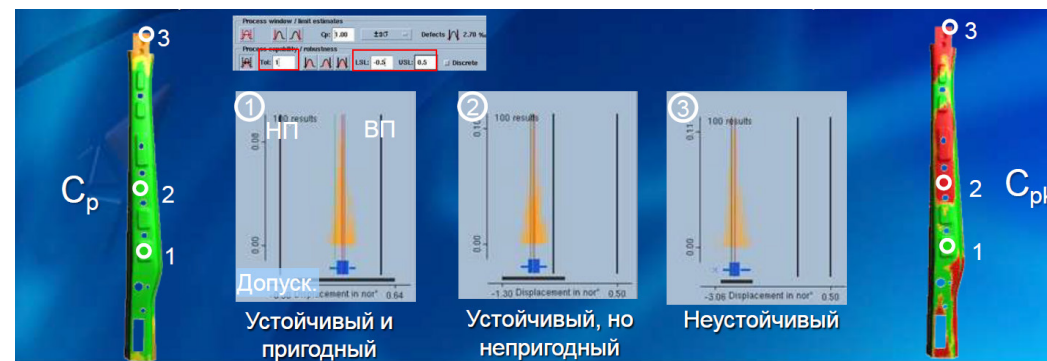


Fig. 3. Stamping reproducibility indexes in Autoform



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## Modernization of Personnel Training for Economic Development

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Received: 25.04.2017 / Accepted: 04.12.2017 / Published online: 31.12.2017

#### Abstract

This article considers the need to modernize the national system of training personnel with a university degree to ensure the growth of industrial output and the significant increase in the production of innovative products. The task of universities is to improve pedagogical skills of teachers so that they could efficiently use modern teaching technologies. Universities must generate students' fundamental competence, which is the commitment to quality. It is proposed to discuss new principal approaches to the system of education and upbringing. The article expresses the view that relatively soon the training of graduates with a Bachelor's degree in technical fields may hamper the development of modern innovative economy.

**Key words:** quality, economy, education, bachelors, engineers, competence, time challenges.

It is generally accepted that the modern world is the world of quality, and we constantly witness it. In life, we want and sometimes demand to receive products or services of the highest quality. And what about the "return"? How do we behave when we produce our own products or provide services to anyone? And how do we get along with our neighbours? What do we teach our children? How do we drive a car? How do we repair roads? How do we teach and provide medical care for people?

For all advanced countries, the quality of products, which is currently determined not only by physical, but also intellectual capital, has become the driving force of development.

It may be said that knowledge economy is becoming one of the main challenges of the XXI century.

This takes place at a time when the world economy is already experiencing the trends of the third industrial revolution. It will

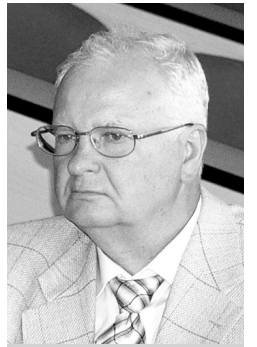
result in the decrease in workers engaged in material production and the majority of them will be involved in intellectual work, such as development, research and design.

It means that economy needs employees of the new formation, able to meet time challenges. This is the task of education system. In the twenty-first century, it must not simply provide knowledge to students, but also guarantee their creative development.

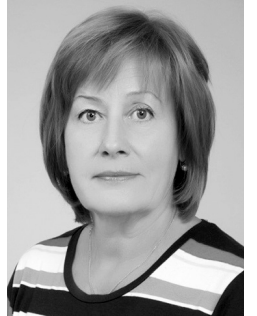
The mutual relationship between education and economy is presented in Fig. 1.

This diagram clearly demonstrates that education is the foundation of social development. In his work "Russia: Virtual and Real Political Prospects", M. Urnov, the National Research University Higher School of Economics, notes that the shortage of qualified personnel is the key factor that hinders the economic growth and modernization of Russia.

