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"Digital Era": Impact on the Economy and the Education System (Country Analysis)

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Artículos

"Digital Era": Impact on the Economy and the Education System (Country Analysis)

"Era digital": impacto en la economía y el sistema educativo (análisis de país)

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Abstract:

The article presents the results of a historiographic analysis of the work on the implementation and use of digital technologies in the national education systems of the world's leading countries. The aim of study was to identify difficulties in the implementation of digital technologies in a national education system and directions for their improvement. The research allowed to conclude that the introduction of digitalization in the national education system generates new difficulties, such as the lack of understanding of the ongoing processes, insufficient funding, etc. However, countries can enter a new level of economy digitalization only with targeted government support.

Keywords: Digital education, digital technologies, digitalization, information, educational environment, protectionism.

Resumen:

El artículo presenta los resultados de un análisis historiográfico del trabajo sobre la implementación y el uso de tecnologías digitales en los sistemas educativos nacionales de los principales países del mundo. El objetivo del estudio fue identificar dificultades en la implementación de tecnologías digitales en un sistema educativo nacional y las instrucciones para su mejora. La investigación permitió concluir que la introducción de la digitalización en el sistema educativo nacional genera nuevas dificultades, como la falta de comprensión de los procesos en curso, fondos insuficientes, etc. Sin embargo, los países pueden ingresar a un nuevo nivel de digitalización de la economía solo con apoyo de un gobierno específico.

Palabras clave: Digitalización, educación digital, información, entorno educativo, proteccionismo, tecnologías digitales.

INTRODUCTION

The last decade was marked by significant developments in the field of digitalization, which have radically changed the entire global ecosystem. Those include a sharp increase in the volume of transmitted and consumed information; constant innovations in the field of communications and tele-communications, and integration of the Internet technologies in the life of the vast majority of the world's population.

The world is becoming different! Undoubtedly, these processes characterize the qualitative technologicalgrowth of the entire mankind providing the use of advanced science and technology even to the developing countries. However, the negative aspects of the digital world associated with the emergence of technological "scissors" are beginning to deepen – only a few countries would saturate the rest of the world with advanced technological products, while the vast majority of other countries would become compelled buyers-hostages of these products (Bentahar & O'brien: 2019, pp.193-218; Nagimzhanova et al.: 2019, pp.361-368; Tsvetkova et al.: 2019, pp.598-612; Frolova et al.: 2019, pp.337-356). This will ultimately create a new colonial world where the metropolitan countries would become the winners of the "digital race".

The historiographic method used in this study allowed to form the agenda of the world's leading economies in the field of digitalization (to which authors include countries with a high level and quality of life). The government activities in these countries are aimed at improving the mechanisms and the general construct of the digital economy, which should sustain the economic competitiveness. Therefore, the purpose of this study was to define difficulties in digitalization of the national education system in world's leading economies and directions for their improvement.

Foreign experience in digitalization of the national educational systems could not but become the subject of particular discussion for scientists and practitioners from different countries. This is no coincidence. The mid and second half of the 2010s was a period of active and widespread adoption of digitalization in the real economy. Such a massive growth of intellectual knowledge and its simultaneous practical implementation have never been observed in the previous epochs, which undoubtedly makes this topic relevant in the scientific community. This section considers scientific works analyzing the formation of digitalization mechanisms in the education system.

Digitalization, as a process or digital society and a state of the economy is of scientific interest for researchers around the world. They study the importance of change, the state of new conditions, problems, and consequences. There are more questions than answers. According to scientists, digital changes can be compared to a rapid tsunami, since digitalization of several business practices creates new relationships and changes marketing landscape of the national education systems (Crittenden et al.: 2019, pp.5-14; Ivygina et al.: 2019, pp.288-314; Strunc, 2020; Ziyadin et al.: 2020; Ivanova et al., 2019; Monkeviciene et al., 2020; Abulhanova et al., 2019).

