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APPROACH TO THE ASSESSMENT OF UNIVERSITY GLOBALIZATION INDEX

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ABSTRACT

It is impossible to imagine the present-day world without changes of politics, economics, social life caused by globalization. The globalization within society influences and updates the system of education quite naturally that is a factor of competitiveness advance and of the modern nation development. That is why in order to determine the general level of nation globalization it is necessary to determine the globalization level of education which is a boundary zone between social life and culture. The purpose of this article is to analyze the informative aspect of factors influencing on integration processes of university education and to formulate an approach for quantitative estimation of globalization index of education of a separate university and of a set of universities. Quality of education as well as its involvement in world global processes is mainly determined by curriculum content and first of all by the set of subjects composing this curriculum. The absence of subjects that are of great importance for the particular scientific sphere is this very factor that reduces the quality of education. To a lesser degree the quality of education also depends on the way the academic activity is organized including teachers' qualifications and the way classes are held. That is the reason why at this work we describe an approach to the evaluation of the globalization level of a separate university, which is based on the comparative analysis of its curriculum content of different subjects with the curriculum content of the world leading universities, or the so-called "ideal curriculum". In order to calculate the globalization index of education in the informative aspect we have introduced a relative additive criterion that uses weighted values of subjects included in the overall ranking.

Keywords: *The Globalization Index Education, Globalization Systems Education, Modernization Of Education, Quality Of Education, Content Of Education, Curriculum, Information Technology*

1. INTRODUCTION

The present-day realities and trends of economy and of society's cultural life are closely connected to the globalization processes. The most prominent processes are: involvement of significant amount of human resources in political and economic processes, considerable contraction of markets, intensification of producer's competition, enforced race after the access to limited resources. Specialized institutes [1] and individual researchers [2]; [3], [4] studying the globalization single out four closely connected aspects of this process development: political, economic, social and cultural globalization. They also mention factors which provide the basis for the globalization index calculation.

The globalization is directly influenced by national education systems. They have to fit in economic conversions and to promote them [5]. Education of the postindustrial period is one of the key factors for solving major problem of innovational activity improvement, in other words of the increase of modern state competitiveness. The reason for this is the fact that size and intensity of innovative process are key components of economic and political authority of the country [6].

The globalization of economic, social, political and cultural life of the modern society requires not only the exchange of goods and funds, but also the exchange of knowledge, students and teachers between higher educational institutions of the world. Thus the globalization of education is a natural and reasonable component of the total globalization [3]. The lack of options in globalization processes of education is quite evident, because an attempt to avoid integration into the global educational space will most likely end up first in technological and then in moral degradation [2]. These grounds determine the necessity to control the globalization level of education.

However the majority of researches on the subject are based on bureaucratic factors of the educational services, namely educational process standardization, common recognition of diplomas, etc. These researches do not include metrics which help to index the globalization level of the educational content of a separate educational

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institution as well as of the educational system as a whole.

The main purpose of this article is to implement the approach to defining the globalization index of educational institutions which include not only formal but also content factors. In order to fulfill this purpose it is necessary to choose comparative evaluation metrics, to define content factors, to apply the given approach to defining the globalization level to the real university.

2. Materials and Methods

At this work we describe an approach to the evaluation of the globalization level of a separate university, which is based on the comparative analysis of its curriculum content of different subjects with the curriculum content of the world leading universities, with the so-called "ideal curriculum". In order to make the research more accurate we use curriculums of baccalaureate specialty *Computer Science*. In this article we define the curriculum as a sum-total of academic subjects studied in different forms but the volume and sequence of studying are definite.

The choice of leading universities was made according to the analysis of three the most popular rankings: *ARWU*, *THE*, *QS* [7], [8], [9], though it's quite possible to use any other ranking if necessary. Fragments of these rankings for 2013-2014 are given in Tables 1-3.