In 2003, the Russian Federation became a full member of the European educational

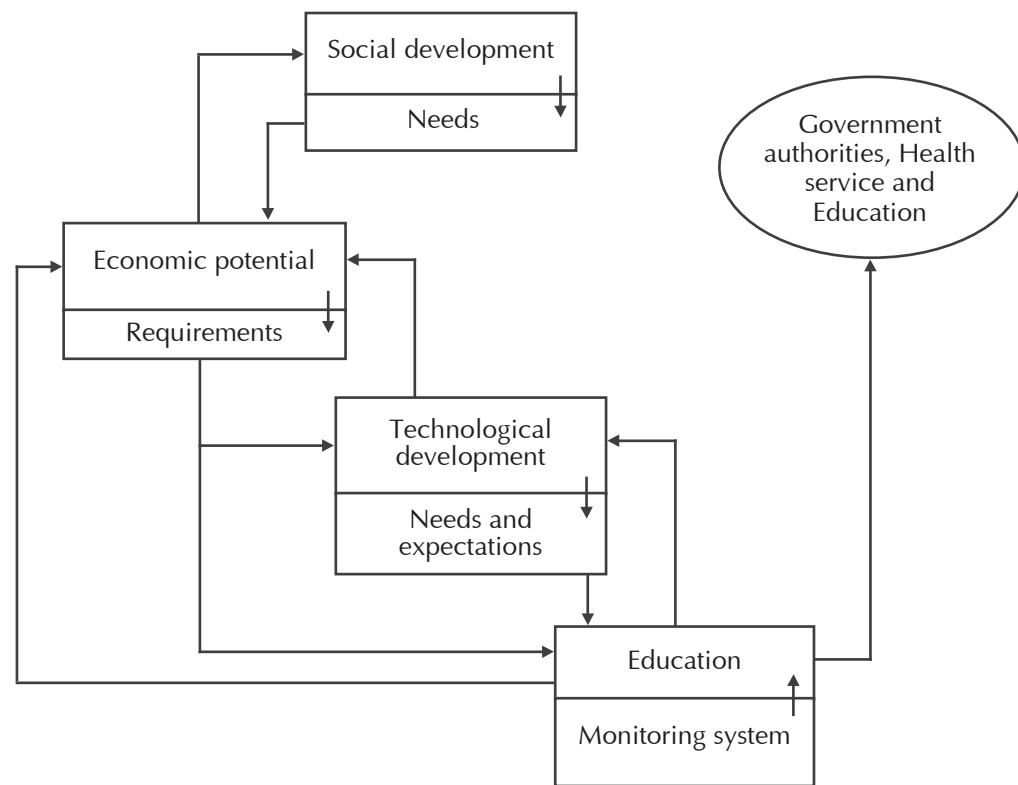


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Fig. 1. Relationship between Economy and Education



process (Bologna, Italy). Obviously, the general public was optimistic about significant changes in the educational process through the principle of students' centrality and competence-based approach to planning and implementation of educational programmes. However, in reality, the educational process hardly changed. What we saw was only a mass transition to the three-level training of bachelors, masters and postgraduates. Some educational fields continued training of specialists.

In the newspaper article "Do We Have a Plan?" ("Arguments and Facts" No23. 2016), Academician A. Aganbegyan of the Russian Academy of Sciences, underlines, that "In order to resume social and economic growth, it is required to move to a single goal-oriented economic policy. It implies the transition from reduction in investments to their accelerated growth. It concerns

not only investments in fixed assets, such as machinery, equipment, etc., but also investments in the "knowledge economy", which covers research, education, information technology, being the main component of human capital".

We consider it necessary to emphasize the importance that E. Deming, the founder of Quality Management, attached to education (training). In his writings he repeatedly stressed, "There is no substitute for knowledge. We should look at education as an investment, not as costs".

In general, quality does not only embrace the quality of products and services, but also the quality of product engineering processes, and therefore, the quality of employees, who manufacture these products. They should all be involved in the ideology of quality.

The adoption of new version of ISO 9000 base standards in 2015 by the International Organization for Standardization (ISO)

was the organization's response to time challenges associated with the increasing economic crises, the intensification of competition and the growing role of intellectual capital in achieving goals of quality of products and services. Russia approved these standards nationwide.

In this regard, let us consider new approaches to the system of higher education and management of educational organizations to ensure the high level of students' training at Russian universities. Especially it concerns those students, who are planning to become engineers.

