Comparative analysis of education quality and the level of competitiveness of leader countries under digitalization conditions

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Abstract

The quality of national education depends on many factors, which traditionally include adult literacy, the total share of students receiving general, secondary vocational and higher education, the level of the material and technical base, etc. Based on these factors, a list of leading countries by the level of education is formed. The authors believe that in the short term it practically does not change, the leaders retain their positions, the lagging countries rarely get out on top positions. However, the world changes, new trends and tendencies determine the constant change and improvement of quality criteria. The authors suppose that the process of digitalization of the economy will play a significant role in this process. New technologies and processes will undoubtedly update the picture of the leaders of the modern educational process. Here, the countries occupying second positions can claim the role of leaders. These aspects determine the relevance of this study. In this regard, the purpose of the work is to perform a comparative analysis of the quality of education and the level of competitiveness of the leading countries in the context of the growing digitalization process. The research methodology is based on a systematic and structural-functional approach. The representativeness and reliability of the research results are based on the use of general scientific and special methods, including analysis, synthesis, modeling, extrapolation, content analysis, historical analysis, and others. Based on the world ratings of the quality of education, the authors' own rating of the best national education systems was compiled. Moreover, the authors noted that this rating also differs little from the rating of countries' competitiveness on the world stage. The main reasons for distinguishing the leading countries include the existing stage of development, the standard of living of the population, investments in education and science, and other reasons.

Key words: *digitalization of education, protectionism, digitalization of the educational system, level and quality of education, information and educational environment.*

Introduction

If one asks an average citizen of any country in the world, which country he or she would choose as the standard of the educational model, most respondents would name the educational systems of the United States of America or Great Britain. People, more competent in this matter,

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could name the system of Germany, Australia or, even, Finland. This is no coincidence. The quality of life in these countries leaves its mark on the quality of education. By such indicators as adult literacy, the total share of students receiving general, secondary vocational and higher education, the level of the material and technical base, access to education and others, these countries have really overtaken the vast majority of countries in the world. The rivalry between countries for leadership in the field of education takes place in a group of 20-30 leading states, while the path to these ratings is still closed to other countries.

However, in recent years, the world began to undergo significant transformational changes associated with the beginning of mass digitalization (Yemelyanov et al., 2020; Tadeu et al. 2019). Changes affect the whole world, countries, state institutions, and specific individuals (Swarts, 2020). The lifestyle of people, as well as its quality, is undergoing tremendous transformations. New managerial mechanisms that destroy or modernize obsolete elements are beginning to take shape.

Undoubtedly, these trends are also covered by national education systems. This, in turn, results in a situation where leadership becomes extremely shaky. Only those countries that can fit into the new digital model, creating new educational trajectories of their development, will be able to maintain their leadership, but hypothetically such a scenario can be noted when new centers of educational growth appear.

Modern scientific literature pays a lot of attention to questions of the level and quality of national education systems in the context of the influence of digital technologies on it. This is due to the fact that technologies, methodologies, and conditions for creating reference models are analyzed. At the same time, examples of bad experiences are studied.

Information technology is the main attempt to improve the quality of education. This is an important event in the education revolution through digitalization. In this regard, transformation is becoming an important factor in the improvement of the quality of the strategy of educational organizations in achieving long-term success (Adams, 2019; Carcolini, 2027; Márque et al., 2018; Öztürkler, 2017). Digital change is like a powerful tsunami when the digitalization of many business practices creates new relationships and changes the marketing landscape of national education systems (Crittenden, et al., 2019). By applying technology rather than prohibiting it, teachers empower students by enhancing sensory perceptions and expanding digital activities, leading to more learning. The stakeholders — universities, professional associations, publishing

companies, and technology companies — must fully support and strengthen teachers' efforts to introduce technology to continually improve learning.