Undoubtedly, being a new trend in the global economy, digitalization cannot but attract and captivate with its prospects. Scientists (Baumol & Bockshecker: 2017; Girdzijauskaite et al.: 2019, pp.171-180; Petrenko et al.: 2019, pp.118-128; Sari et al.: 2019, pp.46-73; Ahel & Lingenau: 2020, pp.341-356; Caurkubule et al.: 2020, pp.469-479) see the benefits of the digitalization process for individual economies and their education systems. They claim that the implementation of sustainable development and the integration of digitalization could be the key to expanding the scale of access to education. This, in turn, should lead to a qualitative leap in national educational systems (Zicmane et al.: 2018, pp.253-258).

Everyone has the opportunity and the need to access the resources of the world's Internet. Based on astudy conducted by two Swedish universities, Amhag et al. (2019) have identified the need for teachers to use digital tools and the subsequent need for digital competency in higher education (Amhag et al.: 2019, pp.203- 220). These trends should be especially considered in the implementation of international open educational courses (MOOCs), where MOOCs (Massive Open Online Courses) means educational technology that allows providing training to everyone, up to several tens of thousands of people at the same

time and absolutely free of charge. Liu et al. (2019) note a close relationship between universities and the state in this matter (Liu et al.:2019, pp. 621-630).

Following the discussion about the role of educational institutions in this process, it should be noted that individual representatives of scientific thought Al-Mansoori and Koç (2019) consider it crucial (Al-Mansoori & Koç: 2019; Fedulova et al., 2019; Panfilova et al., 2020; Bekmansurov et al., 2019). They believe that universities should become a unique place for the formation of innovations, technical transformations, and social changes.

In this regard, transformation is becoming an important factor in improving the quality of university strategies in achieving long-term success. On this basis, Cypriot researchers Öztürkler (2017) have learned that the surpassing universities must ensure cooperation with leading world universities to improve their quality, prestige, and reputation (Öztürkler: 2017, Villalobos et al.: 2018; Ramírez et al.: 2019). As the organizing institution requirement, quality and ethical principles should be more efficient, to find a place among the world's universities. Student satisfaction and research are crucial for defining quality strategies in higher education in future.

Representatives of countries that are not leaders in this process also understand the need to include the education system in the digitalization process. Thus, Ecuador scientists Orellana et al., (2019) consider the idea of supporting digital transformation of Ecuadorian universities (Orellana et al.: 2019, pp.338-343). They analyzed eight models of quality assessment used in the country over the past five years for higher education institutions and professional accreditation. The researchers found that these quality models had their impulse for digital conversion. The identified digital conversion drivers allowed to offer guidance on integrating digital aspects into each quality criterion that encourages digital conversion at Ecuadorian universities. In general, today there is full awareness of the need to create a new model of a digital educational system. Drieschner et al., (2019) and Khalid et al., (2018) conclude that digital transformation will require all participants in this process to reconsider their educational model (Khalid et al.: 2018, pp.264-275; Drieschner et al.: 2019, pp.1386-1392). The bridge between digital transformation and educational models can be strengthened by training future decision-makers at the beginning of their educational activities (Loginov et al.: 2019, pp.291-300). The new educational model can use the construct of a dual (school-university (college)), trial (school-university (college)-enterprise) and even quartile (school-university (college) -enterprise -specialized retraining centers) training. At the same time, the formation of new-level student competencies would only require a computer and the Internet access. Undoubtedly, this approach will not be possible without state support, namely, without a unified training platform and financial support for the first projects.

METHODS

The authors analyzed research papers on the introduction and use of digital technologies in national education systems using a historiographic approach. This method is primarily aimed at revealing its historical knowledge, its type (scientific or socially-oriented), its paradigmatic foundations and connections with the relevant historiographic culture. This approach allowed for the final conclusion regarding the experience of the world's leading countries in the formation of state policy in the field of digitalization of the educational sphere.

The authors considered the events in close connection with the specific historical conditions of their emergence. In this context, the principle of objectivity is no less important. According to the authors of this study, its use presupposes freedom from a "social order", bias, an unbiased analysis of the available scientific literature, "indorsement" of historiographic sources in a specific period of time, and refusal to "judge" one's predecessors.

