EDUCATION AND RESEARCH DUALITY – THE DETERMINING CHARACTERISTIC OF HIGHER EDUCATION

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Abstract. *The article, based on new empirical data, semantic analysis and systematic interpretation of the concepts of "education", "science", "research and development" (R&D), deepens and expands the understanding of higher education as a dichotomy of education and research. The subordinated character of such dichotomy is demonstrated, when the main (primary) role belongs to education and supplementary (secondary), although essential, to R&D. It is argued that the first two subordinately related keywords in the mission statements of higher education institutions – "education" and "research" – serve as canonical birthmark and a criterion for identifying these institutions. The immanent dichotomy of higher education can be implemented in two ways: 1) as the dual "teaching and research" function of the academic staff (the main mode) and 2) via organization of R&D as a separate HEI activity, additionally to the main mode. According to the ratio of educational and research activities, HEIs can be divided into two types: academic (research) and professional (applied). By calculating the magnitude of correlations, it is proved that organization of national higher education and research areas depends on the size of the country and its resources, which overrules the incorrect comparison of Ukraine with small countries. The juxtaposition of universities and research institutions (academies) in Ukraine in order to diminish the role of the latter, following the example of small countries, instigates the disorganisation of domestic higher education and research areas and contradicts the laws and trends of world development.*

Key words: *education, higher education, research and development, subordinate dichotomy of higher education, dual "teaching and research" function, financing of research and development, regularities, tendencies, higher education and research areas.*

INTRODUCTION. PROBLEM STATEMENT

In the context of research and innovation planetary development, the process of formation of global, regional, national education, higher education (HE), research areas determines the need to refine their systemic essence and relationships. Studies of social progress, the place and role of education, science, research and development (R&D) in progress facilitation, the emergence of a new systemic data accelerate and deepen the understanding of HE, enhance its organization model. After all, the issue of proper interpretation of HE and its relationship with education and science (R&D) remains unresolved. Besides, the degree of proximity and difference between the concepts of "science" and "R&D" also needs to be clarified (Luhovyi, Orzhel, Sliusarenko, Talanova, 2017; Kremen (ed.), 2016; Syroid, 2016; Sliusarenko, 2015; Talanova, 2010; SPHERE, 2018).

LITERATURE REVIEW

Various institutions and organizations are engaged in investigation of regularities, peculiarities, trends and forecasting of global development with regard to education, HE, science, R&D, and justification of relevant recommendations, which include UN (UNDP, 2018; UNESCO, 2011; UNESCO, 2015; UNESCO, 2016), OECD (OECD, 2018: Education at a Glance 2018; OECD, 2009), the US National Science Board (National Science Board, 2018), the Eurostat, the Bologna Process Support Group E4 on the formation of an attractive and competitive European Higher Education Area (EHEA) (Sliusarenko, 2015; Talanova, 2010; SPHERE, 2018) and others. The accumulation and availability of large corpus of factual data, the description and discussion of relevant policies and practices open up new opportunities for reflection and synthesis, overcoming sometimes deceptive empiricism of disparate experience of human activity (Britt, 2017; Kremen, (ed.), 2016;

Kurbatov, 2014; Salmi, 2009; National Science Board, 2018; OECD, 2018: Education at a Glance 2018; OECD, 2018; SPHERE, 2018; UNDP, 2018). For example, in the works of the authors of this article, as well as others, special attention is devoted to the disclosure of the principal characteristics of higher education, important for achieving its competitiveness (Kurbatov, 2014; Luhovyi, Orzhel, Sliusarenko, Talanova, 2017, 2018; Luhovyi, (ed.), Talanova, (ed.), 2015; Salmi, 2009; Sliusarenko, 2015; Talanova, 2010).

METHODOLOGY

The article uses a systematic approach, following which the purpose (mission) determines the organization, functions, directions of the development of one entity or another. Also, the method of increasing the conceptual and terminological accuracy in disclosing the essence of a phenomenon is applied. The method of induction has extended the fundamental principle of duality to the interpretation of higher education, as well as the law of the transformation of quantity into quality to find out the correlation and optimization of HE and research areas in Ukraine. Arrays of empirical data are statistically processed to identify patterns, trends and the like.