A number of authors (Ahel, & Lingenau, 2020; Baumol, & Bockshecker, 2017) emphasize the undoubted benefit of the digitalization process for national systems of individual states. The implementation of sustainable development and integration of digitalization can be the key to expanding students' access to education for sustainable development. There is a global opportunity for schoolchildren and students around the world to access the Internet. The study carried out by Amhag *et al*. (2019), based on the research conducted at two Swedish universities, identified the need for the teachers to use digital tools and the subsequent need for digital competency in higher education. The researchers believe that the teachers and educators require extensive government support in creating digital learning (Cáceres-Reche et al., 2019; Glotko et al., 2020; Voronkova et al., 2020; Minakhmetova et al., 2020; Solas & Sutton, 2018).

Digitalization offers tremendous opportunities for the use of massive open online courses (MOOCs). In their study, Liu *et al*. (2019) showed the experience of implementing MOOCs in China. The scientists noted a close collaboration between universities and the state in this matter. Nevertheless, there are some difficulties. Colleges and universities experience such problems as insufficient technical support, inadequate preparation of curricula, lack of uniform national standards for curriculum development, as well as standards (Korableva et al., 2019).

There is an understanding of the need to include in the digitalization process the education system and representatives of those countries that are not leaders in this process. Thus, in the work of the scientists from Ecuador Orellana *et al*. (2019), the idea of supporting the digital transformation of Ecuadorian universities is observed. Eight quality assessment models applied in Ecuador over the past five years for higher education institutions and professional accreditation are analyzed (Igoshin et al., 2020). It is found that the quality models used had their own impulse for digital conversion, digital conversion drivers are identified to offer guidance on the inclusion of digital aspects in every quality criterion that encourages digital conversion at Ecuadorian universities.

The researchers Mok and Leung (2012) also note a number of acute problems that digitalization brings for both the education system and social relations in general. In their opinion, a gap appears between different social groups (namely, "having" and "not having") due to the availability of the access to information and communication technologies and their various uses.

It is troubling that the digital divide will exacerbate existing inequalities, destroy traditional ties between communities, socially exclude disadvantaged people and hinder the growth of the knowledge economy. All this will damage the social structure within the country and international competitiveness from the outside.

In general, the representatives of many scientific fields today come to understand the need to create a new model of a digital educational system. It was realized by Drieschner *et al*. (2019) and Khalid *et al*. (2018) that digital transformation will require all participants in this process to rethink their educational model. The bridge between digital transformation and educational models can be strengthened by educating future decision-makers at the beginning of their educational activities (Espino et al., 2020; Grewal et.al., 2019; Swarts, 2020; Wilcox, 2020).

The analysis of literature conducted by the authors identified the purpose of the study as an analysis of the quality of education and the level of competitiveness of the leading countries in the context of the digitalization process, which is currently gaining momentum. The choice of the goal is not accidental. The world has come to the stage of a dramatic breakdown of existing relations, especially in the field of education. The creation of a competitive educational environment for many countries of the world can be based on the experience of the world's leading countries, which have made progress on the way towards the development of a digital society.

World ratings for assessing the quality of education

In order to understand what processes are taking place in the modern world, it is necessary to understand who and/or what determines the success of the national educational systems of the world. There are a lot of existing ratings for assessing the quality of education; they evaluate it by various parameters. Consider some of the ratings to understand the criteria by which the quality of national educational systems is assessed today.

The first indicator is the Knowledge Economy Index. It characterizes the level of development of a knowledge-based economy in countries and regions of the world. The indicator was developed in 2004 by The World Bank as part of a special program Knowledge for Development (K4D) to assess the ability of countries to create, accept and disseminate knowledge (Knowledge Economy Index, 2019).

The developers of this system believe that the index should be used by countries to analyze problematic issues in their policies and measure the country's readiness to switch to a knowledge-

based development model. Its calculation is based on "The Knowledge Assessment Methodology – KAM" proposed by the World Bank, which includes a complex of 109 structural and qualitative indicators, combined into four main groups:

1. The Economic Incentive and Institutional Regime – the conditions in which the economy and society as a whole develop, the economic and legal environment, the quality of regulation, the development of business and private initiative, the ability of society and its institutions to effectively use existing and create new knowledge.

2. Education and Human Resources – the level of education of the population and the presence of sustainable skills in the creation, dissemination, and use of knowledge. (Adult literacy indicators, the ratio of registered students (students and schoolchildren) to the number of people of the corresponding age, as well as a number of other indicators).

