Chapter

Education and Science for Innovative Development of the Eurasian Economic Union Countries (Russia, Belarus, Kazakhstan, Armenia, Kyrgyzstan)

Nina Bohdan

Abstract

Differences in the levels of human capital and the countries' abilities to maintain, attract, and expand it within them determine the opportunities of innovative development and the future economic growth. That is why, as a rule, all the international comparative assessments of the innovative development levels begin with human resources assessments. The most important investments determining the development of human resources are those in education and scientific research. The goal of this research is to identify the potential of the Eurasian Economic Union (EAEU) countries in the formation of innovative economies based on highly qualified cadres, using the current achievements of science and technology for the growth of their population's well-being. EAEU came into force in January 2015; it includes Russia, Kazakhstan, Belarus, Armenia, and Kyrgyzstan. The article considers the issue of financing education of the EAEU countries; it identifies the problems affecting the quality of training specialists as well as correlations between education and development of scientific research. There were also made attempts to assess the effectiveness of education and science which determine the opportunities for forming modern innovative economies in the EAEU countries and the growth of their citizens' well-being.

Keywords: innovations, education, science, financing, publication, patents

1. Introduction

The Eurasian Economic Union (EAEU) came into force in January 2015; it includes Russia, Kazakhstan, Belarus, Armenia, and Kyrgyzstan. This Union ranks eighth in the world with regard to the amount of population (186 million people), first with regard to the territory (20.26 million km^2), and fifth with regard to GDP (USD 4695.9 bn). According the Agreement on the Eurasian Economic Union, the goals of this alliance are the member states' economic development as well as modernizing and enhancing the competitiveness of these countries in the world market. That said, EAEU is open not only for new member states but also for direct interaction and in-depth economic collaboration with other countries. EAEU ensures freedom of goods, services, capital, and work force mobility as well as pursuing of a coordinated or unified policy in the economy sectors. The integration association of the EAEU countries is based on mutual interests; it takes into account the former USSR single economic area as well as the cultural traditions of many generations, current trends of forming economic knowledge, and objectives of mutual innovative development.

The research of the neo-Eurasian integration processes falls into two directions: optimistic and skeptical. The former comprises researches whose representatives see an opportunity of implementing the potential of the Eurasian region countries in the EAEU project. The basis of the integration policy strategy of Russia, Belarus, and Kazakhstan which formed the customs union at the first stage of integration was their desire to leave behind a long period of disintegration within the Eurasian area and establish the Eurasian Union, alongside the European Union already acting in the Eurasian area. A positive evaluation of the Eurasian Union is given by the Russian expert Karaganov [1]. However, he expresses concerns with regard to accepting the former Soviet Union Central Asian republics to the newly established Union. Ivashov [2] states that within the framework of the single project, there are launched processes which form vertically integrated transnational structures in the leading sectors of manufacture as well as single production and customs areas. At the same time, single areas of culture, science, innovations, and sports are resumed. The analysis of the EAEU prospects is in the focus of the researches done by E. Vinokurov and A. Libman who consider the Eurasian Economic Union the most realistic among the existing integration projects in the post-Soviet area [3].

The second group of experts considers the EAEU project an unsuccessful attempt of revive the former imperial structure [4, 5]. An objective reason for it is a negative experience of integration in the post-Soviet area over the past years. According to them, the creation of the Eurasian Union is facilitated by nostalgic reminiscences without realistic prerequisites [4]. Apart from that, any projects of modernizing the post-Soviet cause fears on the part of the West as regional associations contribute to strengthening weak economies, especially those in Central Asia. However, it is pointed out that a considerable advantage of creating the new Eurasian Union will be the huge single market coupled with decreasing barriers for the goods and people's mobility [5].

Researches of prospects for the cooperation of the EU and EAEU integration associations show that for successful and efficient integration, it is necessary to establish a structure similar to EU by its nature—the Eurasian Economic Union. In this case, it will be possible to build equal partnership relations and expect positive results from this collaboration [6]. Europe + Russia + former Soviet republics have a highly educated and technologically competent population whose skills comply with the requirements of the "knowledge-based society" being formed, which no doubt is of primary importance in the twenty-first century. That is why the creation of the global integration region with free mobility of intellectual resources, work force, good, capitals, and services is able to form Eurasia as a center for the world development.

In this context, the creation of EAEU and its further enlargement can be considered as an important condition for forming a transnational communicative intellectual environment. One should agree with scholars [6] who claim that integration in the social sphere (health protection, education, etc.) is to be based on a personality's central role, which is especially relevant in the context of the world tendency of personifying world political and world economic processes. A dual

Eurasian nature of mentality and behavioral stereotypes of Eurasia's population enables to accept and creatively process the experience of social policy both of Europe (individualism) and of Eastern neighbors (collectivism). That is why a mandatory condition for the countries' integration within EAEU is a social program based on investments in the human capital and determining the prospects of innovative development.

Human capital in the twenty-first century has become a major factor in the development of the economy and society. The quality of human capital is primarily formed by the education system, whereas the contribution of other factors, such as health, migration, and culture, is less significant. "Human capital" means not individuals themselves but the knowledge and skills they possess that enable them to create value in the global economic system [7, 8]. Human capital is also the ability to create new jobs, structures, and activities, in other words, entrepreneurial abilities in a broad sense. In modern society, the key beneficiary of the "human capital" is the person himself/herself and his/her family.