MAIN RESULTS

While the term “education” in world practice is sufficiently stable and consensual in its unambiguous interpretation and application, two other closely associated terms – “science” and “R&D” – are not easy to interpret and need to be clarified. This poses the question: whether education and HE correlate with “science” or “R&D”.

The definition in the ISCED-2011 Glossary reads: “Education. The processes by which societies deliberately transmit their accumulated information, knowledge, understanding, attitudes, values, skills, competencies and behaviours across generations. It involves communication designed to bring about learning” (UNESCO, 2011: p. 79). Therefore, education is procedural in nature. Similarly, the “education” in the Statistical classification of economic activities in the European Community, NACE Rev. 2, (Eurostat, 2008) (Section P of the Broad Structure, as well as Division 85 of Detailed Structure, (Eurostat, 2008: pp. 57, 85)) is presented as a process.

As for HE, the ISCED stipulates that HE “builds on secondary education, providing learning activities in specialized fields of education and aims at learning at a high level of complexity and specialization” (UNESCO, 2011: p. 83).

With regard to “science” and “R&D”, the situation is more complicated, because often these two terms are used synonymously, although somewhat specifically. For example, the website of the OECD (OECD), as well as UNESCO Institute for Statistics (Institute for Statistics UNESCO), in the heading “topics” give preference to “science”, but in the indicators and data under this heading, the term “R&D” is used. UIS UNESCO has the theme “Science, technology & innovation” and provides indicators on R&D (R&D spending as a percentage of GDP and Researchers in full-time equivalent per 1 million inhabitants) within the theme “Science …” (Institute for Statistics UNESCO). OECDs contains the theme “Science and technology”, but provides indicators on R&D (OECD).

A similar situation is observed in the case of the NACE Rev. 2 (Eurostat, 2008) (“science” in Section M of the Broad Structure, while dominantly “research and experimental development” in Division 72 of Detailed Structure (Eurostat, 2008: pp. 57, 81).

The Law of Ukraine "On Scientific and Scientific-Technical Activity" (2015) does not define science (Zakon Ukrainy "Pro naukovu…").

At the same time, authoritative dictionaries (Sykes, J. B. (ed.), 1987; Mish F. C. (ed.), 1994) and other sources (Wikipedia, 2018) give a definition of science and research, in particular, as indicated in Table 1.

Table 1

Comparison of the definitions of the terms "science" and "research" in dictionaries and Wikipedia

N	Source	Term	
		Science	***Research***
1	*2*	*3*	*4*
1	**Merriam Webster's Collegiate Dictionary**	**1**: the state of knowing : knowledge as distinguished from ignorance or misunderstanding **2 a**: a department of systematized knowledge as an object of study … **b**: something (as a sport or technique) that may be studied or learned like systematized knowledge **3 a**: knowledge or a system of knowledge covering general truths or the operation of general laws esp. as obtained and tested through scientific method **b**: such knowledge or such a system of knowledge concerned with the physical world and its phenomena … **4**: a system or method reconciling practical ends with scientific laws … (Mish F. C. (ed.), 1994: p. 1045)	[1]**1:** careful or diligent search **2:** studious inquiry or examination; *esp* : investigation or experimentation aimed at the discovery and interpretation of facts, revision of accepted theories or laws in the light of new facts, or practical application of such new or revised theories or laws **3:** the collecting of information about particular subject [2]**1:** to search or investigate exhaustively (~ a problem) **2:** to do research for (~ a book): to engage in research (Mish F. C. (ed.), 1994: p. 995)
2	**Oxford dictionary**	**1.** (arch.) knowledge. **2.** systematic and formulated knowledge … **3.** (**natural**) ~, physical or natural sciences collectively. **4.** branch of knowledge (esp. one that can be conducted on scientific principles), organized body of the knowledge that has been accumulated on subject … (Sykes, J. B. (ed.), 1987: p. 939)	**1.** careful search or inquiry *after* or *for* or *into*; endeavour to discover new or collate old facts etc. by scientific study of a subject, course of critical investigation … **2.** make researches … **3.** make researches into or for. (Sykes, J. B. (ed.), 1987: p. 884)
3	**Wikipedia**	**Science** (from Latin *scientia*, meaning "knowledge") is a systematic enterprise that builds and organizes knowledge in the form of testable explanations and predictions about the universe.	**Research** comprises creative and systematic work undertaken to increase the stock of knowledge, including knowledge of humans, culture and society, and the use of this stock of knowledge to devise new applications. It is used to establish or confirm facts, reaffirm the results of previous work, solve new or existing problems, support theorems, or develop new theories.