3. The Innovation System – the level of development of the national innovation system, including companies, research centers, universities, professional associations, and other organizations that perceive and adapt global knowledge to local needs, as well as create new knowledge and new technologies based on it. (The number of scientists engaged in research and development; the number of registered patents, the number and circulation of scientific journals, and so on).

4. Information and Communication Technology – ICT – the level of development of information and communication infrastructure that contributes to the efficient dissemination and processing of information.

This index makes it possible to evaluate not only the level of education of the population and the presence of stable skills in the creation, dissemination, and use of knowledge, but also other indicators characterizing, in particular, the components of the new society. Among which, in the authors' opinion, not the least place is occupied by the level of development of information and communication infrastructure.

The second indicator is the Ranking of National Higher Education Systems.

It is based on a global study of the achievements of countries in the field of higher education. The study has been conducted annually since 2012 as part of the global project Universitas 21 (U21) of the international university network, which includes universities from 17 countries (Australia, Great Britain, India, Ireland, Canada, China, Hong Kong, Mexico, the

Netherlands, New Zealand, Singapore, Chile, Sweden, Switzerland, and Japan) with a combined enrollment of more than 1.3 million students and 220 thousand teachers.

The authors of the study believe that the economic development and competitiveness of modern states largely depends on the availability of educated and competent specialists and technologies that increase their efficiency and labor productivity. The higher education sector contributes significantly to these needs. Moreover, in the modern world, high-quality higher education systems that have wide connections at the international level contribute to global development through the exchange of students, researchers, projects and ideas across national borders (Yigit, 2018). Based on these assumptions, the main goal of the project is to find out which countries provide the best higher education. Unlike university ratings (see, for example, the ratings of the best universities in the world, Times Higher Education and Quacquarelli Symonds), which take into account the performance of individual educational institutions, Universitas 21 ranks higher education systems among a relatively large number of countries at different stages of economic and social development.

The rating is calculated according to 24 main indicators, combined into four groups:

1. Resources (investments from the private and public sectors) – 25%.

2. Results (research, scientific publications, compliance of higher education with the needs of the national labor market, including subsequent employment of graduates of educational institutions) – 40% (Lvov et al., 2019).

3. Communication (the level of international cooperation, which demonstrates the degree of openness or isolation of the higher education system) – 10%.

4. Environment (state policy and regulation, educational opportunities) – 25%.

In the final calculations, adjustments for the population of the studied countries are taken into account. The study is conducted in states for which there are confirmed statistics for all indicators. These measurements of the effectiveness of higher education systems are summarized in the final index, which determines the position of each country in the world ranking based on international comparisons (Ranking of National Higher Education Systems, 2019).

The third indicator is the National Education Systems Performance Index. The study has been conducted since 2012 in the framework of the global project The Learning Curve, combining a wide range of international indicators of the state of education in different countries of the world. The authors of the study indicate that the results of the project represent the first attempt to compare

the effectiveness of national education systems among a relatively large number of countries at different stages of socio-economic development (Nadtochy et al., 2016; Polyakova et al., 2019).

The rating is calculated according to the methodology developed by the research company The Economist Intelligence Unit and estimates the level of effectiveness of education systems in the countries of the world according to two main groups of indicators, including the corresponding set of internationally comparable data:

1. Cognitive skills:

- The Progress in International Reading Literacy Study, PIRLS. Implemented by the International Association for the Evaluation of Educational Achievements, IEA. The level and quality of reading and understanding of the text by primary school students are studied in countries with different educational systems.

- The Trends in International Mathematics and Science Study, TIMSS. Implemented by the International Association for the Evaluation of Educational Achievements, IEA. The level of natural-mathematical training of secondary school students in countries with different educational systems and the identification of factors affecting the level of this training are studied.

- The Program for International Student Assessment, PISA. Implemented by the Organization for Economic Cooperation and Development, OECD. The literacy level of high school students and the ability of students to put into practice the knowledge and skills acquired at school are studied.

The study is conducted in OECD countries and OECD partner countries.