Accordingly, education in modern economy should be considered not as a cost-based sphere, alongside with social protection, pension system, government staff, defense, and security, but as an investment sphere determining the scale of the economic growth. Education is the main instrument for ensuring social justice through an "equal start" for all the citizens. The educational function of education ensures the reproduction of the cultural code as well as the development of values of solidarity and patriotism. It contributes sustainability to the social development. The National Strategy for Sustainable Development of Belarus until 2030 indicates that "the education system must ensure that the knowledge and skills obtained be adequate to the rapidly changing requirements of the society and economy, engineering and technology, the development of personal initiative and human adaptability, thanks to which human abilities to integrate and create innovation are expanded" [9].

At this point, the potentials of the EAEU countries with regard to their human resource quality and opportunities for innovative development significantly differ, which is shown by the international indicators (see **Table 1**).

The analysis of international ratings shows that Belarus and Russia have similar ratings of potentials in the field of human development, whereas Kazakhstan maintains a high growth rate of human capital assessment indexes. The weakest human resources potential for innovations belongs to Kyrgyzstan. However, the countries' positions in the assessment of innovative development are not closely related to the

Country	Population, thousand people	Index of human development (rating)	Global index of innovations (rating)		GDP per capita (PPP, USD)		
	2017	2018	2016	2017	2007	2013	2016
Belarus	9507	54	53	88	12,345	17,620	18,060
Russia	144,495	49	48	45	16,729	25,248	23,132
Kazakhstan	18,038	58	82	78	17,354	23,214	25,623
Armenia	2930	83	61	59	6480	7776	8818
Kyrgyzstan	6202	122	109	95	2449	3213	3551

Source: Based on Refs. [10, 11] and http://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD?view=chart

Table 1.
Indicators of EAEU countries' development by international ratings.

assessment of their human resources; for instance, Belarus, unlike the other EAEU countries, over the recent years has weakened its position in the international innovations rating, despite its most developed human capital among the member states. To some extent, this is related to the fact of changing certain indicators in the assessment that are taken into account in the global index of innovations. At the same, other factors also need to be researched, including integration and financial aspects of supporting education, science, and innovations.

2. New problems of EAEU countries in the sphere of education

In the coming years, the demand for human resources with a high level of education is going to grow. According to the EU data, by the year 2025, the proportion of highly qualified labor "International Standard Classification of Education" (ISCED 5-6) in the economy will grow to 39%, and that of low-skilled labor (an ISCED below 3) will reduce from 22 to 14% [12].

Researches [13] show the necessity of changing the policy in the sphere of education, which is determined by a number of factors:

- Growing importance of international trade: economic activity has become globally interconnected on an unprecedented scale, bringing people, goods, and services together faster than ever. In education, this global economic integration creates both a need and an opportunity to develop new curricula to provide students with the skills required in a globalized economy.

- Migration has become much more common, particularly toward affluent countries. The mobility of individuals, families, and human capital is facilitated by technological advances and driven by trade and skill imperatives. International university students' mobility grew from 0.8 m in 1975 to 4.3 m in 2011 and keeps growing. Education systems also have to deal with transferability of skills and experience so that they could adequately recognize prior learning and qualifications of immigrant students.

- Rapid technological development has changed the way we interact with each other and our communities. Information and communication technologies (ICT) offer opportunities to store and share data, foster dialog among education professionals, and strengthen feedback mechanisms and evaluation procedures.

Education reform can only be effective if policies are well implemented. This means that in order to support reforms in evaluation and assessment, there must be coherent indicators.

One of the new indicators in the assessment of innovative development prospects is an education level of youth. As an indicator in the European practice, they use the proportion of population with tertiary education within the population aged 30–34. According to the international system of education classification (ISCED 5–6), the third stage of education can include specialists with completed secondary specialized and higher education. The proportion of such specialists among the young people in EU accounts for 35.8%, and according to the strategy "Europe 2000", by 2020 it should account for at least 40% [14].

Our calculations show that in Belarus the proportion of population with tertiary education aged 30–34 makes 59%, which is higher than in many European countries. An important role in innovative development is played by the structure of training specialists of the so-called science, technology, engineering, and mathematics (STEM) majors. More than 24% of all the students in Belarus are trained in STEM majors, whereas in Russia—23.5%. The proportion of students majoring in STEM is significantly lower in Kyrgyzstan and Kazakhstan (15%). The proportion of university graduates with STEM majors in Russia and Belarus is in line with the all-European structure. However, in Kyrgyzstan, the proportion of youth with a higher education accounts only for 14.5%, and training young females in STEM majors requires special care of the government and financial support.

Special attention to the results of training is a consequence of the changing role of information in the society and enhancing information transparency, in the context of which the accountability to the society in the broad sense of the word is becoming just as important as observing the legal and regulatory norms.

The World Bank surveys in Belarus [15] show that business as a consumer is not satisfied with the quality of training specialists: 22% of the respondents have pointed out that the specialists' competencies are not sufficient for business growth. This problem is specific not only for the EAEU countries. The surveys show that developed countries have similar problems: 20–30% of employees mark incompatibility of their education with the required skills ([16], p. 54).