Table 1. Rankings of universities ARWU (course Computer Science – 2013)

World Rank	Institution	Total Score
1	Stanford University	100
2	Massachusetts Institute of Technology (MIT)	97.8
3	University of California, Berkeley	89.4
4	Princeton University	77.8
5	Harvard University	77.4
6	Carnegie Mellon University	76.8
7	Cornell University	73.1
8	The University of Texas at Austin	70.9
9	University of California, Los Angeles	69.4
10	University of Southern California	66.2
11	University of California, San Diego	65.2
12	University of Toronto	65.2
13	California Institute of Technology	64.9
14	University of Illinois at Urbana-Champaign	63.8
15	University of Maryland, College Park	62.5
16	University of Michigan – Ann Arbor	61.8
17	University of Oxford	59.8
18	Technion-Israel Institute of Technology	58.6
19	Purdue University – WestLafayette	57.7
20	Rutgers, The State University of New Jersey – New Brunswick	57.1
21	Columbia University	56.9
22	Georgia Institute of Technology	56.9
23	Weizmann Institute of Science	56.3
24	The Hong Kong University of Science and Technology	55.6
25	University of Washington	55.3

Table 2. Rankings of universities THE (Top 100 universities for Engineering and Technology 2013-14)

Rank	Institution	Overall score
1	Massachusetts Institute of Technology (MIT)	93.1
2	Stanford University	91.9
3	University of California, Berkeley	90.6
4	California Institute of Technology (Caltech)	90.5
5	Princeton University	89.5
6	University of Cambridge	88.8
7	University of Oxford	87.6
8	ETH Zürich – Swiss Federal Institute of Technology Zürich	86.9
9	Imperial College London	86.0
10	University of California, Los Angeles (UCLA)	84.9
11	Georgia Institute of Technology (Georgia Tech)	82.3
12	Carnegie Mellon University	81.3
13	National University of Singapore (NUS)	79.8
14	University of Texas at Austin	79.4
15	École Polytechnique Fédérale de Lausanne	78.9
16	University of Michigan	78.7
17	Cornell University	77.3
18	University of Illinois at Urbana Champaign	74.3
19	Northwestern University	72.1
20	University of California, Santa Barbara	71.0

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We need to generalize the results of rankings under analysis in order to get a unified scale of leading Computer Science universities. First we standardize all ranking in 100-point scale. Then we compare rankings according to their competency level. For this research we have chosen only widely recognized ranking systems *ARWU*, *THE* and Q*S*, that is why we consider that they have the 1 level of competency. The next standardization will help us to get final overall ranking of world universities (Table 4).

Table 3. QS ranking by Subject 2013 (Computer Science & Information Systems)

QS Rank	School Name	Overall
1	Massachusetts Institute of Technology (MIT)	96.70
2	Stanford University	92.10
3	University of Oxford	92.00
4	Carnegie Mellon University	90.50
5	University of Cambridge	89.80
6	Harvard University	88.40
7	University of California, Berkeley (UCB)	88.00
8	National University of Singapore (NUS)	87.20
9	ETH Zurich (Swiss Federal Institute of Technology)	87.10
10	University of HongKong	84.00
11	Princeton University	83.70
12	The Hong Kong University of Science and Technology	83.60
13	The University of Melbourne	83.40
14	University of California, Los Angeles (UCLA)	82.10
15	University of Edinburgh	81.50
16	University of Toronto	81.00
17	Ecole Polytechnique Fédérale de Lausanne	80.20
18	Imperial College London	79.70
19	The Chinese University of Hong Kong	79.50
20	The University of Tokyo	79.40