2. Level of education:

• Literacy Index. Data from an international study by the UNESCO Institute for Statistics for countries around the world.

• Index of the total share of students in secondary and higher education. Data from the international study Education at a Glance of the Organization for Economic Co-operation and Development for OECD countries and OECD partner countries.

These two basic measurements of the effectiveness of the education system are summarized in the final Index, which is a weighted sum of the indicated indicators and determines the position of

each country in the world ranking according to the results of the international comparison (Rating of the Effectiveness of National Education Systems, 2019).

Rating the countries of the world in terms of the quality of education

Consider the top 20 countries in terms of the above-reviewed ratings.

As the first indicator, the authors take the Knowledge Economy Index (2012).

Table 1

Knowledge Economy Index of the TOP-20 countries (2012)

RATING	COUNTRY	KNOWLEDGE ECONOMY INDEX	KNOWLEDGE INDEX
1	Sweden	9.43	9.38
2	Finland	9.33	9.22
3	Denmark	9.16	9.00
4	Netherlands	9.11	9.22
5	Norway	9.11	8.99
6	New Zealand	8.97	8.93
7	Canada	8.92	8.72
8	Germany	8.90	8.83
9	Australia	8.88	8.98
10	Switzerland	8.87	8.65
11	Ireland	8.86	8.73
12	United States of America	8.77	8.89
13	Taiwan	8.77	9.10
14	Great Britain	8.76	8.61
15	Belgium	8.71	8.68
16	Iceland	8.62	8.54
17	Austria	8.61	8.39
18	Hong Kong	8.52	8.17
19	Estonia	8.40	8.26
20	Luxemburg	8.37	8.01

Source: Knowledge Economy Index, 2019

The table 1 shows that four countries – Sweden, Finland, Denmark, and the Netherlands are the most reference countries with the index close to 10. In total, the rating covers more than 146 countries, and there are even such states that scored less than 1 (for example: Sierra Leone, Myanmar, Haiti).

According to the second indicator cited in 2019 (the Ranking of National Higher Education Systems), which assesses the quality of higher education, the list of leading countries is changing. The undisputed leader is the United States, which is more than 10% ahead of its closest pursuers.

Table 2

Ranking of National Higher Education Systems (2019)

RATING	COUNTRY	INDEX
1	United States of America	100
2	Switzerland	88.6
3	Great Britain	84.5
4	Sweden	82.9
5	Denmark	82.5
6	Canada	81.9
7	Singapore	81.3
8	Australia	80.9
9	Finland	80.4
10	The Netherlands	80.2
11	Norway	77.8
12	Austria	77.2
13	Belgium	73.6
14	New Zealand	71.5
15	Hong Kong	70.2
16	Germany	69.6
17	France	67.6
18	Israel	67.3
19	Ireland	64.7
20	Japan	61.7

Source: Ranking of National Higher Education Systems, 2019.

Finally, consider the National Education Systems Performance Index (2019). Despite the fact that this index is broader than the previous rating scale, nevertheless, the leading countries have practically not changed. The United States still occupies the highest position, surpassing the nearest country (Switzerland) by the quality of educational processes by more than 10%.

Table 3

National Education Systems Performance Index (2019)

RATING	COUNTRY	INDEX
1	United States of America	100
2	Switzerland	87.2
3	Denmark	84.2
4	Great Britain	84.8
5	Sweden	82.2
6	Finland	82.0
7	Netherlands	81.6
8	Singapore	80.6
9	Canada	79.6
10	Australia	77.6
11	Belgium	75.7
12	Norway	75.3
13	Austria	74.7
14	New Zealand	70.9

15	Hong Kong	70.9
16	Germany	70.3
17	France	68.3
18	Israel	67.6
19	Ireland	65.2
20	Japan	64.2

Source: National Education Systems Performance Rating, 2019

The next step in the study will be a comparison of the countries of the world according to the indicated ratings and the allocation of an average list of leaders. According to the authors, the purpose of this comparison is not to determine the exceptional countries of the world. Based on heterogeneous international assessments of the quality of education, the authors single out the TOP-10 countries that, in their opinion, are leaders in education.