The EAEU countries over the recent years have been striving to enter into international projects for assessing the quality of education. Russia, the only one among the EAEU countries, participated in the implementation of the Assessment of Higher Education Learning Outcomes (AHELO) in 2012. The attention of the Russian educational community to AHELO and other alternative international tools for assessing the quality of education is also due to the fact that the positions of Russian universities in international ratings are still weak, and given the lack of alternatives to international ratings, they have to either be part of them or develop their own ratings. The experience of the AHELO project in Russia, which included a wide variety of universities, both leading universities (federal, national research) and nonuniversity institutions, showed that a strong motivation for improving the quality of education, achieving international quality standards, and internationalization is demonstrated today by many Russian educational institutions. Participation in international projects such as AHELO could be a good alternative for many universities to benchmark the level of curriculum development (benchmarking), to self-assess and adjust their development strategies, as well as to confirm their international competitiveness in general and in certain areas of training.

Kazakhstan and Russia have experience of participating in Program for International Student Assessment (PISA) projects—for 15-year-old school students' assessment of the quality of education. The study does not cover the level of mastering the school curriculum but the ability of adolescents to apply the knowledge gained in their lives. Orientation at the transfer of a large body of knowledge does not form an independent thinking. It is PISA that makes it possible to understand which country will be more competitive in the future due to the potential of the younger generation. Russia—in the PISA assessments of the quality of education—is at the level of OECD countries, whereas in Kazakhstan the results of 15-year-old students are much lower than the average in OECD countries and lower than in most countries participating in the PISA program ([17], p. 82). The other EAEU countries have not yet participated in this international project, which is due to a lack of financial resources.

In 2017–2018 a number of Belarusian universities took part in the European Fostering Competencies Development in Belarusian Higher Education (FOSTERC) project aimed at strengthening the use of innovative principles and approaches to teaching and learning in Belarusian higher education institutions to improve the results of graduates' education based on competencies. Within the framework of the project, there were seminars and 3 large questionnaires, in which over 5000 graduates of Belarusian universities, over 3000 instructors, and 260 employers participated. The results of the survey were analyzed. The analysis showed that there are noticeable discrepancies between the requirements of the labor market and the competencies provided by universities. The abilities to negotiate, diagnose problems, and adapt to changes are the most problematic. Curricula provide low skills and knowledge for being involved in entrepreneurship [18]. The results of the research still require profound study and transformation of knowledge into new pedagogical methods and curricula as well as improvement of management and financing.

Kazakhstan has a very interesting initiative of the state in the field of internationalization of higher education, the "Bolashak" program, which has been operating since 1993. The "Bolashak" scholarship is designed to train future leaders in the field of economy, state politics, science, technology, medicine, and other key areas. About 10,000 people received government scholarships for the "Bolashak" program. They have been trained in the leading universities in 23 countries, including Canada, the United Kingdom, and the United States. In 2014, a total of 1297 young people aged 18–28 years became recipients of the "Bolashak" scholarship [14]. Upon the completion of their study abroad, scholarship recipients are obliged to work in Kazakhstan within their majors for 5 years. Priorities of the "Bolashak" scholarship program are currently aimed at supporting and developing graduates in certain subject areas that will contribute to solving the tasks of the state program of industrial and innovative development of Kazakhstan. However, this initiative of Kazakhstan has not found support in the other EAEU countries. In part, only the initiative of Russia's "global education" coincides with it. "Global education" is being implemented in Russia in accordance with the presidential decree of December 28, 2013, "on measures to strengthen the human resources capacity of the Russian Federation." Any citizen of Russia who independently entered a university included in the list of the leading foreign universities, for the purpose of training in one of the priority majors for the country, can apply for payment by the state of his/her studies. In exchange, such citizens must work within their majors for 3 years in Russia. The grant awarded to participants covers both education expenses and part of the related costs—flights, accommodation, etc. The list of universities where the program participants can be trained includes 225 leading universities from 27 countries. Training participants can take place by 32 majors being a priority for the country [19].

Thus, the EAEU countries face the global problems of the formation of a new educational policy that takes into account the dynamics of modern development and requirements to the growth of the quality of education. The growing complexity of the sociocultural educational environment related to the dynamic development of science and technology strengthens the need for pedagogical cadres capable of solving the tasks of modernization at all levels of education. There is a need to develop a unified strategy for the integration of the EAEU countries aimed at increasing the international competitiveness of educational organizations and the education system as a whole.

3. Specifics of financing education in EAEU countries

The quality of education is largely determined by the financing possibilities. Public spending on education in the EAEU countries considerably varies (see **Table 2**). Over the recent years, with respect to GDP, expenditures on education in

Indicators	Armenia	Belarus	Kazakhstan	Kyrgyzstan	Russia
Government expenditures on education (% GDP)	2.4	4.9	3.3	6.0	3.8
Expected years of schooling (year)	11.2	15.4	15.0	13.0	15.0
Tertiary education enrollment index (% of population of respective age)	44.3	94.3	48.5	45.9	78.7

Source: Calculated according to Ref. [20].

Table 2.
Education indicators in EAEU countries (2015).