Professor K. Ishikawa, the famous Japanese Quality specialist, wrote in his book "Japanese Management Methods of Product Quality", "I keep saying that Quality Management begins with training of personnel and ends with training personnel".

Let us take the advantage of the well-known Japanese proverb that says, "A bad owner grows weeds, a good owner grows rice, a clever owner cultivates soil, a far-sighted owner brings up an employee". The ideology of quality, which the society should be concerned about, is precisely targeted at upbringing employees. It means that it is a far-sighted policy.

And what do we mean by quality? The generally recognized concept of quality was formulated in GOST R ISO 9000 – 2015, the National Standard of the Russian Federation. Currently, it reads, "The degree of compliance of the assembly of the object inherent features to the requirements" Moreover, the "inherent feature" must be a constant sign for the quality carrier, be it an object or a product. A requirement is "a need or expectation that is specified. It is generally implied or it is obligatory". The term "quality" can be used with such adjectives as "poor", "good" or "excellent".

It means that the concept of "quality" can be applied to any products, goods, services and actions. The quality of products or goods can obviously be assessed more specifically, if products or goods have such measurable features as capacity, size, physical and

mechanical properties, service life, and many others. All household appliances, electronics, computers and cars are selected on the basis of technical performance. Sometimes people say, "Beauty arises in the eye of the beholder", i.e. quality is perceived by each person in their own way. Dr. E. Deming noted that Quality Management does not mean perfection. It means manufacture of products that meet expectations of the market in their quality.

In the philosophical sense, quality expresses the integrity of the object, its inner certainty and specificity. Quality is directly related to economy, therefore, the economic aspect of quality plays a decisive role. However, the social aspect is equally important. It embraces the level of education, intellectual development and well-being. At the same time, the social level of people impacts the quality of their work.

We should underline the moral aspect of quality, which is associated with development of the individual, the level of self-expression and morality.

#### Economy – Personnel - Quality

We cannot fail to notice the tendencies of modern production development, which are based on information technology, automation and robotization. These trends will lead to qualitative changes in the management system of production processes. As a result, such work positions as production supervisors and workshop foremen will gradually cease to exist.

The article of Yuri P. Adler and V.L. Shper, Russian experts in Quality Management, convincingly demonstrates that the upcoming 3-rd industrial revolution will require the transition from the person – performer, "cog in the wheel", to the person-creator [1, p. 38]. The new industrial revolution will need employees who are able to undergo quick retraining, learn new things, change stereotypes of their behavior. These employees need solid knowledge and broad vision.

We should also be aware of requirements for specialists during their certification. Functions of specialists-creators in

engineering and technology are significantly broader than job functions described in professional standards, The latter are related to production foremen. This is clearly demonstrated in the article of Professor V.S. Gryzlov, city of Cherepovets [2, p. 43-44].

Currently, the task of universities is to ensure that the national economy has employers who will contribute to its modernization and further development. According to "Russia in Figures" statistics digest, in terms of industrial production growth, Russia lags behind several developed countries (See Table 1).

The data provided in Table 1 refer to production sector, resources industry and construction in their entirety. We can see that after a sharp slowdown due to the crisis and economic sanctions, these sectors of the national economy demonstrate growth, which began in 2016. However, as Academician A. Aganbegyan stated (see above), much needs to be done. The 2017 Investment Forum emphasized that the share of innovative products in Russia does not exceed 9% (A. Kudrin's speech). This proves, that in order to change the situation, the national economy needs trained employees.

The developed countries see the tendency of labor resources flow from material production to the spheres of services, education, civil service, transport, construction, etc. According to the 2013 data, the employment structure of the US

population is represented by the following figures:

- the number of employees in the industrial sector was less than 15%;
- the number of employees in agriculture was about 3%;
- over 80% of the working population were employed in service sector and intangible production [3, p. 135].

Based on the same statistics digest, the structure of labor resources distribution in Russia from 2002 to 2015 is presented in Table 2.