The assessment methodology is based on the indicators of the countries of the three previous ratings. The calculation is carried out on the basis of the allocation of the total weight of each country in the framework of three scales of calculation, with a further summation of their total weight. There is one exception: Singapore is included in the table, which over the past few years has taken tremendous steps to improve its national education system (this country was not included in the TOP-20 rating of the Knowledge Economy Index).

As a result of the analysis, the authors compiled the following rating:

Table 4

TOP-10 index of the countries, leading in the field of education

RATING	COUNTRY
1	United States of America
2	Switzerland
3	Denmark
4	Sweden
5	Great Britain
6	Finland
7	Netherlands
8	Canada
9	Australia
10	Singapore

Source: compiled by the authors.

Based on the table, it can be noted that the leaders are almost the same, the location of some countries has changed. Moreover, the first three states are the United States of America, Switzerland, and Denmark.

Rating of competitiveness of leading countries of the world

In order to assess the degree of correlation of the quality of educational systems with their role in the global market, the authors analyze the economic competitiveness index, namely the Global Competitiveness Index. This index is calculated according to the methodology of the World Economic Forum and is compiled using a combination of publicly available statistics and the results of a global survey of company executives – an extensive annual study, conducted by the World Economic Forum in conjunction with a network of partner organizations – leading research institutions and organizations in the countries, analyzed in the report. The authors of the study emphasize that countries with high rates of national competitiveness, as a rule, provide a higher level of well-being of their citizens.

In general, the competitiveness of national economies is determined by numerous and very diverse factors. Thus, the inefficient management of public finance and high inflation have a negative impact on the state of the economy, and the protection of intellectual property rights, a developed judicial system, and other measures can have a positive effect. At the same time, along with institutional factors, the education and advanced training of the workforce, continuous access to new knowledge and technologies are crucial. All variables are combined into 12 benchmarks that determine national competitiveness (The Global Competitiveness Index, 2019):

1. The quality of institutions.

2. Infrastructure.

3. Macroeconomic stability.

4. Health and primary education.

5. Higher education and training.

6. The effectiveness of the market for goods and services.

7. Labor market efficiency.

8. The development of the financial market.

9. The level of technological development.

10. The size of the domestic market.

11. Competitiveness of companies.

12. Innovation potential.

In 2019, countries were assessed for their degree of competitiveness, as a result of which it can be concluded that some countries included in the TOP-10 of the authors rating of the quality of national educational systems were not included in the similar TOP-10 of the most competitive (see Table 5).

Table 5

Countries' competitiveness index (2019)

EDUCATION OF COUNTRIES OF THE WORLD BY QUALITY OF EDUCATION	COUNTRIES	RATING OF COMPETITIVENESS OF COUNTRIES OF THE WORLD
1	United States of America	2
2	Switzerland	5
3	Denmark	10
4	Sweden	8
5	Great Britain	9
6	Finland	11
7	Netherlands	4
8	Canada	14
9	Australia	16
10	Singapore	1

Source: compiled by the authors.

Currently, the leaders of the educational sector are leaders in the competitiveness rating, but with a certain exception (Finland, Canada, and Australia, which occupy positions below the TOP-10 in terms of competitiveness rating). In the authors' opinion, this dissonance will be temporary, the quality of education will play a positive role, and after some time these countries will rise in the competitiveness rating, which should be helped by the active movement of these countries along the path of digitalization of the economy and the educational system.

Discussion

So, it was concluded that a variety of ratings practically do not change the list of leading countries by the quality of education, which, in turn, affects the competitiveness of states

(Magsumov, 2013). However, what determines the supremacy of these countries, their leadership? Is there only large-scale financing, the standard and quality of life of the population, etc.? Probably not. The use of advanced technologies in the education system, including on the basis of digitalization, is a key factor in their dominant position.

At this point in time, a situation has arisen called "digital inequality" when there is economic and social inequality between people (groups, communities, countries, and regions), based on different possibilities of access to information and communication technologies and, therefore, to information and knowledge. Digital inequality leads to the fact that the informationally poor segments of the population (and even the state) are being squeezed out of the modern information economy, which further widens the gap between rich and poor at different levels (Iakova, 2016; Tarman, 2009). This leads today to a new round between countries for a new "oil" of the global economy – the possession of information.