A historiographic analysis of the work on the introduction and use of digital technologies in national education systems was carried out based on the scientific articles from Scopus database for 2015-2020 years (Toribio Fontenla et al.: 2012, pp.244-245; Munro: 2018, pp.11; Fadhilah et al.: 2019, pp.391-396), which allowed the authors of this study to present the most relevant view of the problem under consideration.

Moreover, the authors applied structural-functional analysis – one of the most important research approaches to the study of social phenomena. A huge contribution to the development of the structural-functional approach was made by the sociologists E. Durkheim (Durkheim: 2004, pp.59-68), M. Weber (Weber: 2011, pp.290-314), T. Parsons (Parsons: 1975), R. K. Merton (Merton: 1968), N. Luhmann (Luhmann: 1972), who considered the problems of "social harmony", the ambivalence of the functions being implemented, the normative components that ensure social unity. The theoretical and methodological substantiation of structural functionalism was carried out by D. E. Durkheim (Durkheim: 2004, pp.59-68).

It is this approach "that allows considering culture as an integrity divided into structural units, in which each structural element or complex of elements is associated with a specific functional purpose" (Kagan: 1996). Its use is justified by the fact that, in the most general form, structural analysis of human activity reveals such components as material and spiritual culture. The phenomenon of digitalization that is discussed in the current study is the result of the spiritual and material transformation of the world of nature and society by man, the embodiment of his practically transformative and creative activity (Franco & Bedin: 2019, pp.118-129; Maguth & Koskey: 2019, pp.1-37; Vlasov et al., 2019; García-Martínez et al., 2019; Sousa et al.: 2019, pp.862-869; Bykanova et al., 2017).

The combination of the historiographic and structural-functional method allowed the authors of thisstudy to present the experience of leading countries, which have been successful in the transition of domestic education systems to the needs of new digital trends, along with their successes and failures in this process.

To study the digitalization processes on a country-by-country basis, using historiographic and structural-functional approaches, the authors identified the key elements in the digitalization process, the main functions performed by digital technologies in terms of economic and social development and studied the most significant scientific works on digitalization over the past ten years. The authors understand that this single article cannot present every factor that influences the development of the digital environment. The elements selected in the matrix characterize the main features of digitalization in the practice of state-building. As a result, the collection of information for the study according to the selected set of methods was carried out in the following (matrix) form (See Table 1). This approach made it possible to group, classify, analyze the information, draw the necessary scientific conclusions, and achieve certain author's and scientific results. The matrix approach allows correlating countries with the level of development of their education system (historiographic approach) and various factors that contribute to digital transformation (structural and functional approach). Thus, this author's method combines well-known approaches for creative solutions to the problems posed in this study.

Table 1. The author's (matrix) model as a set of historiographic and structural-functionalmethods adopted in the study.

	Government institutions responsible for digitalization of economics and education	Composition, structure, and dynamics of investments in digitalization projects in the country	Features of reforming the education system in the context of the economy digitalization	Vulnerabilities of the economy and education digitalization
Country 1				
Country 2				
…				
Country N				

The authors used content analysis to identify the vulnerabilities of the digitalization process on a country-by-country basis. In this case, content analysis is understood as a special method for studying the contents of text files and communicative correspondence products to identify the problems of digital transformation in different countries. The research base involves around 30 specialized Internet sites from 10 countries, approximately 100 sources in periodicals from the same number of countries, about 10 statistical collections and 50 scientific articles on the topic under consideration. The content analysis allowed studying the sources that are invariant in the structure and substance of content, but exist externally as unsystematized, randomly organized textual material. The philosophical meaning of content analysis as a research method for solving the problems posed by the authors of this article was to climb from the variety of textual material to an abstract model of text content. In this sense, content analysis makes it possible to determine the composition and structure of digitalization problems in the world, to determine their quantitative significance, and to identify priority directions for the improvement of national educational systems.

RESULTS

Experience of the leading countries in the formation of state policy in digitalization of the educational sphere

In this section, let us consider the experience of some leading countries that have been successful in the transition of domestic education systems to the needs of new digital trends, their successes and failures in this process. Let us consider the process within the logical chain.