As can be seen from the data above, over the recent 15 years Russia also experienced a decline in employees involved in industry and agriculture. And in which spheres of economic activity do we see the increase in employees? As in many countries, this trend is observed in the service sector. It should be reminded that all spheres of economic activity, except for industry and agriculture, belong to the service sector. In Russia, the transition to market economy gave rise to the new service sectors, which primarily applies to banking, real estate transactions and lease.

The operation of any economy is determined by employees. Primarily, it is impacted by their professional potential, i.e. their educational level. According to the statistics digest mentioned above, in 2015, educationwise, the entire active population of Russia was distributed as follows:

**Table 1. Records of Industrial Production Growth (%) across Several Countries of the World from 2015 to 2016**

Russia	2015	2016
China	7,0	6,1
USA	3,0	2,1
Great Britain	1,8	0,3
Germany	1,5	1,5
Japan	0,7	0,5
France	0,5	1,0
Russia	- 3,5	0,8

**Table 2. Distribution of Labour Force by Economic Activity**

Activity types	Years				
	2002	2005	2008	2014	2015
Industry	22,5	19,1	18,0	16,2	15,9
Agriculture	11,7	11,4	10,0	9,4	9,4
Construction	7,8	7,5	8,1	8,4	8,3
Transport and Communications	7,8	7,9	7,9	8,0	8,0
Education	9,1	9,1	8,7	8,1	8,1
Financial Operations	1,3	1,3	1,6	1,9	1,9
Real Estate Operations	–	7,3	7,3	8,7	8,8
Government Administration	4,5	5,1	5,4	5,5	5,5
Other services	35,3	31,3	33,0	33,8	34,1

- higher education – 33 %; secondary vocational education – 45 %, including 25.8% of employees involved in training programmes for mid-ranking professionals; general secondary education – 18.4%; compulsory education – 3.4%; with no compulsory education – 0.2%.

Fig.1 demonstrates the trend of change in the number of employees with a higher education. From 2002 to 2015, this number increased by almost 10 %. However, it should be borne in mind, that since 2005, almost 50% of graduates of governmental higher education institutions received their diplomas through extramural education programmes. Thus, the percentage of recent full-time graduates amounted to:

- 53% in 2010; 52% in 2011; 51% in 2012;
- 50% in 2013; 50% in 2014; 49% in 2015.

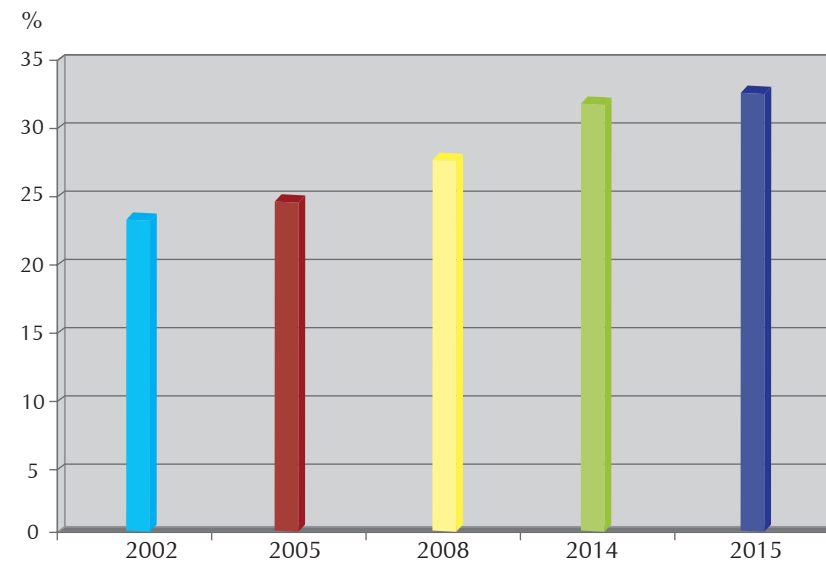
It should also be borne in mind that about 85% of graduates of non-governmental universities received their diplomas through extramural education programmes.

