of Technical Sciences and Doctors of Technical Sciences.

Figure 4. The number of researchers in all fields of science divided into age groups «on or before 29 years old» (Doctors of Sciences).
Figure 5. The number of researchers in all fields of science divided into age groups «on or before 29 years old» (Candidates of Sciences).

We have considered the efficiency in training scientific specialists during the period from 2000 to 2016, comparing the indicators of postgraduate department performance in that time, see figures 6, 7 [1].

Figure 6. The basic indicators of postgraduate department performance.
Thus, in 2016 the number of postgraduates in technical disciplines decreased at 23% (from 33763 to 25992 students) in contrast with 2010, meanwhile, the number of postgraduates who defended the thesis decreased at 61% (from 9611 to 3730 students). The number of postgraduates, who were specialized in physical and mathematical sciences and graduated, 8963 students, but only 1348 postgraduates (15%) defended the thesis.

The conducted analysis shows that the time has come for changes in this field, because to develop economics properly, we need new methods and approaches of academic personnel training development of the economy. In this respect, mentoring is one of the most effective ways to train and develop postgraduate students. The scientific supervisor of a postgraduate is, first of all, a mentor. Mentoring is the most beneficial method of adapting to the occupation at any stage of a professional career, as it is individual and aimed at improving professionalism, especially in engineering. The basis of mentoring is the interaction between a mutual interest and a value-oriented situation.

The more teachers of high qualification work at the University, the higher the level of students and postgraduates training is and the more popular a particular educational institution becomes. To increase the popularity of an institute of higher education, first of all, it is necessary to make attractive the teachers, working there [2]. Both a postgraduate's scientific supervisor and a mentor have the same requirements: the constant improvement of methodological textbooks and curricula, the systematic scientific research, the participation in international conferences and forums, the publication of articles in scientific journals from the lists of Scopus, Web of Science, and the Higher Attestation Commission of the Russian Federation. A mentor is someone who knows a lot and can help, is ready to teach and give knowledge, and, as a result, receives active and educated students; who does not get greedy, and shares connections and experience; who does not cheat [3].

The mentor must possess certain qualities and characteristics that can influence the development of his/her student. «A mentor stands behind all Great people». Alexander the Great had Aristotle as a mentor, meanwhile, Aristotle had Socrates as a mentor, and the mentor of Socrates was Plato. Christian Wolff, a German philosopher, supervised Lomonosov, and Nikolai Lobachevsky was directed by Grigory Kartashovsky, a teacher at the Kazan Imperial University, who not only broadened the young man's horizons, but also developed his critical sense so that he was not afraid of showing his creative
courage. Nikolai Lobachevsky says « ... the art of educators (mentors) is: to discover the Genius, to enrich him with knowledge, and to give the Genius freedom to follow his suggestions».

In Soviet times, mentoring was seriously developed both in industry and in education, especially at school. At school the mentoring process was not interrupted, it only abated a little. When studying the literature on this topic, come across some information about the teacher mentoring. In the last decade, a lot of attention has been paid to mentoring in business, especially in large companies. The studies of large funds, companies, and organizations are devoted to this issue. Companies are ready to spend a significant amount of money on such researches. Successful business development requires talented employees, administrators, managers, those who are able to make a breakthrough in various fields of economics.

In the book "The War for Talent" after E. Michaels, H. Handfield-Jones, and E. Axelrod, the issues of «talents» management are urgently raised; it also is proved that the development of «talents» presents one of the main problems connected with the progress in economics. In this regard, the question arises how to develop «talents» within the organization, what tools to choose for this purpose. The authors of the book point out that informal training or mentoring plays the main role in the development of «talents» [4].

We focus our attention on mentoring as an effective tool for the development of a scientist (a postgraduate or a doctoral student). The role of a mentor in the training and development of a scientist is difficult to overestimate. In an unstable situation, when economics is increasingly moving away from the material assets and is based more and more on knowledge, it is necessary to cultivate employees with extraordinary thinking. Steve Jobs said: «When I did not have enough money – I sat down to think, but not to run to earn. An idea is the most expensive commodity in the world». That is why a special attention is paid to talented employees, including scientists, postgraduates, doctoral students, and Master’s students. This results in the constant improvement of approaches to the interaction with talented employees because the future success of a company (an organization) depends on them. This is another reason why the topic of talented employees is becoming more and more relevant nowadays, and why in Russia there are education reforms, including the sphere of postgraduate education. «Talents» management is a complex system.

The analysis of foreign and Russian publications shows that mentoring is a priority tool for employees’ development around the world – most large companies develop individual mentoring programs, taking into account their peculiarities and areas of activity [4 - 8]. Mentoring programs in institutes of higher education are aimed to provide an integrated and individually-oriented approach to training of a scientist. This process is rather difficult, but necessary for any modern university. Here, a mentor’s personality plays a vital role – not every teacher or professional can become a mentor. The implementation of this approach allowed to solve a number of engineering problems at the Russian University of Transport (MIIT) with the help of mathematical simulation and computer software systems and the direct interaction of young scientists and their tutors [9 - 13].