Country	State expenditures on tertiary education in percent to GDP		State expenditures on tertiary education in percent to total amount of state expenditures on education	
	2008	2013	2008	2013
Belarus	0.91	0.93	20.07	17.58
Russia	0.95	—	23.11	—
Kazakhstan	0.36	0.4	13.9	13.13
Armenia	0.36	0.2	11.29	8.72
Kyrgyzstan	0.97	0.89	16.44	12.03

Source: Compiled according to Ref. [10].

Table 3.
Expenditures on tertiary education in EAEU countries.

Russia and Belarus have declined; they have increased in Kyrgyzstan and remain low in Kazakhstan and Armenia.

Expected duration of study is the indicator of education statistics, which is taken into account in the calculation of the Human Development Index. Regarding this indicator, the EAEU countries also have significant differences. While Belarus, Russia, and Kazakhstan—with regard to this indicator—have almost approached the developed countries (France, 16.3; Germany, 17; UK, 17.9), Armenia and Kyrgyzstan are significantly behind, which affects the reduction of the rank of the countries in the Human Development Index (see **Table 1**). The EAEU countries have different indicators of the young people coverage with tertiary education ("International Standard Classification of Education"—ISCED 5–6). The highest indicators are in Belarus and Russia (94.3 and 78.7); they are lower in Kazakhstan, Kyrgyzstan, and Armenia (48.5, 45.9, and 44.3, respectively).

One of the features of financing education in the EAEU countries is a low proportion of costs for higher education. For example, in Belarus, with a high proportion of students enrolled in the third stage of education, the share of costs for third-level education in the budget for education is low and keeps declining: in 2008 it was 20%; in 2013, 17.5% of the total funds are allocated for education; and in the other EAEU countries, it is even lower (see **Table 3**). The main part of the expenditures on education is used at the level of secondary education. In developed countries, the share of spending on tertiary education in the structure of the costs of education is much higher: in 2013 it amounted to 26.1% in the United States, 36.6% in Canada, 29.9% in Norway, and 28% in Germany ([10], p. 759).

If we consider expenditures on tertiary education with regard to GDP, within the EAEU countries, these costs significantly vary, from 0.2% of GDP in Armenia to

0.9 GDP in Russia and Belarus (see **Table 3**), and they do not have a tendency to grow. Part of the reason is the smaller enrollment of students at the higher level of education, but the share of funds spent on the education of the third stage in Belarus in Russia, where the student body is much larger, requires an increase. In the rest of the world, the situation is different. Education expenditures have a steady upward trend regarding GDP, with spending on the third stage of education regarding GDP in developed countries being much higher than in the EAEU countries. For example, in 2015 in South Korea, these expenditures made 1.8%; in EU (22), 1.3%; and in OECD, 1.5% of GDP.

Comparison of training costs per one student on tertiary education (% of GDP per capita according to PPP) shows that in 2013, according to UNESCO, those costs in Russia were 14% and in Belarus, 15% of GDP per capita (for comparison: in Finland, 36%, and in France, 35% of GDP per capita). An alarming tendency to reduce the relative costs of training a third-stage student in Belarus should be noted: in 2004, according to UNESCO, these costs accounted for 27.6% of GDP per capita, whereas in 2013 they made only 15%, i.e., over the last decade, they have almost halved with regard to GDP per capita. Today, in absolute terms, the training cost per one student in Belarus is USD 2763 with regard to purchasing power parity (PPP) (this indicator in the CIS area is lower only in Moldova), and in Russia it is USD 3900, with the average European level being USD 13,000.

Low costs for higher education lead to negative consequences. Stable underfunding of education reduces its quality and stimulates the outflow of students to study in other countries. According to UNESCO statistics (Global Education Digest 2012), for example, 28.8 thousand students from Belarus were studying abroad; in 2014 there were 35 thousand of them. The largest number of students who chose education abroad from the EAEU countries is in Belarus, 6.39% of the total; in Kazakhstan, 6.25%; and in Armenia, 5.67%. Students from Russia who chose foreign education make up a relatively small amount, 0.67%, the most attractive for them being Germany (17%), the Czech Republic (9.4%), and the United States (9.2%).

The problem of lack of funds creates another problem: Belarusian universities have limited access to the world-renowned scientific journals. In Russia and the other countries, this problem is solved through the organization of consortia and purchase of access to databases of the journals using budgetary funds. In Belarus this task has not been solved yet due to lack of funds. This is largely due to their high price—it is about several tens of thousands of dollars each year. In Kazakhstan there is an inefficient distribution of funds between universities. Thus, "Nazarbayev University" accounts for a significant portion of the total public expenditure [17], which limits funding for the rest of the education system.

Insufficient financing of education at the level of higher and secondary special education is fraught with a decline in its quality and a weak prospect of attracting promising young people to study in the country. According to the indicator characterizing the share of Belarusian students studying abroad, Belarus ranked 20th in the Global Innovation Index 2013, and with regard to the share of foreign students in the country, Belarus ranks 61st. International students in Belarus make up 4.8% of the total student contingent (2016–2017 academic year), and in Kazakhstan (2014) they accounted for 2.1%.