As we can see from Table 1, "research" is mostly presented as a process, "science" as a result. That it is why, education should correlate rather with research, than science. Besides, research is wider, science is narrower by subject and methods.

This is consistent with the definitions by Frascati Manual 2015 (OECD, 2015) as the "world standard" (OECD, 2015: p. 19), that "provides the definition of research and development (R&D) and its components, basic research, applied research and experimental development" (OECD, 2015: p. 43).

"Research and experimental development (R&D) involves creative and systematic work undertaken in order to increase the knowledge base – including knowledge of mankind, culture and society – and to develop new applications of available knowledge" (OECD, 2015: p. 44). It is important that "R&D is found in the social sciences, humanities and the arts as well as in natural sciences and engineering" (OECD, 2015: p. 44). Definitions of Frascati Manual are also used in the report "Science and Engineering Indicators. 2018" of the US National Science Board (National Science Board, 2018), however, the Glossary of Digest 2018 "Indicators of Science and Engineering. 2018" (National Science Board, 2018: Digest) gives somewhat different formulations (see Table 2).

Table 2

Comparisons of different definitions of R&D components

N	Components of R&D	Frascati Manual (OECD), p. 45 Science & Engineering Indicators 2018 (US), p. 4|105	Digest 2018. Science & Engineering Indicators 2018 (Glossary and Key to Acronyms) (US)
1	*2*	*3*	*4*
1	**Basic research**	Experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view	Systematic study to gain more comprehensive knowledge or understanding of the subject under study without specific applications in mind
2	**Applied research**	Original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific, practical aim or objective	Systematic study to gain knowledge or understanding to meet a specific, recognized need
3	**Experimental development**	Systematic work, drawing on knowledge gained from research and practical experience and producing additional knowledge, which is directed to producing new products or processes or to improving existing products or processes	Systematic use of the knowledge or understanding gained from research directed toward the production of useful materials, devices, systems, or methods, including the design and development of prototypes and processes

As can be seen from Table 2, in the Frascati Manual "experimental development" are defined closer to "applied research", because they include, in addition to the use of available knowledge ("knowledge gained from research and practical experience"), also "producing additional knowledge" (OECD, 2015: p. 45). The proximity of experimental development to applied research gives grounds, in certain cases, to replace the complex term "R&D" with the simple term "research". This, for example, is used in the name of the European Research Area (ERA) (European Research Area…).

According to Frascati Manual, R&D activity is concentrated by share of R&D expenditure and personnel in such sectors as: business, government, HE, and private non-profit (OECD, 2015: pp. 31-34).

Also, Frascati Manual states that in certain cases (and these cases are identified) there are "difficulties in separating R&D from other scientific and technological activities (STAs)" (OECD, 2015: p. 70).

Authors (Luhovyi, Orzhel, Sliusarenko, Talanova, 2017; Luhovyi, Sliusarenko, Talanova, 2018) interpret HE conceptually as an integration of education and R&D, as illustrated in Fig. 1.

Fig. 1 shows the correlation between HE and R&D (upper part) and intensity of research activity (lower part). In education, excluding HE, the R&D is not significant, but episodic. In the R&D area, excluding HE, the R&D is dominant, a small portion of the activity falls under education at the levels of HE (preparation of masters, doctors of philosophy and doctors of sciences, or habilitated doctors). R&D component in HE is very heterogeneous, which is illustrated by financing of R&D in leading US universities as part of their budget (About Harvard; Johns Hopkins University; The Rockefeller University, 2017).