Table 4. Overall ranking of universities

Institution	Total Score
Massachusetts Institute of Technology (MIT)	100.00
Stanford University	98.71
University of California. Berkeley	93.26
Princeton University	87.47
Carnegie Mellon University	86.54
University of Oxford	83.62
University of California, Los Angeles (UCLA)	82.44
University of Cambridge	80.34
California Institute of Technology (Caltech)	80.20
ETH Zürich – Swiss Federal Institute of Technology Zürich	80.09
Cornell University	79.37
University of Texas at Austin	79.12
National University of Singapore (NUS)	75.42
University of Toronto	75.12
Imperial College London	75.05
Georgia Institute of Technology (Georgia Tech)	74.66
University of Michigan	74.56
University of Illinois at Urbana Champaign	73.64
École Polytechnique Fédérale de Lausanne	72.66
Hong Kong University of Science and Technology	71.30
Tsinghua University	68.92
Northwestern University	67.78
University of California, Santa Barbara	67.75
Delft University of Technology	66.62
The University of Sydney	66.49
Columbia University	66.32
Korea Advanced Institute of Science and Technology (KAIST)	66.29

It is evident that the overall ranking, that we will use for the purpose of our research, includes universities of all continents. We consider overall ranking score of universities to be the weighting features of their curriculum matter. Thus we can make a conclusion that curriculum content weights are determined according to statistical analysis of different components of universities activity, expert poll and reliable analytical evaluation of universities achievements.

All subjects included in the universities curriculums were ranked according to calculated weighting coefficients stated in overall rankings

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(Table 4). The subject is included in overall list even if it is mentioned only in one university curriculum. The overall score of the subject is determined as a sum of the subject weight in all universities, which include it in their curriculum. Weight of every mandatory subject in the university curriculum is equal to the weight of the curriculum itself. The subject has zero weight if it is absent in the curriculum. Weight of the subject from selectory course is determined as the product of curriculum weight and a fraction, the numerator of this fraction is number of selectory subjects that a student should choose from this selectory course and the denominator of this fraction has the total number of subjects in the selectory course. Note that the number of hours set for studying the subject in any university has no influence on the subject rank.

3. Results

It is necessary to pay attention that different universities use different names for academic subjects which have more or less similar programs [10], [11], [12], [13], [14], [15]. We treat these subjects as equivalent and use one uniform name for them. For example, courses named as *Compilers, Compilers and Interpreters, Compilers Design* are considered to be equivalent. Courses *Wireless Networking, Embedding Wireless Systems, Wireless Computing and Sensor Networks* could be considered as equivalent in some ways.

The subject program from one university quite often comprises materials of two or more subjects from other universities. For such cases we decided to regard not one general course but several special ones. For example, the subject *Operating Systems and Networks* is quite naturally divided into two: *Operating Systems* and *Computer Networks*, which are included into the final list of subjects.

Ranking results of subjects included in curriculums of the universities (Table 4), which teach students the course of *Computer Science*, are presented in Table 5. Note that not all subjects with less than 10 points are included in this Table.

We divide all subjects of the rankings into two parts: all subjects with the rankings above a certain threshold equal to *N* points we include into the first part and will study further and all other subjects will compose the second part.

Table 5. Overall Ranking Of Subjects

Subject name	Ranking (R)	Subject name	Ranking (R)
-Programming and Data Structures	100.00	- Wireless Systems	33.92
- Databases	90.61	- Computer Animation	29.59
- Programming languages	87.61	- Web-programming	29.26
- Design and Analysis of algorithms	87.24	- Functional Programming	23.52
- Operating Systems	87.12	- Distributed System	22.52
- Discrete Mathematics	83.40	- Project Management	20.97
- Computer Security	71.42	- Software Engineering	12.88
- Computer Networks	64.29	- Mobile and Multimedia Networking	9.32
- Computer Architecture	64.26	- Information Systems	6.79
- Compilers	62.38	- Natural Language Processing	6.74
- Computer Graphics and Image Processing	55.60	- Data Mining	4.51
- Artificial Intelligence	54.69	- Digital Technology	4.06
- Object Oriented Software Development	51.65	- Programming Methodology	3.37
- Concurrent programming	47.45	- Machine Learning	3.37
- Computational Complexity	45.50	- Software Specification	2.73
- Object Oriented programming	45.00		

Surpassing of the threshold *N* (in this work it is equal to 20 points) guaranties that the subject will be included into curriculums of some universities from the top of the ranking or it will be included into curriculums of a large number of universities from the bottom part of the ranking and more often into both parts simultaneously. The threshold *N* is a controlled parameter of the created system. The authors have created a special software application that helps to form the value of the threshold according to rankings data received from the net.