The understanding of the need to engage in the "digital era" has become the dominant factor in the state policy of the leading countries of the educational process. So, over the past few years, the so-called "digital revolution" has taken place in Australia's education system. As part of this initiative, the Australian government aims to bring meaningful changes to teaching and learning through the use of information and communication technologies in Australian schools. It is assumed that as a result of the steps taken by the government, students will be better prepared to continue their education and training, for their future life and work in the digital world (Andre, 2019).

The government of the country places particular emphasis on high-quality education in the fields of science, technology, engineering, and mathematics (STEM). In this connection, the National Strategy for School Education STEM for 2016–2026 was approved. The focus is on basic skills, the development of mathematical, scientific and digital literacy, as well as the development of critical analysis and creative thinking skills. The country's leadership is investing huge amounts of money to develop a number of curricula using artificial intelligence technology in schools. At the same time, the key areas of popularization of artificial intelligence (AI) technology in education are: conducting research on the use of AI and new technologies in schools and identifying the best teaching practices; conducting training webinars for teachers on the use of AI technologies in the educational process; the creation of specialized online resources for schoolchildren, students and

teachers (On the Development of Scientific, Technical, Mathematical Education and Digital Technologies in Schools in Australia, 2019).

The development of Switzerland in this direction is also of great interest. The basic direction for the country is recognized as the development and implementation of ICT and digitalization of all spheres of life, stimulating the movement towards the so-called "Economy 4.0". In the "Strategy for the Development of the Information Society", the goal is very succinctly formulated – the development of the economy through the use of advanced ICT; the use of ICTs for the benefit of all residents of the country. The basic principles of the transition of the Swiss Confederation to the information society were declared back in 1998 in the first edition of the Strategy. The first paragraph in this act was that every Swiss citizen should have access to information and communication technologies (and at affordable prices); ICT will be introduced in all areas of the daily life of the country's population; the information society will develop on the basis of market mechanisms and citizen initiatives. The tasks of the state included providing a framework for the functioning of the information society, promoting the formation of social equality of citizens and creating basic principles for the political solution of security issues in the use of ICT. Subsequent legal acts developed and detailed the main activities of the Confederation in the transition to the information society. The latest edition of the document (2012) formulated the main provisions of state policy in this area for the period until 2019: "To promote the development and implementation of ICT in all spheres of life; level the digital divide in society; to establish itself as a sustainable information society". A number of government documents aimed at implementing the main provisions of the Strategy deal with overcoming the existing imbalance associated with the digital divide in Swiss society. The attention of government agencies is focused on special programs aimed at developing high-speed broadband infrastructure, providing open access to information networks, and stimulating the process of digitalization of data. In 2016, a new state program called "Digital Switzerland" was developed, which describes in more detail the processes of transferring all spheres of the life of the state to digital platforms (Iakova, 2016).

Other countries see similar events. Thus, one comes to understanding that the competitiveness of the economy is based on the quality of education, and that, in turn, today uses the tools of the digital world. The criteria for this process today are:

1. Systematic state policy;
2. Development of a state strategy;

3. Creation of legal, economic and social institutions that contribute to the development of technologies and tools of the digital world;

4. Economic motivation of all participants in the digitalization process;

5. And, finally, the creation of barriers preventing washing out the intellectual property of participants in this process by the digital environment.

Conclusions

At the end of the study, it should be noted that nowadays there are many world ratings that rank countries according to the quality of education. It was noticed by the authors that the leading countries in them practically do not change. Even if one compares the ratings of the quality of education and the level of competitiveness of the country on the world stage, there are no serious deviations from the leading states. It is evident that there are many reasons for this. The main ones include the current stage of development, the quality and standard of living of the population, abundant investments in education and science and other reasons.

Among all these reasons, the authors include the degree of the country's participation in the digitalization process. Without proper government policy in this area, without strategies for the development of the digital economy and the development of relevant institutions, it will be difficult to maintain existing leadership positions.

Acknowledgments

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