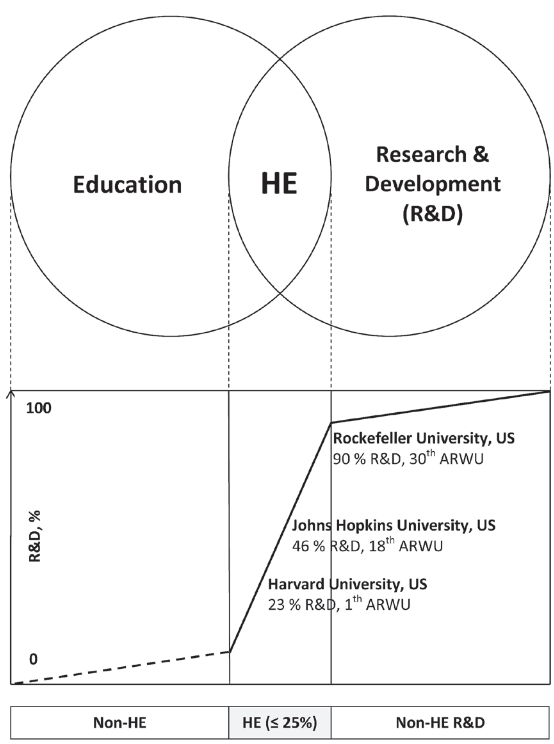

Fig. 1. Organization model of higher education and illustration of its research heterogeneity

R. Britt notes, that only a small proportion of higher education institutions (HEIs) in the country (US) has separate funding for the R&D: "higher education R&D expenditures data were collected from a census of 902 universities and colleges that grant a bachelor's degree or higher and spend at least $ 150,000 in R&D in FY 2016" (Britt, 2016: p. 1). It shows that only a fifth to fourth of the approximately 4.7 thousand US HEIs has separate funding for R&D.

Such situation is predetermined by the composition of HEIs' missions as a system-forming factor (Luhovyi, (ed.), Talanova, (ed.), 2015). The missions were analysed (Luhovyi, (ed.), Talanova, (ed.), 2015; Sliusarenko, 2015) and results presented in Table 3.

Table 3

Comparison of key words of HE missions in the definition of various associations (groups) of HEIs

N	**Key words**	**Associations (groups) of HE institutions**			
		Association of American Universities	European University Association	European Association of Institutions in HE	Top-30 HE Institutions in Academic Ranking of World Universities
1	*2*	*3*	*4*	*5*	*6*
1	**First word**	Education	Education	Education	Education
2	**Second word**	Research	Research	Research	Research
3	**Third words**		Innovation		Knowledge, Create
		Service		Service	

As seen from Table 3, the first key word in HE missions is "Education", the second is "Research". While, the third key words are different, such as: "Service", "Innovation", "Knowledge", and "Create".

In other words, the essence of HE is expressed in two terms "Education" and "Research".

With regard to R&D, the dynamics of their global development in 2005-2017 is shown in Table 4.

Table 4

Dynamics of the total amount of financing of R&D and its share of GDP in the world and its some leading parts in 2005-2017

N	Year	World and its leading parts											
		World		OECD (35)		US		China		EU (28)		Japan	
		Bln $, *PPP*	%	Bln $, *PPP*	%	Bln $, *PPP*	%	Bln $, *PPP*	%	Bln $, *PPP*	%	Bln $, *PPP*	%
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
1	2005	984.3		778.1	*2.14*	328.1	*2.51*	86.8	*1.31*	226.8	*1.66*	128.7	*3.18*
2	2010	1415.4		1000.7	*2.30*	410.1	*2.74*	213.5	*1.71*	308.3	*1.84*	140.6	*3.25*
3	2011	1526.8		1060.3		429.8		247.8		328.5		148.4	
4	2012	1620.3		1092.2		434.3		292.2		340.9		152.3	
5	2013	1725.5		1149.2		454.8		334.1		355.3		164.7	
6	2014	1832.5		1201.4		476.5		370.6		371.2		169.6	
7	2015	1917.9	***1.83***	1237.6		496.6		407.4		383.9		169.7	
8	2016	2038.7[1]	***1.86***[2]	1266.1	*2.34*	511.1	*2.74*	451.2	*2.11*	392.0	*1.93*	168.6	*3.14*
9	2017	2167.2[1]	***1.89***										
10	2016/ 2005	2.1		1.6		1.6		5.2		1.7		1.3	

Note: [1] Estimation based on linear approximation of the increase of world expenditures on R&D in 2010-2015 (annual growth was 6.3 %).