A subject surpassing the threshold will definitely be included into curriculums of at least four universities from top-10 or is already a part of the curriculums of the majority of 30 world leading universities. Thus, subjects that have received from *N* to 100 points could be treated as an ideal curriculum. It is necessary to compare curriculums of separate universities or of groups of universities, globalization index (*G*) of which we are to evaluate, with this ideal curriculum. This index is calculated according to formula

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$$G = 100 * \sum_{i=1}^{n} (R_i * \beta_i) / \sum_{i=1}^{n} R_i ,$$

where R_i – is overall ranking of i subject from Table 5,

β_i = {0, 1} – «0», if the subject is not included into the curriculum of the university to be evaluated, «1», for another case,

n – is number of subjects in Table 5.

Overall ranking R_i evaluates the contribution of every subject according to its significance for universities.

We will test the offered approach on baccalaureate curriculums of Russian universities where *Computer Science* is a major. According to national standard of the 3d generation professional education cycle in the Russian Federation consists from basic and variable part.

Basic part of education courses "Applied Mathematics and Informatics" and "Applied Informatics" include the following profession-oriented subjects: "Programming Languages and Methods", "Databases", "Numerical Techniques", "Operating Systems", "Computer Networks", "Computer Networks, Systems and Telecommunications", "Information Systems and Technologies", "Data Systems Engineering", "Information Security", "Software Engineering". We can also add general subjects directly connected to the discussed professions: "Informatics and Programming", "System Theory and System Analysis", "Computer Architecture", "Computer Graphics".

Variable part of curriculum cycle is defined by universities at their own discretion. This very part of academic program (profile) displays the specific character, educational focuses and methods of their implementation. This means that the correct organization of variable part of professional cycle ensures that the curriculum meets the present-day educational requirements of leading foreign universities.

It should be taken into account that focused specialization within the course requires a number of subjects typical for this specialty only. For example, specialty "Software engineering" implies preparatory studying of such subjects as "Software Systems Engineering", "Test Techniques", "Object-Oriented Analysis", "CASE tools", etc. In this work we discuss only those subjects that compose curriculums of courses related to the *Computer Science* field.

Let's compare a set of subjects from the highlighted area of Table 5, i.e. the subjects which we regard as mandatory in the global world to subjects taught for example in 2013 at *National Research Nuclear University MEPhI* for specialty "Applied Mathematics and Informatics" and "Applied Informatics". According to this comparison we can make a conclusion that curriculums of this university do not cover (completely or partially) modules of such subjects as: *Compilers, Artificial Intelligence, Wireless Systems, Web-programming, Distributed Systems*. Thus, according to the formula the globalization index of educational content of the university under investigation will be G=83.88.

In order to implement the represented calculations we have developed a special information system. Database of this system contains information about rankings of universities, information about their curriculums, types of academic sessions and some quantitative aspects. This system also has basic parameters of national educational standards including a list of mandatory subjects. Lists of subject names are unified and gathered in renewable reference books in two languages – Russian and English. Weight indexes that define the value of different subjects for different specialties could vary. There are applications that automatically replace outdated rankings by new ones every year.

4. DISCUSSION

Further technocratic development of curriculum comparison provokes a detailed examination of curriculum content (certain philosophies, technologies, software products). It provides opportunity to copy the best examples. However there are many attached problems related to political, cultural and infrastructural peculiarities of certain countries and territories that are vividly discussed by researchers of globalization processes.