Extensionists of the National Educational Digitalization Concept

The study showed that the introduction of digitalization institutions through government bodies is common to the world's leading countries (Glotko et al.: 2020, pp.2181-2195). This is due to several principal reasons, among which one can single out the centralized and effective gradual introduction of new technologies within the state, as well as the organizational and financial impossibility of even the largest business structures to launch similar projects (moreover, transition of this direction to corporations may turn into management difficulties in the future) (Turgaeva et al.: 2020, pp.2243-2254; Voronkova et al.: 2020, pp.2170-2180; Yemelyanov et al., 2019; Saifullova et al., 2018).

In this regard, in Germany, two ministries are responsible for the adjustment of digitalization processes - the Federal Ministry of Education and Scientific Research of Germany and the Federal Ministry of Economics and Technology (Mayevskaya: 2018, pp.72-86). In Australia, for the first time, the development

of digitalization ideas began in 2010 under the control of two ministries – the Ministry of Information and Communication Technologies in Education and the Ministry of Professional Training (Andre: 2019). Almost the same situation is observed in other countries. In Iceland, these issues are dealt with by the Ministry of Education and Culture, which is responsible for the legislative framework of all its levels – from preschool to adult education (it is also responsible for the effective development of the education system, for conducting experimental work in educational institutions); in the South America– the Ministry of Education, Science and Technology; in Finland - the Ministry of Education and Culture.

A slightly more complex system for managing the digitalization process has developed in Switzerland. The main conductor of the scientific, technical and innovation policy of the state in the country is the State Secretariat for Education, Research and Innovation (SBFI). It is responsible for the management and financing of the complex of federal polytechnic schools, the regulation of activities and partial financing of higher specialized schools, as well as for the support of cantonal universities. The executive functions are assigned to the Technology and Innovation Commission. It operates in three areas: project financing, creation of new enterprises and facilitation of the knowledge and technology transfer between science and industry. The focus is on the incitement of the innovative activity of small and medium enterprises (Belov: 2014). Moreover, thereare corresponding units of federal departments (ministries), as well as formally independent federal agencies that provide financial support for research and innovation based on competitive selection of projects submitted by the applicants. These federal agencies are the Swiss National Science Foundation and the Commission on Technology and Innovation (in January 2018 it was renamed into InnoSuisse – Swiss Innovation) (Klavdienko: 2018).

The authors examined the features of state policy in the field of innovation support, including theintroduction of new digital technologies to identify trends common to all countries. This will reveal the most effective ways of digital transformation of education systems and national economies. As a rule, national universities and federal higher polytechnic schools conduct basic research in the field of digitalization. The private sector, in turn, supports applied research conducted by higher specialized schools, as well as the practical application of scientific developments and their commercial implementation. It also carries out a significant part of all investments in significant high-tech sectors of the economy.

The volume of investments allocated by the countries for digitalization

It is quite difficult to determine the volume of investments allocated in the countries to create a digital economy system or its individual industries (for example, education). Over time, the amounts announced at the beginning of the projects change, new projects are added, etc. Using the example of several countries, the authors attempted to present the volumes of total investment in the process of creation, establishment, and dissemination of digital technologies, as well as the financing of individual projects (Table 2).

Table 2. The volumes of total investment in the process of creation, establishment, and dissemination ofdigital technologies, as well as the financing of individual projects.

No.	Country	Period (years)	Volume of investment
1	Germany	2018-2022	5.7 billion USD
2	Australia	Since 2010	2.2 billion USD
3	The Republic of Korea	1998	1.1 billion USD
		2015	2.4 billion USD

Source: Compiled by the authors based on analysis (Bogdanova & Fedoseev: 2010, pp.89-99; Polushkina: 2016, pp.118- 122; Mayevskaya: 2018, pp.72-86).