[2] Considering the estimation of world GDP in 2016, based on its volume in 2015 and 2017. Source: (UNDP, 2018; OECD, 2016; OECD, 2017; OECD, 2018; National Science Board, 2018: *Digest*).

As illustrated by Table 4, R&D space develops faster than the global economy progresses, confirming the knowledge and innovation character of social progress. The largest investors in R&D are the US and China (together 47.2 %). The EU and Japan are the next largest source of funding of R&D. At the same time, in terms of volume and share of expenditures on R&D, China is the fastest growing state, which correlates with the growth of its economy, now the largest in the world (in 2017, China's GDP for purchasing power parity, PPP, was $ 21.2 trillion, while the US GDP amounted to $ 17.7 trillion, together 33.9 % of world GDP that reached $ 114.8 trillion (UNDP, 2018: pp. 56, 57).

Regarding HE, the undisputed leader is the US, but China is developing a similar space at a fast pace. The US and China are world leaders in the number of world-class universities presented in 2018 Shanghai ranking: in the top 500 respectively 139 and 62 institutions, in the top 1000 – respectively 217 and 146, together 36.3 % (Academic Ranking of World Universities, ARWU, 2018). In general, according to the Webometrix rating, there are now more than 27,000 HEIs in the world (The "Webometrics Ranking of World Universities", 2018). None of Ukraine's 289 universities, academies, institutes are represented either in the general version of the Shanghai ranking (59 countries) or in its field version with 54 subjects (83 countries) (Luhovyi, Sliusarenko, Talanova, 2018; ARWU, 2018).

It is important to understand clearly the contribution of HEIs to the R&D area. There is sometimes a misconception that R&D can be predominantly or entirely concentrated in universities. In fact, R&D is implemented in specialized research institutions (the main type of activity of which is R&D, according to the Classifier of Types of Economic Activity. SC 009: 2010, code 72 (Natsionalnyi klasyfikator Ukrainy…)), but not at universities (whose main activity is education, although higher, Classifier of Types of Economic Activity. SC 009: 2010, code 85.4 (Natsionalnyi klasyfikator Ukrainy…)). In the world, in terms of funding, the contribution of HE sector to R&D is usually no more than fifth to fourth of total expenditure on R&D (in the US – 13 %, Japan – 12 %, Korea – 9 %, China – 7 %, somewhat more in European countries, in particular Germany – 18 %, France – 22 %, United Kingdom – 25 %). In addition, this share tends to decrease (see Table 5).

Table 5

Percentage of gross domestic expenditure on R&D performed by HE sector of the biggest investors in R&D in 2010 and 2016

N	Years	Share of R&D performed by the HE sector, %				
		OECD	US	China	EU	Japan
1	*2*	*3*	*4*	*5*	*6*	*7*
1	2010	18.4	14.5	7.9	23.6	13.2
2	2016	17.5	13.2	6,8	22.9	12.3
3	**Change during 2010–2016, %**	**-4.9**	**-9.0**	**-13.9**	**-3.0**	**-6.8**

Source: OECP, 2017, 2018 (OECD, 2017, 2018).

The R&D in universities is primarily aimed at providing modern HE (for example, US universities self-finance of their own R&D is 25 %, in particular, Harvard University – more than 28 %, while the contribution of the business is less than 6 %), as seen from Table 6.

Table 6

Expenditure for R&D in US HEIs by sources in 2015 and 2016

N	Source of expenditure	2015		2016		2016/2015,%
		Bln $	%	Bln $	%	
1	*2*	*3*	*4*	*5*	*6*	*7*
1	All sources	68.8	100.0	72.0	100.0	+ 4.6
including:						
2	- Federal government	37.9	55.1	38.9	54.0	+ 2.4
3	- State and local government	3.8	5.6	4.0	5.6	+ 5.6
4	- Institution funds	16.8	24.4	18.0	25.0	+ 7.5
5	- Business	4.0	5.8	4.2	5.9	+ 5.2
6	- Other sources	6.3	9.1	6.8	9.5	+ 8.9

Source: (Britt, 2016: p. 2; Higher Education R&D expenditures …).