Russia remains attractive for foreign students of the countries of the former Soviet Union. For instance, in 2014 35,000 citizens of Kazakhstan out of 48,800 studying abroad were trained in Russia. Of 5800 students of Kyrgyzstan studying abroad, 3200 study in Russia. Two thousand six hundred Armenian students also study in Russia. The predominance of the Russian Federation for students from the countries of the post-Soviet area can be explained by a number of factors. They include geographical proximity, language compatibility, the number of scholarships provided by the Russian Federation to students in the countries of the former USSR (in particular, for students from regions bordering on the Russian Federation), and the similarities between education systems.

So far, within the framework of the EAEU countries, the most active cooperation in the sphere of education is between Russia and Belarus. Interaction between Belarus and Russia is carried out at the intergovernmental, interdepartmental, interregional, and interuniversity levels. Regular joint meetings of the collegiums of the Ministries of Education of the Russian Federation and the Republic of Belarus are held. More than 550 agreements on cooperation have been signed between universities and scientific organizations of Russia and Belarus. Such relations are determined by the existence of the Union State "Russia-Belarus"; however, such relations do not apply to the other EAEU countries.

It should be noted that the lack of unified statistical approaches and indicators of the assessment of education for the EAEU countries hinders a comparative analysis and does not allow the development of the unified approaches to the educational policies of the integration association's countries.

4. Financing science and assessment of its effectiveness in EAEU countries

An important role in innovative development is played by investment in research. The main source of investment in science in developed countries is the expenditures of the business sector (up to 70%). In the EAEU countries, the main source of investment in science is the budget expenditures undertaken to support the real sector of the economy. Despite the fact that the main sector of costs for science is entrepreneurial (see **Table 4**), funding from this source in the EAEU countries in 2013 was small: in Kazakhstan it accounted for 28.9%; in Russia, 28.1%; and in Belarus, 43% of the total costs of research ([10], p. 753).

For the development of education and the growth of its quality, investments in science in the higher education sector are important. In developed countries, it is the higher education sector that carries out fundamental research, which is then implemented in applied scientific research and development. The increase in the costs of scientific research in higher education institutions also affects the quality of higher education. In Belarus, the proportion of expenditures on science in the

Country	R&D Expenditures (% GDP)		R&D expenditures in 2013 by sectors of performance (%)			
	2008	2014	Entrepreneurial sector	State sector	Universities	Non-for-profit sector
Belarus	0.74	0.52	65.32	23.82	10.84	0.02
Russia	1.04	1.19	60.6	30.26	9.01	0.13
Kazakhstan	0.22	0.16	29.43	29.68	30.69	10.2
Armenia	0.22	0.24	—	88.63	11.37	—
Kyrgyzstan	0.19	—	23.36	65.18	11.46	—

Source: Compiled according to data [10, 21].

Table 4.
Distribution of expenditures on scientific research by sectors of EAEU countries.

higher education sector is significantly lower than in developed countries, and it keeps declining (e.g., in 2005 it was 17%; in 2016, 9.6% of the domestic expenditures on research) [21]. As the analysis shows (**Table 4**), the financing of this sector in all the EAEU countries is small—it is at the level of 10% of all the expenditures on science. Significant changes have taken place in Kazakhstan, where reforms in the structure of higher education and science resulted in growth of financing this sector to 30% of the total expenditures on research (in 2009 it was only 15%).

It should be noted that over the recent years, there has been no positive change in the growth of the GDP science intensity in the EAEU countries. Data analysis (see **Table 4**) shows that only in Russia the level of the GDP R&D intensity exceeded by 1%. The planned tasks set by the State Program of Innovative Development of Belarus for 2011–2015 regarding the growth of this indicator (2.5% of GDP) have not been fulfilled. In 2015–2016 this indicator accounted for just 0.52% of GDP. The most disturbing, from the standpoint of conformity to the world trends, is the indicator that characterizes expenditures on R&D per one researcher. Our calculations for Belarus show that from 2007 to 2015, they rose from 35 to 45 thousand dollars, but this is almost 4 times less than the average in the countries with an income level above the average and corresponds to the underdeveloped countries of Africa. In Russia, this indicator in 2013, according to UNESCO, accounted for 56.6 thousand dollars, which is higher than in 2007 (47.4 thousand dollars), but it is clearly not enough to preserve promising scientific cadres, because in developed countries this figure is 205 thousand dollars [10].

In Kazakhstan, according to the state program of industrial and innovative development of the Republic of Kazakhstan, the task is to increase the GDP science intensity to 2% of GDP by 2020; however, this indicator in 2015 did not exceed by 0.17% of GDP. Russia has approved the "Strategy for Scientific and Technological Development of the Russian Federation." The regulatory framework for the launch of the "National Technology Initiative" was provided, which is a key tool for the transition of research results to products and services that contribute to the leadership of Russian companies in promising markets. At the same time, the level of science intensity of Russia's GDP lags behind that of the developed countries (2.5–3% of GDP), and researchers note a discrepancy between the resources and the results of scientific-technological and innovation activities [22].

Thus, the current state of financing science in the EAEU countries does not correspond to the world trends in the growth of research and development costs. In the world, according to UNESCO, the R&D intensity accounts for 1.7% of GDP, and despite the crisis symptoms in the economy, investments in research and development (R&D) significantly increased: in the period from 2007 to 2013—by 31%. This exceeds the growth of the world GDP for the same period (20%).