The educational level of employees in various sectors of the national economy is significantly high (see above reference data) with only 22% of those who did not receive a formal training. At the same time, despite the high level of education, in labour efficiency, Russia lags far behind other nations in almost all manufacturing sectors. In 1999, the labor efficiency in Russia was 19% compared to that of the US, and by 2015 it reached only 36% of the US level. The depreciation of fixed assets is the major reason of efficiency gap. Russia needs technical retrofitting and upgrading, which is achievable through training and retraining of workers and specialists with a secondary and higher education.

Massive training of specialists through extramural higher education programmes will hardly be efficient.

Higher education should imply the generation of the system of thought, the development of intelligence in a certain field rather than eligibility to obtain a better job position or perform certain activities.

Fig. 1. Number of employees with a higher education in oil economy sectors, % by year



This combination of skill and knowledge is called a profession.

The Russia's new economic policy triggers the change in the paradigm of higher vocational education, which means the transition from education "for life" to education "throughout life". This is related with several contemporary social processes taking place in Russia. Primarily, these processes include:

- significant changes in production processes and, as a consequence, changes in professions and specialties;
- increase in the role of horizontal mobility of employees in the course of their career development;
- decentralization of economic responsibility and responsibility for product and service quality;
- change in lifestyle at all levels, such as social, organizational and individual;
- use of "managerial" approaches in vocational education management;
- increase in the dynamism and uncertainty factor;
- increase in the role of personal development ("skills for life") [4, p. 50 - 51].

The acquisition of new socio-economic experience requires new approaches to

training specialists, as the most dynamic participants of economic transition.

#### Bachelors or engineers?

The analysis of the ten-year experience of Bachelor's training programmes in technical fields and the subsequent employment of graduates lead to disappointing conclusions. In transition to the level training system of specialists in various fields, it was expected that at the first level, i.e. Bachelor's degree programme, trainees would receive a "broad" education and would be self-dependently employed. It was also expected that specialty training would be conducted by employers and possibly, with the involvement of the education organization. However, this did not happen! Employers need graduates prepared to perform work for a specific job position, although the graduate is just a Bachelor with no practical skills.

However, in the near future, the training of Bachelors in technical fields will hamper the development of modern innovative economy.

First of all, this will manifest itself in science-intensive industries and in industries with complex production units in such

sectors as metallurgy, chemical production and complex technical facilities, which include rocket engineering, shipbuilding and aircraft construction. In our opinion, the return of engineering training to organizations of higher education is the time imperative.

The growth of the national innovation-based economy requires specialists with a key competence, which is the "commitment to quality". In our opinion, in order to train modern engineers, it is needed to solve at least two tasks:

- to develop the plan of continuous preparation in Quality for each technical field;
- to introduce elements of Quality Management System (QMS) in educational process and demonstrate students the results achieved. It is desirable to involve students in QMS activities, which cover correction of inconsistencies and preventive actions. Additionally, it is necessary to identify satisfaction level by educational process participants.

To solve the first task, it is appropriate to review goals of each discipline and determine, whether they are related to product quality. In accordance with this, it is required to make adjustments to the content of educational disciplines. In addition, teachers, primarily of graduate departments and developers of special courses, need to study professional standards for potential job positions of graduates. After all, it is achievable to train students to perform relevant job functions, and to some extent job actions, efficiently using all types of practices.

Professor Yu.S. Karbasov, President of the National University of Science and Technology MISIS (NUST MISIS), in his review of our book "Education for Innovative Economy" outlined the task of university teachers as follows, "Currently, there is no issue with what to teach our students. The main issue is how to teach, in order to achieve the result, which is the product of graduates' professional and cultural competencies".

It is known, that education is a dual process involving two parties: a teacher and a student. In modern educational process, their relationships change. They are based on external and internal goals of education system. External goals are those, which are anticipated by the state and society, by means of organizing and funding education system. These goals are associated with further involvement of graduates in the economy development and, ultimately, with improvement in people's quality of life. However, we should not forget about internal goals either, which are associated with satisfaction of students with their "growth" in the eyes of their relatives and people around them, inclusive of their teachers. Internal goals also concern teachers' satisfaction with their significant work for the entire society and teachers' status.