Data in Tables 4, 5, and 6, in terms of the volume and proportion of university R&D for the US, may vary insignificantly due to their degree of completeness / incompleteness as presented by the OECD (OECD, 2017. 2018) and the National Science Foundation of the US (Britt, 2016; Higher Education R&D expenditures …), which does not affect the findings. Table 7 shows the distribution of funding for R&D in HEIs by sources in selected US universities.

Table 7

R&D by source of funds and total expenditures at some HEIs in 2016 financial year

N	I. R&D by source of funds / II. Total institutional expenditures	HEIs							
		Harvard University		Johns Hopkins University		Rockefeller University		All this HEIs	
		Mln $	*%*	*Mln $*	*%*	*Mln $*	*%*	*Mln $*	*%*
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
I. R&D by source of funds									
1	All R&D expenditure	1077.3	*100.0*	2431.2	*100.0*	335.1	*100,0*	3843.6	*100.0*
2	Federal government	558.6	*51.9*	2104.7	*86.6*	80.7	*24,1*	2743.9	*71.4*
3	State and local government	2.6	*0.2*	6.1	*0.3*	0.6	*0.2*	9.3	*0.2*
4	Institution funds	306.9	*28.5*	96.5	*4.0*	228.3	*68.1*	631.7	*16.4*
5	Business	50.7	*4.7*	75.3	*3.1*	8.7	*2.6*	134.7	*3.5*
6	Nonprofit organizations	138.5	*12.9*	139.0	*5.7*	16.4	*4.9*	293.9	*7.6*
7	All other sources	20.0	*1.9*	9.6	*0.4*	0.5	*0.1*	30.0	*0.8*
II. Total institutional expenditures									
8	Total	4700.2	*100.0*	5332.9	*100,0*	370,7	*100,0*	10403.8	
9	Share of R&D, %		*22.9*		*45.6*		*90,4*		*36.9*

Source: (About Harvard; Britt, 2016: p. 5; Johns Hopkins University; The Rockefeller University, 2017; Higher Education R&D expenditures …).

The business financing of R&D in HEIs and in other countries is small (see Table 8).

Table 8

Percentage of HE expenditure on R&D financed by the business sector in OECD, EU and some leading countries in 2015 year

N	OECD, EU, countries	Percentage of HE expenditure on R&D financed by the business sector
1	*2*	*3*
1	OECD-Total	6.2
2	EU28 (OECD estimates)	6.4
3	France	2.8
4	Germany	13.9
5	Japan	2.6
6	Korea	12.3
7	United Kingdom	4.4
8	United States	5.2

Source: (OECD, 2018: p. 50).

Distribution of R&D by their main types in the US makes it possible to understand that university R&D does not focus on business through applied research and experimental development (see Table 9).

Table 9

Total HE R&D expenditures by type of R&D in US in 1953–2016 years

N	Year	Basic research, %	Applied research and development, %	Including development, %
1	*2*	*3*	*4*	*5*
1	1953	43.1	56.9	
2	1963	75.3	24.7	
3	1973	71.2	28.8	
4	1983	67.3	32.7	
5	1993	66.7	33.3	
6	2003	75.1	24.9	
7	2013	64.6	35.4	9.4
8	2016	62.8	37.2	9.4

Source: (Higher Education R&D expenditures …).

According to the OECD data, in the budgets of US HEIs, expenditures on R&D are roughly 11-12 % total (OECD, 2018: pp. 254, 255). The overwhelming majority of universities provide basis for R&D by creating conditions (lower academic workload, competitive wages, developed educational and research infrastructure) for the implementation of the dual "teaching and research" function of their academic staff (Luhovyi, Sliusarenko, Talanova, 2018; SPHERE, 2018). Otherwise, "research professors" are employed, researchers being lower status employees. In leading US universities, including Harvard, the professors' fees are 2.5 times higher than researchers' (Luhovyi, Talanova, 2016).

Also, the ratio of the intensity of education and research (with the development) activities of HEIs and, depending on the types of research (following definitions of Frascati Manual (OECD, 2015) and education (according ISCED (UNESCO, 2011)), HEIs can be divided into two types – academic (research) and professional (applied). Within each of this type, there is a tendency to achieve the optimal balance of excellence both in teaching and research (Luhovyi, Sliusarenko, Talanova, 2018; SPHERE, 2018).