Thus according to works [2], [3] if the globalization of education is reached by direct reproduction of leading universities activity then it could lose its cultural identity, i.e. national, ethnic, confessional uniqueness of education. There are specifications to this research in the work [16] that examines questions of linguocultural globalization, because language is a basis of education. There was emphasized such notions as linguistic hybridization, mosaic of mind and multiple identity in culture. These researches define a background for globalization processes of different countries but do not

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contain any ideas about content variations depending on specific character of countries. In the work [17] it is mentioned that the present-day available literature has no detailed analytical researches devoted to interconnection between economic growth and globalization of Central and Eastern Europe which has transitional economy. There are references based on economic factors only. A specific attention is paid to the fact that in order to form a globalization model specification it is necessary to be able to evaluate the consequences of growth of such variables as education and federal expenditure on infrastructure which are hardly mentioned in available resources.

The research field is described in a volumetric work [5] devoted to evolution of higher education globalization based on triangulation theory. This description corresponds to a classical work [18] and highlights 5 basic globalization coordinates that should be evaluated in accordance with the indicators: teachers and students, brand's image, international cooperation, administrative support of successful programs, advance of global perception towards integration. However this work does not offer an answer to the question: how to mark successful programs with regard to their content and how to change global perception towards the integration. There is a similar research [19] where a regression analysis is used. In this research authors try to estimate the influence of political, economical and demographic factors on globalization of higher education. According to the article the author failed to find any reliable impacts of these factors on the globalization of public education. The existing indicators of universities world rankings are analyzed in a critical manner in work [20]. The author of this work points out that regional universities have no chance to change the established status quo in a global ranking. The only way out for the universities that are outside the top list is to make better curriculums than leaders. Single issues of globalization in the field of training of masters were considered in Russia [21].

Therefore a discussed approach of evaluation of a globalization level of a separate university is based on a comparative analysis of its curriculum content in different academic courses. The aim of this approach is to reduce the dependence of globalization level of education from bureaucratic factors of politics, economics, infrastructure and demography. The globalization index is calculated in accordance with integrated specifications of the leading universities curriculums. Further investigation should be made concerning the problem of choosing a threshold value for the purpose of detection of valuable subjects in the overall ranking (Table 5); and also concerning the question of determination of weighting coefficients of different rankings of universities according to which the overall ranking is calculated. It might be efficient to use simulated models in these investigations [22]. The recommended globalization index helps to determine whether the set of subjects of a particular course corresponds to the world standards. In other words the quality of education approaches the world standards with the increase of globalization index.

5. Conclusion

The discussed approach to formation of globalization index of university education is based on comparative analysis of its curriculum content with some "ideal curriculum". The application of this approach ensures permanent results even in a constantly changing world regardless of any existing single rankings of universities and without any risks for national, ethnic of confessional uniqueness of a nation. According to the suggested procedure for formation of the overall ranking of the world universities and then for the creation of an "ideal curriculum" we can make the following conclusions.

We can take the calculated overall scores of universities for weighting features of their curriculums; therefore we can confirm that curriculum weights are determined according to statistic analysis of different components of universities activity, to expert poll and reliable analytical evaluation of universities achievements.

The hypothesis-driven threshold value applied to cut-off non-attractive subjects guaranties that the subject will be included into curriculums of some universities from the top of the ranking or it will be included into curriculums of a large number of universities from the bottom part of the ranking and more often into both parts simultaneously.

In order to calculate the globalization index of education while solving the problem of globalization in the informative aspect we have introduced a relative additive criterion that uses weighted values of subjects included in the overall ranking. For index calculations we use

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the most common threshold value of subject weights (yes/no) and consider them to be independent. If we take into account subjects correlations then we have to set weighting coefficients by values of the interval [0, 1] and we will also need additional information for calculations.

The given approach to defining university globalization index gives opportunity to shift the index calculation procedure from the absolutely formal assessment scope to combined ones, which include both formal and content factors. In the long view the development of this approach in terms of teaching resource record and mass open on-line courses module application will increase the content component of combined assessments.

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