The goal of studies changes, i.e. students need not only knowledge, because it is their intermediate goal, but also professional skills. It means that through knowledge students obtain their professional skills. The content of independent work changes and includes not only an independent study of teachers' material, but also an active and dynamic acquisition of the entire complex of issues, which arises from the ultimate goal of training formulated in the competence model.

Teachers' impact on students is required for the generation of professional consciousness of specialists that are required by modern society.

Ancient Greeks used to say that "the ship will not sail with the wind if the skipper does not know the final destination".

For the system of higher education, the requirements for future specialists belong to the "final destination". Currently, such requirements cover graduate competencies formulated in the Federal State Educational Standard and the educational programme. These are precisely the "inherent features" of our products. Graduates are expected to have "features" of their competency, which differ in breadth, depth and ability. However, they are not expected to be below

the established level of future professionals being moral, purposeful and responsible members of our society.

We believe that education is “climbing up” a wide staircase, for at each step, i.e. semester, students study several interrelated disciplines. These are horizontal relationships. This transition is followed by the next step, which implies the beginning of “consumption” of previously acquired knowledge and skills. These are vertical relationships, which are connected with horizontal relationships of this step. Similarly, students use the knowledge acquired in secondary school. In addition, we must take into account that academic disciplines are taught by different teachers.

Long-term experience confirms that training of specialists in higher education establishments will be rewarding if all academic disciplines are interrelated in content. They should be arranged in the curriculum to ensure not so much the accumulation of knowledge by students as the continuously improving ability to solve various problems through the synthesis of knowledge.

In any educational programme, academic disciplines differ not only in content, but also in the required acquisition level. It is advisable to consider them as learning objectives. B. Bloom identified six levels of learning goals, which include knowledge, understanding, application, analysis, synthesis and evaluation.

To describe education results in accordance with levels of goals, we will use active verbs:

- **knowledge** – to reproduce, tell, formulate, etc.;
- **understanding** – to classify, recognize, etc.;
- **application** – to demonstrate, solve, etc.;
- **analysis** – to calculate, estimate, etc.;
- **synthesis** – to contrast, plan, etc.;
- **assessment** – to discuss, express judgment, etc.

In order to establish relationships between education results and future

professional activities, it is appropriate to generate a certificate for each key competence. Table 3 exemplifies the certificate of generalized competence named “To Manage Production Process”. Manifestation signs of this competence in professional activity belong to its important element. The contrast between generated specific competences and manifestation signs of generalized competence make it possible to determine training orientation of each discipline, implementation of projects, course research work and implementation of practical training.

At present, educational organizations and individual teachers have the latitude to select educational technologies, which is beneficial. However, there is a danger that we might not take proper advantage of this opportunity, due to insufficiently high and somewhere even low technology competency of teachers.

What precludes educational organizations from providing the required training quality of graduates that would satisfy consumers?

In our view, the key reasons include:

- insufficient input level of prospective university students, primarily in mathematics, physics, chemistry and drawing;
- performance of students during their study. Specifically, it is absence from university and falling out of the disciplinary system;
- low motivation of students to achieve a high level of knowledge, skills and competencies in a selected profession;
- insufficient knowledge of contemporary teaching methods by teachers;
- educational institutions are insufficiently provided with contemporary learning technologies;
- inconsistency between customers' requirements and educational programmes.

How can we ensure quality education for graduates?

Training is not a walk in the park or a show. It is hard work, which involves two participants of educational process: the teacher and the student. Universities have

Table 3. Competence Certificate

Competence	Competence Manifestations	Elements of Education Process	Generation Procedures
To manage production process.	<ol style="list-style-type: none"> <li>1. Understands the essence of production process.</li> <li>2. Reveals inconsistencies.</li> <li>3. Determines management actions.</li> <li>4. Corrects process.</li> <li>5. Evaluates object reaction to external actions.</li> <li>6. Understands consequences of decisions made.</li> <li>7. Trains personnel.</li> </ol>	<ol style="list-style-type: none"> <li>1. Disciplines (list of disciplines).</li> <li>2. Practical training.</li> <li>3. Course research work.</li> </ol>	<ol style="list-style-type: none"> <li>Lectures / Practical sessions.</li> <li>Laboratory classes.</li> <li>Practical training.</li> <li>Trainings.</li> <li>Engineering games.</li> <li>Intellectual games.</li> </ol>

competitive admissions because not every young person can cope with this challenge. In our opinion, Russian organizations for higher education are locked into patterns, their activities are tied by limitations. In order to “spread the wings”, national universities need to look around, evaluate their performance and ask themselves, “Are we doing everything we can to achieve the goal, which is to provide the quality education?”