Insufficient funding of science and the lack of positive dynamics reduce the interest of young people in a scientific career and result in a reduction in the number of science personnel (see **Table 5**). The analysis shows that in Russia, Belarus, and Armenia, there has been a decline in the number of science personnel, but in Kazakhstan and Kyrgyzstan, despite the continuing low funding for science, the number of scholars has increased. A probable cause of such dynamics is the change of incentives to engage in scientific activities. This trend requires additional research.

Russia has the most powerful potential in terms of the number of science personnel; the reduction in the number of researchers has been gradually overcome. Belarus lost 27% of the science cadres in the period of 2000–2016, the decline being steady and stable. As a result, in Belarus the number of researchers per 1000 employed in 2001–2013 decreased from 7.3 to 6.3 persons. At the same time, almost in all the European countries over the period of 2001–2011, the number of

	2000	2005	2010	2011	2012	2013	2014
Armenia	7.3	6.9	6.6	5.7	5.6	5.2	5.6
Belarus[1]	32.9	30.2	31.7	31.2	30.4	28.9	27.2
Kazakhstan	14.8	18.9	17.0	18.0	20.4	23.7	25.8
Kyrgyzstan	2.9	3.4	3.1	3.3	3.3	4.2	4.2
Russia	887.7	813.2	736.5	735.3	726.3	727.0	732.3

Source: Compiled according to Ref. [20].
[1]*In 2016—25.9.*

Table 5.
Amount of personnel involved in R&D by EAEU countries (thousand people).

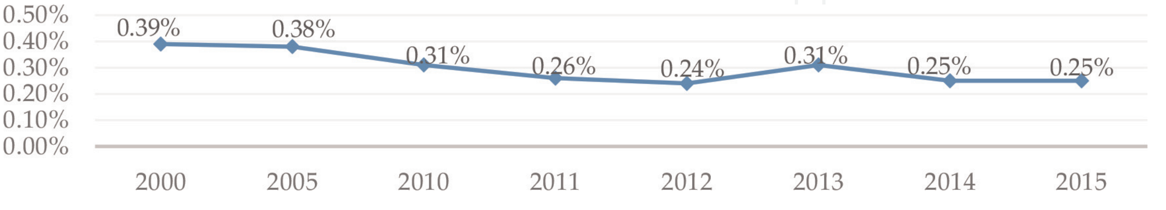

Figure 1.
Financing science from the national budget of Belarus in 2000–2015, % of GDP. Source: Compiled according to Ref. [21].

personnel in science grew. On average, in the EU the proportion of researchers per 1000 employed in 2011 was 11.1 persons, and in the northern EU countries—more than 20 persons.

The main reason for the reduction in the number of researchers in Belarus is a reduction of financing scientific research from the budget (see **Figure 1**). Over the years 2005–2015, the investment in fundamental science decreased from 20.5 to 15.3%, and this might cause a lag in the development of new promising areas of research.

In international practice, the effectiveness of research is assessed through patenting in five of the world's leading patent offices—the United States, Japan, EU, South Korea, and China. What concerns international applications for inventions under the Patent Cooperation Treaty (PCT) procedure is that Russia leads the EAEU countries, which is substantiated by its potential: the number of applications has increased from 658 in 2005 to 949 in 2014. In Belarus there are very few such applications: in 2012, 12, and, in 2014, 13. For comparison, in 2014 researchers from the Netherlands and Sweden made 4206 and 3913 applications, respectively [23]. Therefore, entering in the world patent market is still a weak link in the EAEU countries and requires additional incentives.

Another aspect of assessing the cost-effectiveness of research is international publications. The total amount of scientific-technological products indexed in the bibliometric database of SCOPUS was increasing in the period of 2003–2012 almost by 8% per year. In the United States, the total number of publications over this period grew by 50%, in China—almost 4 times, which is the result of increased funding for science. High citation index indicates the appropriate "quality" of scientific products. According to the UNESCO report data, Russia, Belarus, and Armenia have quite a good scientific publication rating (i.e., their potential was preserved); however, there was no noticeable growth over the period of 2005–2014. A positive dynamics of the scientific publication rating is in place in Kazakhstan, which indicates the motivation of researchers for publication in top-rated scientific journals (see **Table 6**). The EAEU countries should improve cooperation and exchange of experience in new areas of work.

Country	Amount of publications										Amount of publications per 1 million residents	
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2008	2014
Belarus	978	945	914	1033	998	964	1067	1133	1046	1077	108	116
Russia	24,694	24,068	25,606	27,418	27,861	26,869	28,285	26,183	28,649	29,099	191	204
Kazakhstan	200	210	255	221	269	247	276	330	499	600	14	36
Armenia	381	404	418	560	497	574	670	775	705	691	188	232
Kyrgyzstan	46	47	51	54	51	57	65	67	95	82	10	15

Source: Compilations according to Ref. [10].

Table 6.
Scholarly publications by EAEU countries.

On average in the world, the indicator of the number of publications per 1 million inhabitants over the period of 2008–2014 increased from 158 to 176, whereas in the European Union—from 542 to 609. Thus, the EAEU countries still lag far behind the advanced countries. It is established that the growth of publication activity is directly related to the amount of science financing. For example, in China in 2014, the funding per one researcher was USD 195.4 thousand, which affected the scale of publications: its share in the world scientific publications accounted for 20% [10].