As the topic of concentration of R&D in universities remains relevant in Ukraine (Syroid, 2016), this article provides, in addition to the above examples, coefficients of the correlation of parameters of the size and weight of the country with the share of R&D performed by universities (see Table 10).

Table 10

Correlation (of the Spearmen ranks and of the Pearson) of the share of R&D performed by HEIs with GDP, the population, the share of GDP for R&D, as well as the share of GDP for R&D with GDP and the population of the country

N	Parameters, that correlate	Correlation coefficient			Character of correlation
		Calculated		*Critical*	
		K_{sp}	K_{pear}	K_{cr}	
1	*2*	*3*	*4*	*5*	*6*
1	Share HE R&D – GDP	- 0,31	- 0,42	0,27	negative
2	Share HE R&D – Population	- 0,31	- 0,37	0,27	negative
3	Share HE R&D – Share GDP for R&D	- 0,37	- 0,42	0,27	negative
4	Share HE R&D – GDP for R&D	- 0,40	- 0,44	0,27	negative
5	Share GDP for R&D – GDP	0,17	0,17	0,27	lack of correlation
6	Share GDP for R&D – Population	- 0,03	0,06	0,27	lack of correlation

Note: Using data (UNDP, 2018; OECD, 2018).

Table 10 demonstrates, that the higher GDP, population, share and volume of R&D in the country's GDP, the lower is the share of R&D performed by HEIs. This conclusion is confirmed by Table 11.

Table 11

Dependency relation between the share of HE R&D minimum and maximum for different groups of countries

N	Countries' parameter in the group	Groups of countries by parameters' value	Share HE R&D	
			%	Max/min ratio
1	*2*	*3*	*4*	*5*
1	Population, *mln*	< 5	28,0	2,1
		> 100	13,6	
2	GDP, *bln*	0,05 and less	32,5	2,7
		3,5 and more	11,9	
3	GDP for R&D, *bln*	< 1	32,5	2,3
		40 and more	14,4	
4	GDP for R&D, %	< 1	31,1	3,0
		> 4	10,4	

Note: Using data (UNDP, 2018; OECD, 2018).

Tables 10 and 11 testify that Ukraine cannot be compared with small countries like Estonia, Latvia, Lithuania, Georgia as far as the concentration of R&D in HEIs is concerned. In addition, the juxtaposition of universities and research institutions (academies) in Ukraine aimed to reduce the role of the latter, following the example of small countries contributes to disorganization (increased entropy) of domestic HE and research areas and contradicts the laws and trends of world development.

Table 12 shows the distribution of "Top-200 Ukraine" 2018 (Reitynh universytetiv "Top-200 Ukraina" 2018 roku) Ukrainian HEIs among the declared types of economic activity in the Unified State Register of Legal Entities, Individuals Entrepreneurs and Public Associations (Yedynyi derzhavnyi reiestr yurydychnykh osib…).

Table 12

Distribution of "Top-200 Ukraine" 2018 Ukrainian HEIs by kinds of economic activities declared in 2018 year

N	Character HEI economic activity declared	Number of HEI	Share of HEI
1	*2*	*3*	*4*
1	HE as the only main activity	200	100 %
2	R&D as additional activity	136	68 %
3	HE as the only one activity	20	10 %
4	Multiple average of different kinds of HEIs activities	Near 8	
5	R&D as additional activity for top-20 HEIs	19	95 %
6	R&D as additional activity for lowest-20 HEIs	4	20 %

As demonstrated by Table 12, some Ukrainian HEIs do not declare R&D in their statutes even as an additional (subsidiary) activity. After all, the main reserve for the activation of R&D in universities is the development of the dual "teaching and research" function of the academic staff by reducing the excessive teaching workload and ensuring competitive wages, providing the necessary training and research infrastructure to ensure effective independent work of students and the professional development of teachers on research-innovative basis. That is why, the Law of Ukraine "On Higher Education" adopted in 2014 makes "education and research" dichotomy for institutions and academic personnel obligatory (Zakon Ukrainy "Pro vyshchu osvitu"). According to Article 28, HEIs (universities, academies, institutes, colleges) are obliged to carry out research. According to Article 58, the scientific-pedagogical (academic) staff of HEIs are obliged:

– to provide teaching on a high scientific-theoretical and methodological level and to carry out scientific activity;

– to update systematically their pedagogical skills and scientific qualification;

– to integrate academic integrity in the educational process and scientific, creative activity and to ensure its respect by students;

– to develop autonomy, initiative, creativity of students.