In this article we cannot consider all possible types of educational technology. Some of them are presented in the work book [5, p.126 - 136]. However, we would like to focus on major approaches to the system of education and upbringing.

**First**, the situation with training quality of university graduates will dramatically improve if **retaking exams and tests is repealed** nationwide. It is required to introduce the system of recurrent education. Possibly, students will have to pay tuition fees and previously settle the matter with drafting in the army.

This will require changes in the State educational standards in terms of restricting duration of educational programmes. These restrictions must be withdrawn.

It should be noted that many countries have been using this education system pattern for many a year.

**Secondly**, the issue related to students, who combine their studies with work, can be successfully resolved if the system of **duplication of all (day and evening) training sessions** is in place. Students are expected to choose time of their studies and attend all their classes.

This will require an increase in budgets of universities. At the same time, university management “will be compelled” not on paper, but in real life **to reduce classroom hours and strengthen independent work of students**.

**Third**, teachers' capacity will be used more efficiently if students are taught in classrooms and their number is limited to 25 people to a group. It means that classes are not to be divided into lectures, seminars and practical sessions [6, pp. 3-4].

This implies a significant reduction in batch lectures except for humanities lecture sessions. It would require additional human, financial and information resources. However, this system of educational process will immediately enhance the level of students' performance, especially in such “difficult disciplines” as higher mathematics, physics, chemistry, material sciences, electrical engineering, physical chemistry, strength of materials, analytical mechanics, etc.

It is no coincidence, that numerous leading US universities have this teaching method in place.

These and other proposals appear in publications, but, unfortunately, are never discussed, as if unnoticed.

We believe that it is required to focus on one more issue. Russia has launched the campaign on developing Professional Standards (PSs). The Professional Standard of Teachers was approved, however, in order to execute educational activities at universities, relevant PSs surprisingly do not contain the requirement for pedagogical qualification of teachers. In practice, most teachers, especially members of major departments, do not have a teacher education.

Back in Soviet days, this drawback was eliminated through the system of refresher training. For example, all teachers of the Moscow Institute of Steel And Alloys attended refresher courses in teaching. Refresher sessions were performed by members of the Centre for Studies. Below are the excerpts from the training package:

- Elements of Pedagogical Communication in Educational Process delivered by Academician I.A. Zimnaya, the Russian Academy of Education.
- Implementation of University Active Teaching Methods Into Practical Use delivered by Professor A.A. Verbitsky.
- Acquisition of Test Check Methods of Students' Achievements delivered by Professor V.S. Avanesov.
- Scientific Basis of Educational Process Management delivered by Professor N.F. Talyzin.

These topics are still relevant.

#### Conclusion

During the President's news conference on December 23, 2016, V. V. Putin said, «First, the authorities and businesses have joined efforts to adopt the National

Technology Initiative, as you know. We are drafting a comprehensive economic development plan to 2025»

However, the question is, "Will the human resources be prepared for the real economic development? Is this part of the development plan?"

In our opinion, to ensure a sustainable innovative growth of Russia's economy, it is required:

- to determine priority fields of economic development and universities' schools of sciences, which are capable of providing education rather than simply training specialists;
- to allocate targeted funds for scientific and educational activities of these schools, without stretching funds across universities;
- in some universities, to extend training duration in priority fields; to increase the level of requirements for graduates, to deliver students from "retention pressure";
- in priority fields, to bring into force the State employment guarantee for graduates and lend them material support after their graduation;
- to assess competence level of students and qualification of teachers by independent experts;
- to examine the quality of extramural students' training in technical fields. If the level of preparation is insufficient, it is required to equate it with advanced training.

The national system of higher education needs fundamental reforms. It is wise to take advice from G. Ford, "Failure is only the opportunity more intelligently to begin again".

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