As a matter of fact, the scale of international cooperation is also important. What concerns publications abroad is that scientists of the EAEU countries mainly publish their works in co-authorship (see **Table 7**).

On the one hand, international co-authorship testifies to the existence of international relations and the implementation of joint scientific projects, which enriches scientific research and promotes the exchange of research experience. On the other hand, a high share of joint publications indicates the weakness of the country's scientific potential, which makes it difficult for individual publications to be printed in foreign journals.

The most active cooperation of Belarus is observed with Russia (2059 publications over the period analyzed), Germany (1419), Poland (1204), the United States (1064), and France (985). The data of **Table 7** show that among Belarusian and Kyrgyz scientists, the percentage of citing in 10% of the most cited publications is higher than that of Russia and Kazakhstan. Armenia stands out from the EAEU countries by the level of citation and its quality (9.2% among the most cited scientific publications), with the main publications being on physics (of the 691 published works in 2014, 406 were in the field of physics-related sciences). But in comparison with the developed countries, where the level of citation is 15–18%, the EAEU countries look quite modest.

Russia, according to 2014 data, leads in publications in physical (7941), chemical (5159), biological (2440), and technical (2755) sciences. A significant contribution to the publication activity of Russian scientists is made by academia (university science): in 2015, with the participation of faculty members and university researchers, 29,628 works were published in scientific journals indexed in the Web of Science, which accounts for two-thirds of the all-Russian flow of publications. In addition, the higher education sector also significantly stands out in terms of the effectiveness of inventive activity: there are 14 patent applications for inventions per 100 researchers employed there, which is 4 times higher than the average level calculated for the whole scientific-technological complex of Russia [24].

Country	2008–2014		2008–2012	
	Total	With international co-authors, abs. (%)	Citations on average (%)	Among 10% of mostly cited (%)
Belarus	7318	4274 (58.4)	0.79	6.6
Russia	194,364	64,190 (33)	0.52	3.8
Kazakhstan	2442	1496 (61.3)	0.51	4.5
Armenia	4472	2688 (60.1)	1.03	9.2
Kyrgyzstan	471	373 (79.2)	0.67	6.2

Source: Thomson Reuters' Web of Science, Science Citation Index Expanded, data treatment by Science-Metrix.

Table 7.
Scholarly publication in international cooperation (2008–2014).

Belarus has also retained its strongest potential in the natural and technical sciences. For example, in 2014, according to UNESCO data, Belarusian scientists published 442 works in the international editions on physics; 143, on chemistry; 105, on engineering sciences; 70, on biology; 43, on mathematics; and 46, on medicine. The reputation of scientists is high, but the professional attractiveness of scientific activity in Belarus remains low, which weakens the inflow of young people into this industry and creates threats to the innovative development of the country. Thus, the number of doctoral and postdoctoral students graduating (ISCED—7, 8) per 1000 population aged 25–34 in 2016 was 0.6 (decreased in comparison with 2012–2014, which was 0.8), and it lags behind the EU—28 (1.8) on average 2.5 times [25]. In Russia, the proportion of young researchers per 1000 persons is 1.4., i.e., twice as high.

Another problem of modern science is the aging of cadres. Over the past 10 years, the proportion of researchers aged 30–39 in Belarus has halved (from 30 to 15%), and that of researchers aged 60 plus grew more than sixfold. Russian science has similar problems, and, despite the fact that in Russia since 2004 the number of researchers below 39 years old grew by 30%, Russia remains a donor of human capital for the world science [26].

A weak connection between the education, science, and production of the EAEU countries is manifested in the low level of innovative activities of enterprises, which is 8–9% for Russia and Kazakhstan, and in Belarus it decreased from 23% in 2011 to 19% in 2015, whereas the EU countries retain innovative activity of business at the level of 50%. Innovations in the EAEU countries are mostly in place at large, economically sound organizations with sufficient financial, human, and intellectual resources. In Russia, 46.3% of enterprises that implemented technological innovations in industrial production have more than 500 employees. The level of innovation activity grows in proportion to the size of firms: from 1.4% (in companies with up to 49 employees) and 4.4% (50–99 people) to 76% (5000–9999 people) and 87.2% (more than 10,000 people) [21]. In Belarus the situation is similar. Small- and medium-sized enterprises have a much lower level of innovative activity: in 2016 only 3.4% of small and medium enterprises allocated funds for innovation.

5. Modern education challenges for the EAEC countries

The accomplished level of education and the growing social demand for learning provide a number of advantages to the EAEU countries. According to the Global Human Capital 2017 report published by the World Economic Forum in September 2017 [27], the EAEU countries occupy high positions with regard to capacity measured as a level of formal education of younger and older generations as a result of past education investment (Russian ranks 4th; Kazakhstan, 2nd; Armenia, 3rd; and Kyrgyzstan, 1st out of 130 counties of the world). As a result, EAEU countries see the activeness of population in the sphere of applying innovations and a high per capita level of cultural consumption and technological innovation consumption. For instance, in Russia the involvement in creating user innovation in 2017 accounted for 9.6% of the respondents, which is higher than in the UK (6.1%) and in Finland (5.4%) [28, 29].