Also, "education and research" dichotomy is promoted in National Qualifications Framework (NQF) approved by the Cabinet of Ministers of Ukraine in 2011 (Pro zatverdzhennia Natsionalnoi ramky kvalifikatsii…) and later specified by the Basic Law of Ukraine "On Education" in 2017 (Zakon Ukrainy "Pro osvitu"). NQF qualification levels correspond to the levels of higher education (short cycle, first cycle, second cycle, and third cycle, as well as the doctor of sciences level), research competencies are required at these levels (Zakon Ukrainy "Pro osvitu"; Pro zatverdzhennia…). Research competences also are required by HE Standards developed on the competence-based approach (Zakon Ukrainy "Pro vyshchu osvitu").

The basic strategic vision for implementation of research-based teaching and learning in Ukraine includes (Luhovyi,V. I., Sliusarenko, O. M., Talanova, Zh. V., 2018):

– development of the dual "teaching and research" function of academic staff using approach "into auditorium through laboratory";

– enhancement of students learning activity ("from auditorium to laboratory");

– provision of relevant learning and research infrastructure.

The main obstacles are the following:

– overload of academic staff with contact hours (up to 600 hours per year), therefore lack of time for self-development and research;

– uncompetitive wages of academic staff, leading to overwork due to additional works involvement;

– weakness of learning and research infrastructure due to dispersal of higher education institutions network and deconcentration of resources.

CONCLUSIONS

On the basis of the above, the following conclusions can be drawn.

1. Understanding new empirical data and a systemic interpretation of the concepts of "education", "science", "research and development", as well as the type of modern progress make it possible to deepen the understanding of the dichotomous "educational-research" nature of HE. Such a dichotomy has a subordinate character: the main (primary) role belongs to education, and complementary (secondary), but essential – to R&D. At the same time, in the discourse on Education, HE, R&D preference to the term "R&D" should be given, rather than "Science", as a broader and process in nature.

2. The first two subordinately related keywords of HEIs' missions – "education" and "research" – serve as a canonical birthmark and a criterion for identifying these institutions among other educational and research organizations. In such subordinate dichotomies, "education" relies on "research," and the latter serves education, that resulting in the expansion of research-based HE.

3. Following the intensity and type of educational and research (with development) activities, HEIs can be divided into two types – academic (research) and professional (applied). Within each of these types there is a tendency to achieve the optimal balance of excellence both in teaching and research.

4. It is confirmed that the immanent dichotomy is realized in two ways: 1) via the dual "teaching-research" function of the academic staff (main mode) and 2) via the organization of R&D as a separate complementary activity to the main educational activity (complementary mode). The conditions for the effective implementation of main mode are: minimizing the academic workload of the teaching staff, providing competitive wages, establishing a modern educational and research infrastructure that promotes students' independence and self-improvement of academic workers.

A prerequisite for this in Ukraine should be the consolidation of the dispersed and deconcentrated HEIs network.

5. In Ukraine, about two thirds of HEIs claim both modes, one third of institutions rely on "teaching and research" dualism of academic staff and does not declare R&D as a separate activity, as stated in the Unified State Register of Legal Entities, Individual Entrepreneurs and Public Associations.

6. Empirical and theoretical analysis confirms that universities, based on their essence, cannot fundamentally replace and / or fully integrate (absorb) research institutions (in particular, academies) due to their different generic purpose, various main activities following the Classifier of Types of Economic Activities. The calculation of the magnitude of corresponding correlations proves the dependency in organization of national HE and R&D areas according to the size of the country and its resources. The juxtaposition of universities and research institutions (academies) in Ukraine in order to reduce the role of the latter, following the example of small countries, will result in disorganization (increased entropy) of the national areas of HE and R&D and is in contradiction with the laws and trends of world development.

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