In one of the largest European countries, Germany, the Federal Ministry of Education and Research has invested 5 billion euros in the so-called Digital Package, the aim of which was to provide digital education in primary, secondary schools and professional institutions throughout the country within five years (from

2018 to 2022). This project includes the provision of digital equipment, such as broadband, WLAN and other devices. In Australia, significant financial resources have been allocated for the implementation of the digital education ideas. According to preliminary estimates, the government has allocated 2.2 billion USD to provide targeted financing for the modernization of information and communication technologies in grades 9-12 of secondary schools, about 100 million USD to support schools connecting to fiber-optic media. Furthermore, the government provided financing for the following actions:

- 32.6 million USD within two years to provide students and teachers across Australia with online tools and resources to support the national curriculum, as well as conference equipment to help teachers with special subjects such as languages (Andre: 2019);
- Work with the state's governments and local authorities, with the leaders of higher pedagogical educational institutions in order for future teachers to master new teaching methods – already using ICT, which will allow raising school education to the most modern level (Andre: 2019);
- Development of interactive learning and providing access to educational resources, which will allow parents to participate in the educational process (Andre: 2019);
- Allocation of 10 million USD within three years to develop mechanisms to help schools implement ICTs (Andre: 2019). At the same time, the country's leadership has allocated about 64 million USD to finance STEM education. The priority is the development of mathematical, scientific, technical education and state support of relevant initiatives in the field of early and school education. In general, the authors were not able to determine the exact amount of funds allocated for digitalization. However, the total amount allocated for financing research and development is impressive and makes up more than 3% of the country's gross domestic product. It is important to note that about 2/3 of all research and development expenditures were financed by the private sector and only 30% – from the federal and cantonal budgets. Asian countries have not come far behind in digitalization processes. The history of introducing information technology in the educational process of the Republic of Korea began in 1998. At that time, the project budget for exploration amounted to approximately 1.1 billion USD. The real result was a fixed index of the development of information and communication technologies in the world (ICT Development Index), according to which South Korea occupied the second place in the world. Approximately 2.4 billion US dollars should have been allocated for the implementation of the Smart Education project, the goal of which was to provide electronic textbooks to each student by 2015.

The brief review makes it possible to conclude that the countries claiming a leading position in the global economy are actively investing in the digitalization process. Long-term financing of digitalization projects is becoming an important factor in creating a digital environment. It will allow to create the necessary infrastructure, to train qualified personnel, thereby paving the way for future economic growth based on digitalization.

Reformation of the education system as part of the digital transformation

In the presented section hereof, the authors consider modern educational initiatives related to digitalization around the world. They should form the platform of the future digital society. Since 2016, the leadership of the Federal Republic of Germany has begun to actively support e-learning projects and promote initiatives introducing new technologies and educational formats in special subjects. Education gradually switches to a more convenient format and becomes individual; freedom of discursive and research training arises. Higher education institutions become available to people for whom higher education was previously inaccessible. University profiles are being reviewed, access to education is becoming a unilateral statement .

In Australia, the whole range of activities aimed at introducing digital literacy at all levels of educationis being formed and implemented. Those include measures that are being implemented to ensure Internet security for schools and students, to support the sites dedicated to Internet security, and online lessons

for students. The elementary school curriculum conducted by the Australian Communications and Media Authority (ACMA) in Australia where children collectively investigate and discuss issues related to Internet security is of particular interest (Andre: 2019).

Other key areas of artificial intelligence technology popularization in education involve research activities on the use of artificial intelligence and new technologies in schools, as well as identification of the best teaching practices; conducting training webinars for teachers on the use of artificial intelligence technologies in the educational process; creation of specialized online resources for schoolchildren, students, and teachers (Korableva et al.: 2019, pp.468-475). For example, numerous ideas for lessons using digital technologies are now posted on the Digital Technologies Hub platform, along with the best methods and advice from Australian teachers in primary and secondary schools. With the help of the Lending Library project, any teacher, including from a rural school or remote regions, can use digital educational equipment and lesson plans developed for different age groups in accordance with the national curriculum for free. In general, the country's leadership considers high-quality education in the field of science, technology, engineering, and mathematics (STEM) a priority for the country. In this connection, the National Strategy for School EducationSTEM for 2016–2026 was approved. Its 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.