What should be pointed out is the weaknesses of the real impact of the formally high level of population's education in the EAEU countries on the economic growth and its sustainability. With regard to the indicator which characterizes "breadth and depth of specialized skills use at work," Russia ranks 42nd among 130 countries; Kazakhstan, 64th; Armenia, 47th; and Kyrgyzstan 70th [27]. In particular, the research of FOSTERC project for Belarusian universities (financed by the EU

"Erasmus+" program) showed that, despite the high level of developing relevant skills and putting skills to effective use, there is a significant gap between the competences of specialists with a university degree and employers' requirements. The biggest gap is with regard to the "ability to make decisions in the context of uncertainty" and "ability to effectively regulate time, i.e., time management" [18]. There is also a lack of soft skills and transferable skills that ensure skills of business communication, doing business, understanding risks, networking management, and working in a team.

The global economy and the development of an entrepreneurial society pose new challenges for universities. Leading universities are formed as third-generation universities. In addition to the educational and scientific mission, they develop an "entrepreneurial mission." In developed countries, a common concept is the concept of an entrepreneurial university [30]. In the Russian and Belarusian university community, a concept of "University 3.0" aimed at improving the activities of the higher education institutions has been formed. However, oftentimes the focus is made only on entrepreneurship training and the commercialization of intellectual property, without making changes in the management structure and modernization of the motivation system and reduction of bureaucracy. Universities are meant to develop pragmatism and the ability to respond to sociocultural problems without neglecting traditional values and fundamental research related to them.

The analysis shows that despite the political goals of building a knowledge-based economy, the EAEU countries have not increased their research intensity of GDP in recent years. R&D and technology policies should recognize that a dense network of interactions and linkages—between enterprises and knowledge sources, on the one hand, and between enterprises and customers, on the other hand—are critical aspects of the innovation development process. In the context of these considerations, the governments of the countries should adopt a more nuanced approach to evaluation, with less reliance on quantitative indicators and greater appreciation of evaluation as a tool for learning as much as a tool for accountability. The quality of framework conditions is essential for achieving strong innovation performance. The framework conditions include macroeconomic stability, many aspects of the regulatory regime and the tax system, competitive markets, openness to international trade and foreign direct investment, as well as modern education policy that fulfills its function to provide incentives for innovators while not unduly impeding the diffusion of ideas. The future development of technical operations in the promising areas requires political decisions to revise national legislation.

6. Conclusion

The Eurasian Economic Union project is seen as a response to an objective challenge to the geopolitical and geo-economic transformations of the twenty-first century, when new centers of power are being formed in the Eurasian area, and therefore, there is an objective need for consolidation of the states of the post-Soviet area to preserve their integrity. Intensive integration processes and increasing flexibility/mobility of personnel, information, technologies, and network interactions open up new opportunities for the development of individual countries and integration associations. The increasing complexity and ambiguity of these processes are becoming a serious obstacle to the long-term perspectives of interstate alliances.

Increasing the role of financing education and science for the internationalization and globalization of research and innovative activities is obvious but difficult to implement at the country level. So far, the integration processes in the EAEU are mainly focused on economic activities and cross-border movement of goods and services and do not address the issues of joint educational, scientific, and innovative policies. This is partly due to the fact that the scale of global changes is not yet fully understood by most of the political elites of Eurasia countries. Support of intellectual potential in the EAEU countries' integration policies is becoming an increasingly urgent task for the formation of a new level of integration and ensuring development prospects. The EAEU should find its place in global changes, not only as an interstate institution but also as a community based on common cultural traditions and social needs.

The analysis shows that science and education retain their importance in solving all the pressing problems, which requires increasing financing and increasing the prestige of scientific activity. So far, the EAEU countries are lagging behind the neighboring countries on the most important indicators characterizing the role of this sphere in the society. The countries' governments do not actively invest in applied and fundamental research in order to turn discoveries into commercially viable and sustainable products or technologies with potentially beneficial socio-economic consequences. Effective coordination and interaction between authorities (representing different areas of activity of the EAEU member countries) regarding innovations are weak, and the solutions needed for the development of this sphere are blocked due to adherence to stereotypes and traditional approaches. It is important to transfer expert ideas into administrative logic and to drafts of specific solutions. In solving the tasks of innovative development, the EAEU members are called:

- To form a policy based on facts (evidence-based policy), which involves the use of modern indicators for assessing the effectiveness of policy and the harmonization of education statistics, science, and innovations with the world practice

- To take into account the world development trends and support fundamental science, especially in the higher education sector and increase funding for the third stage of education

- To develop a joint strategy for the development of education, science, and innovations of the EAEU countries for the period until 2020 based on the common concept of the educational and scientific-technological area

- To create a program of academic mobility in the Eurasian area

- To share experience more widely in complex issues of innovative development of countries within the framework of joint international seminars and conferences

The problem of the gap in knowledge and skills can be solved in the sphere of education. This is a multifaceted problem that affects not only higher education and but also the education system of the EAES countries as a whole.

Author details

Nina Bohdan
Belarussian State Economic University, Minsk, Belarus

*Address all correspondence to: bohdannina@gmail.com

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