The results of numerous studies of mentoring have repeatedly proved its necessity and effectiveness. For example, in 2012 the Agency «Contact» conducted the research, devoted to the topic «The mentoring system and personnel reserve». The research showed that 80% of the effectiveness of the personnel development is provided by the head (the mentor) of the reservist, and not by the participant himself in the personnel reserve. If the Head (the mentor) is not motivated to train and develop his/her student, then a huge part of the time will be wasted. The results of the research also showed that 63% of the respondents experienced mentoring as the personnel training system. We can conclude that mentoring is not only a relevant issue, but also a phenomenon that works effectively in practical training and development of talented employees and scientists [3]. Esaulova I. A. enumerates many models of mentoring [5]: the traditional model of mentoring («one-on-one» mentoring), team, situational, short-term or goal-setting, speedy, flash-mentoring. Each of them has its own advantages and can be applied in a higher educational institution as a special case of social partnership [14] in the field of engineering education due to the practical implementation of the «student – mentor» model.
In the work «The War for Talent» it is clearly proved that the economic growth requires the presence of «talents» and the need for them will grow \[4\]. The book included the research in which 13 thousand managers had taken part and the activities of 27 companies had been analyzed. This research resulted in the identification of five obligatory company actions to achieve the desired result in attracting and developing talents:

- accept the orientation to «talent»;
- make attractive the process of «talent» learning and development;
- rebuild the recruitment strategy;
- provide the process of continuous personnel development;
- differentiation and inspiration of people.

The study of scientific personnel training and the changes, taking place in the regulatory legal acts in the postgraduate education, as well as the study of big commercial companies in the situation when people are tend to change jobs more frequently and the working place affects greatly on the employee’s motivation, so all these data reveal that the existing experience in «talent» training may be applied and extended to the preparation of scientific personnel, including postgraduate students, doctoral students, Master’s students, etc. Thus, it is proposed to create a team of «talents» (a register of possible mentors from university scientists, followed by their association into a scientific school) in the system of postgraduate education to meet the demands for «talents» and promote the attractiveness of «talent» training and development.

In order to change the priorities when recruiting the staff, it is important to take a completely new look at the strategy for the postgraduate enrollment, i.e. a postgraduate does not look for a scientific supervisor, but a supervisor – mentor selects a postgraduate student. It is necessary to conduct a survey among the students of the first two years of studying, to make contracts with companies to train talented employees-scientists for them, and to advertise staff training. One postgraduate can have a large number of mentors at different times and in different fields. In addition, it is possible to attract the Heads of departments of different companies as mentors in universities.

In order to support the constant personnel development, it is necessary to implement the processes aimed at the personal growth of an employee (a student). Development plays a crucial role in attracting and retaining students: gifted people tend to leave if they are not allowed to make a further step. If we speak about postgraduates, the growth of any postgraduate student is mainly determined by the personality and qualities of his/her mentor. It should be emphasized that this condition can be met only under the proper student selection, otherwise, it is better to leave a student without regret. Thus, it turns out that in order to prepare the necessary number of scientific personnel, each university must have a register of suitable students for postgraduate, doctoral, Master’s degree educational programs (a permanent reserve of those who want to develop their scientific knowledge). Development takes place due to the tasks that develop professionalism, professional partnership with a postgraduate focused on creativity and implementation of special changes in the personal or professional life, as well as the process of mentoring.

Thus, the salary for growing up «talent» rises, and the «talent» cost increases as well – these are the facts of present days.

The differentiation in payment, the creation of opportunities and various investments, the motivation in scientific and any other activity in the institutes of higher education are completely similar to the processes that occur in any company which claims to develop and succeed.

The experience of big foreign companies shows that the best (the most successful) businesses conduct a thorough assessment of employees in each department, and for them this procedure is as important as budget planning \[4 - 8\]. The also make plans for staff development and they control this process. The similar changes are being introduced in the regulations of the postgraduate education. It is time to develop a mechanism for implementing these standards in the system of higher education and put it into practice as soon as it is possible.
The company management spends half of the time on keeping track of the staff performance. This is aimed at having a talented employee in each department. In other words, the work on creating a register of mentors should never stop at university either. The constant search for both mentors and mentees (postgraduates, doctoral students and Master’s students) should be done without any break. Both mentors and mentees should be assessed according to their results: the talented employees should be promoted (as in an effective company), and the «weak» ones should be disposed of. Such measures will allow each higher education institution to create a team of higher quality that is able to enhance the image of the university and make it attractive to study there. Moreover, such an approach contributes to the prestige of the profession of a scientist a lot. However, when implementing the above proposed changes, it is necessary to take into account the needs of a particular university, its history and traditions, as well as existing scientific schools.

In addition, it is necessary to take into account in each university that one of the promising tasks of mentoring is to unite like-minded people in groups to achieve certain goals (self-development, personal development and professional development), when mentoring programs are planned. Ideally, mentoring programs lead to formation of the component that will exclude the competition within the group for the fastest achievement of the goal. The cross-section (the comparison) of the results of achievements should be made in regard to other similar groups. The task of mentors is to eliminate any competition within the group, to prioritize the goal of human development, to increase the achievements of each member of the group in order to boost the competition of the entire group.

It is the regular analysis and comparison of the results of such groups (scientific schools) that will give an impetus to the development of a scientist (a postgraduate student, a doctoral student, a Master's student), his/her extraordinary thinking, resulted in the creation of a new product on the basis of new technological solutions. It is the mentoring approach to training and development of a postgraduate student that will allow to get a scientist of a new quality, and to change the quality demands a sufficient amount of material and intellectual resources. All of these confirm once again that «talent» is becoming much more expensive. Nevertheless, as the previous researches and the analysis of the available literature have shown, only «talent» can create competitive economics relied on new technologies.

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