A more meaningful approach to this process was developed in Switzerland. Several Swiss structures are involved in digitalization projects, providing funding for activities to develop science and innovation in the following areas:

- Two Federal Higher Polytechnic Schools, located in Zurich (ETHZ) and Lausanne (EPFL), are known worldwide for their achievements in the field of natural sciences. Federal higher polytechnical schools include four research centers. One of them – the Paul Scherrer Institute (PSI) – is one of the leading research institutes in Europe. Scientists from all over the world come here to conduct research on equipment such as a synchrotron radiation source (Swiss Light Source) and a neutron source (Spallation Neutron Source).
- The Swiss National Foundation for Scientific Research (FNS) provides support for basic research in all areas of science, including history, medicine, and engineering. Every year, the Foundation supports more than 3,200 projects, in which participate around 14,800 scientists.
- The Swiss Agency for Innovation Support (Innosuisse) supports innovation based on science and created for use in the economy, as well as in the public interest, and thereby enhances the competitiveness of Swiss small and medium-sized enterprises, as well as start-ups (Yamova et al.: 2018, pp. 777-787; Kolmakov et al.: 2019, pp. 159-172).
- The Swiss Confederation also provides financial support to the Association of Swiss Academies and about 30 research institutes, in addition to higher schools. A well-developed network of techno-parks and start-up centers, which facilitate the creation and development of young innovative enterprises, complement the country's innovation support system. Most of these institutions have a specific industry specialization or thematic focus and are contact forums and incubators of innovation. In such centers, it is often possible to rent premises on preferential terms during the start-up and initial stages of the company's activities, use the common research infrastructure and get expert advice. A significant number of technology parks and business incubators are located in Switzerland, where, based on a pool of interests, high-tech companies, venture firms creating know-how, university departments and departments, investment and venture funds that finance the innovation process collaborate with each other (Belov: 2014).

In fact, these processes, one way or another, have led to an increase in the role of digital technologies. Let us explain our argument. Any innovation is new knowledge. Knowledge is the result of data and information transfer between people to solve an innovative problem. Information (digital) technologies

make the process of data and information exchange and, accordingly, knowledge and innovations faster, more operative and more efficient. Accordingly, any institutions supporting innovation in any country, in this case in Switzerland, will intensively introduce digital technologies, which will lead to the digitalization of science, education and production. This is a new reality.

In Switzerland, each of the 26 regions has its own educational system, independent of the others. Ifnational online education initiatives arise, they are most often local. On top of that, more and more independent figures are beginning to get involved in modern educational technologies. In response to this trend, an incubator with 45 startups in the field of educational technologies was launched at the Federal Polytechnic School of Lausanne. At the same time, great attention is paid to the reliability of the information taught. In this regard, special control extends to massive open online courses that could potentially disseminate inaccurate materials.

The main activities on the country's digitalization are considered in the "Confederation Development Concept for 2016–2019". An important direction for Switzerland is the development and implementation of information and communication technologies and the digitization of all spheres of life, stimulating themovement towards the so-called "Economy 4.0". A distinctive feature of the new economy will be the transformation of the main administrative, financial, industrial processes into a digital form using elements of artificial intelligence and self-learning systems. In 2016, a new state program was developed under the name Digital Switzerland (2019), which describes in more detail the processes of transferring all spheres of the state's life to digital platforms. The purpose of every documentary act is reduced to the mass digitalization of the entire economic, educational, and social space of the country (Polyakova et al.: 2019, pp.130-139). All administrative and procedural issues (from obtaining certificates to paying taxes) would be solved by a citizen using a single electronic certificate (Utyuzh et al.: 2020, pp.568-575). Over the last decade, Switzerland has been consistently constructing the "electronic government" based on the intensive introduction of new information technologies in management processes (the first stage of this process was the introduction of electronic document management in all government bodies at the federal and cantonal levels) (Yakova: 2019; Rosa et al.: 2019, pp.85-90). The main result of this process, as well as the use of all digital technologies, was a reduction in the cost of servicing the processes of providing services. The second result was a reduction in maintenance errors due to human factors. This allowed defining the negative aspects of this process. First, this is the increased risk of financial fraud. Secondly, this is the risk of loss of personal data and important information due to technical failures and computer viruses.

South Korea rather quickly becomes one of the leaders in world education, while Korean students regularly fall into the top three according to the results of the PISA study (International Program for the Assessment of Educational Achievements of Students) in assessing reading skills, mathematical and natural knowledge. In 2005, the government launched a home-based digital learning system as part of Korea's national broadcast educational system, which allowed every student to access e-learning directly from home. In 2011, the computerization of all public schools began, which ended in 2015. Such ambitious projects as the introduction of wireless systems in each school to create a unified educational environment accessible through various types of electronic devices, including computers, laptops, tablets, and smart TV were also practically implemented. Given the national emphasis on technology and education, as well as the fact that South Korea has a very developed high-speed Internet network coverage (one of the largest in the world), South Korea continues to blur the boundaries between technology and education under the Smart Education project, one of the aspects of which is the initiative to introduce electronic textbooks (Baranov et al.: 2017, pp.40-55).

The Chinese educational system has gone along a similar path. At the beginning of the new century, the country also voiced ideas for conducting smart reforms in education (Lyubin: 2011). The idea of transformations was aimed at training students with electronic media skills. Some aspects of school reform concerned the direct provision of computer access to every student in schools. To date, the purpose of

this program has become even more complicated; cloud technologies are starting to be actively used in the educational process of schools and higher educational institutions.

In 2016, Finland adopted a new national curriculum covering primary and secondary education. Ineducational programs, considerable attention is now paid to digital competence as an interdisciplinary component of all levels.

Digitalization vulnerabilities on a country-by-country basis

Undoubtedly, the implementation of a digitalization policy implies several difficulties that impede the progressive development of countries in this direction. Those include a new paradigm of relations, introducing new technologies, insufficient funding for projects, etc. In this section, the authors define some specific problems that countries face in implementing reforms in the educational sphere:

- In Germany, the process of digitalization of the educational system is moving very slowly, confronting not only organizational problems, but also the reluctance of students to accept new rules. Students often require external support to cope with the requirements of the educational process with elements of digital technology or the requirements of industry 4.0. In addition, students themselves do not welcome trainingformats with digital support; they are satisfied with traditional forms of training. Digital learning is most effective when actively applied by teachers (Mayevskaya: 2018, pp.72-86).
- One of the central problems of the upcoming digitalization, as seen by Swiss scientists and politicians, is the digital divide. Today this concept means 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 informationally poor segments of the population are squeezed out (excluded) from the modern information economy (and the educational sphere), which further widens the gap between rich and poor at different levels (groups of people – countries). Despite the implementation of state programs aimed at the development of information and communication technologies and the use of their achievements in all areas of public life, digital inequality within the country continues to exist. According to scientists, the solution to this problem requires an integrated approach, addressing several problems, intensively developing the infrastructure of information and communication technologies, introducing innovations of the latest generations, and at the same time creating conditions for improving professional skills and education of the population in this area (Yakova: 2019).
- South Korean digital developers are faced with a copyright problem. The implementation of the Digital Education project required a huge number of relevant textbooks, but in practice, it turned out that not all textbooks are protected by copyright (Yankovskaya et al.: 2019)

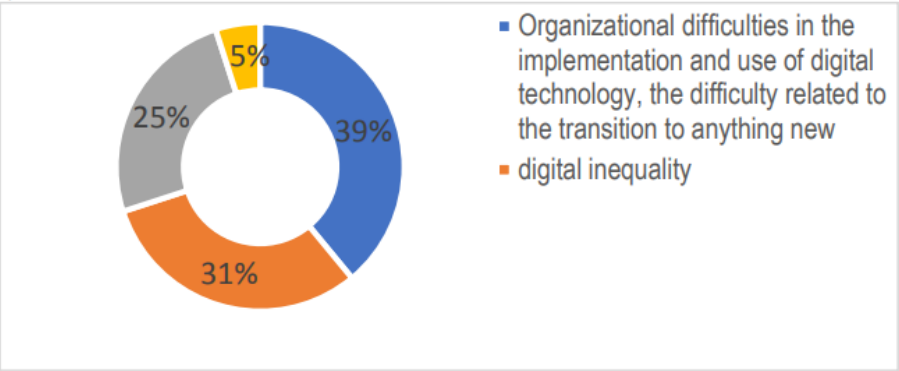

Figure 1. Vulnerabilities of the digitalization process on a country-by-country basis in % of the total number of processed scientific publications. Source: compiled by the author.

This is only a partial list of all the existing problems. It can safely be assumed that over time the number of problems will increase, but with a similar steady increase in the quantity and quality of digital technologies used. The objective of the national governments, public institutions and universities is to provide a solution to these problems, which should create milder conditions for the entry of national economies into the "digital era".

DISCUSSION

The presented study examined the bases for the organization of institutions supporting innovation, fundamental and applied science, digitalization processes, including in the field of education based on international experience. This allowed analyzing the initiatives of states, including the volumes of financing the implementation of digital technologies. The authors have reviewed the available literature on the research topic (Sollberger: 2013; Öztürkler: 2017). These researchers have already presented the generalized experience of their countries in the development of digitalization processes. The objective of this study is toapply the systematic approach and the author's (matrix) approach to identify factors that contribute to improving the effectiveness of the national education system in the digital age.

The analysis of digitalization processes required the use of several methods, including analysis and synthesis, which was supplemented by historiographic analysis. This method allowed for a conclusion on the experience of the world's leading countries in the formation of state policy on digitalization of the educational sphere.

The study showed that digitalization of the economy is becoming a key activity of the leading countries of the world. Moreover, the general trend is the introduction of digitalization institutions and mechanisms not through a private commercial initiative, but through government intervention. The volume of investments allocated for this program by country amounts to billions of dollars, increasing each year. The list of countries that are most actively involved in investing in the digitalization process includes Germany, Switzerland, Australia, and some others.

At the same time, countries follow the path of accelerated development, investing not only in current projects, but also in the educational environment, in the hope of gaining greater effect in the future. Despite this fact, there is still a problematic field for the implementation of these initiatives, which significantly slows down the digitalization process. The major problems in the education system involve organizational difficulties, digital inequality, the problem of using copyright.

CONCLUSION

The experience in implementing digital technologies in the above countries shows that the implementation of digital technologies in the national educational system will bring the Russian education system closer to the world level. As demonstrated by the present study, the movement of the country's innovative development to digital development is accompanied by an increase in the quality level of the national education system of the countries surveyed. At the same time, the introduction of digitalization in the field of education will create certain difficulties in its implementation. The need for digital technologies in modern education is not in doubt; however, the range of the related problems creates certain prerequisites for the development of countermeasures.

The authors carried out a historiographic analysis of the studies on the introduction and use of digital technologies in the national education systems of Sweden, China, Switzerland, and Ecuador. The researchers analyzed mechanisms of digitalization in national educational systems of different countries of the world.

The analysis of digitalization experience of the leading countries in the field of national education indicates not only the successes but also the vulnerabilities in this area. The study showed that the centralized state introduction of digital technologies in education has become the principal one. It was the state apparatus that became the conductor of the ideas of national census digitalization in several countries, such as Germany, Australia, Iceland, Finland, and Switzerland.

The research has shown that the volume of total investment in the process of creation, establishment, and dissemination of digital technologies, as well as the financing of individual projects in a number of leading countries, is significant and difficult to assess, due to a number of changes introduced in the initial estimates of projects. Not only state budget funds but also the private sector was attracted as sources of financing, which testifies to the existing understanding of the role of digital technologies for the national education system.

Quality assurance of the future digital society is guaranteed by educational initiatives related to digitalization and supported in the world today. Several leading countries, such as Germany, Austria, Switzerland, and South Korea, are implementing a range of measures to master digital technologies.

Despite the successful implementation of digitalization, national economies face numerous specific problems when reforming the educational sphere. Those include conservative approaches to student learning (Germany), digital inequality between people based on different possibilities of access to information andcommunication technologies and, therefore, information and knowledge when the poor are squeezed out (excluded) from the modern information economy (Switzerland), the copyright issue (South Korea).

Summarizing the above results, it can be concluded that digital technologies will continue to conquer the modern world, while governments and their citizens should endeavor to implement national educational priorities. Further aspects of the study are related to the refinement of the format and design of the digital transformation of the national education system, which will require a detailed examination of the digital technologies used in the educational systems of other countries.

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