Natalya N. Novikova, Vladimir V. Mironov, Mikhail D. Kitaygorodskiy, Vita F. Poberezkaia. (2021). Realities and Prospects of Digital Transformation of Additional Education for Children in Russia. *International Journal of Early Childhood Special Education (INT-JECSE),* 13(2): 1164-1173. DOI: 10.9756/INT-JECSE/V13I2.211163

Received: 24.06.2021 Accepted: 30.09.2021

Natalya N. Novikova[1]
Vladimir V. Mironov[2]
Mikhail D. Kitaygorodskiy[3]
Vita F. Poberezkaia[4]

Realities and Prospects of Digital Transformation of Additional Education for Children in Russia

Abstract

The relevance of the research is due to the development of the digital space and the processes of restructuring the entire education system. Currently, a modern educational environment is being created in Russia to create conditions for the digital transformation of education with access to individual learning trajectories of students. A special place in modern education is occupied by the additional education of children. Additional educational activities are carried out based on target models for the development of regional systems in the regions of Russia. Different approaches to implementation in the field of digitalization are being developed in each subject of the Russian Federation. In this regard, it becomes relevant to assess the readiness of institutions of additional education for children in the regions to the challenges of modern digital society. The purpose of the publication is to identify the current state and prospects of digital transformation of additional education for children in Russia (on the example of the Komi Republic), considering the key features of the development of the modern digital industry. The leading methodological approaches to the study of the problem under study are system-pragmatist, personality-oriented, and differentiated. The methods of socio-historical and theoretical-methodological analysis, evaluation and generalization of the best practices of institutions for additional education of children, analysis of normative and program documents, and comparative analysis of static data were used in the course of the research. The main trends in the digital transformation of additional education for children have been identified. Promising directions for the development of additional education for children have been identified, considering the key approaches to the implementation of the National Technological Initiative and the National Project "Education". End-to-end technologies of the digital industry have been identified as a result of the research and the correspondence of the directions of educational programs in modern models for additional education of children to these technologies has been determined. The experience of educational activities in modern centers of additional education of the Komi Republic has been summarized: "Kvantorium", "IT-cube", "House of scientific collaboration". The practical significance of the research lies in the possibility of using the obtained data to improve the processes of digital transformation of additional technical education. The research materials can be in demand by managers, methodologists, teachers of the system of additional education for children when developing the concept of development and planning educational activities.

Keywords: National Technological Initiative, End-to-end Technologies of the Digital Industry, Digital Transformation of Additional Education for Children, Modern Resource Centers for Additional Education.

Introduction

Digitalization of all sectors of the economy and the social sphere is a global trend, which is defined as a new technological revolution – Industry 4.0. It has become possible to talk about such a technological revolution in connection with the explosive development of such areas as robotics, the industrial Internet of things, additive technologies, digital modeling, etc. Many of the modern technological trends are also penetrating

Natalya N. Novikova[1], Pitirim Sorokin Syktyvkar State University, Syktyvkar, Russia.
Vladimir V. Mironov[2], Pitirim Sorokin Syktyvkar State University, Syktyvkar, Russia.
Mikhail D. Kitaygorodskiy[3], Pitirim Sorokin Syktyvkar State University, Syktyvkar, Russia.
Vita F. Poberezkaia[4], Pitirim Sorokin Syktyvkar State University, Syktyvkar, Russia.

the education system, as educational content or as a means of teaching.

The modern strategy for the development of additional education for children in general and the digitalization of the educational process, in particular, is determined by the guidelines and requirements outlined in the National Technology Initiative, the Strategy of scientific and technological development of the Russian Federation, the Priority directions of development of science, technology, and engineering in the Russian Federation, the National project "Digital economy", National strategy for the development of artificial intelligence for the period up to 2030, etc.

The "Education" National Project is being implemented to develop the education system in Russia. Therewith, the activities of additional education organizations in the field of digitalization are determined by the initiatives of the following Federal projects: "Digital Educational Environment", "Modern School", "Success of every child".

The goals and objectives of the Digital Educational Environment project provide for the creation of a modern educational environment in educational institutions that allows for the availability and high quality of education, as well as the functioning of digital education centers for schoolchildren − "IT-cube".

The implementation of the "Modern School" Federal project provides for the modernization and methodological support of technological education of schoolchildren, the creation of conditions for the formation of basic knowledge and skills in the field of high technologies, and the organization of training based on high-tech equipment in modern Kvantorium centers.

The federal project "Success of every child" is aimed at developing a system for identifying and developing students' abilities in various fields, as well as creating conditions for organizing the educational process according to individual curricula.

Thus, the development of a digital society and modern requirements for the organization of the educational process requires the modernization of the infrastructure of additional education for children, which implies the creation of a network of modern resource centers, such as: "Kvantorium", "Point of Growth", "IT-cube", "House of Scientific Collaboration". The educational programs of resource centers are primarily determined by promising areas of development of modern digital technologies.

Within the framework of the problem under study, we consider it necessary to identify the current state and prospects of digital transformation of additional education for children (hereinafter – AEC) in Russia (on the example of the Komi Republic), considering the key features of the development of the modern digital industry.

Literature Review

The analysis of the scientific literature has shown that the problems of the development of the AEC system have been relevant for many years. Researchers are studying the issues of the historical development of additional education for children in Russia (N.A. Morozova, E.V. Smolnikova, A.B. Fomina, I.Yu. Rudnev) and aspects of periodization (M.O. Chekov, V.V. Lobanov, O.E. Lebedev).

The concept of "additional education" is considered from various positions in scientific works. Thus, E.B. Evladova defines the additional education of children as a part of the pedagogical process: "an integral part of general education, which goes beyond the state educational standards and assumes a free choice of the child's spheres and types of activities focused on the development of his/her personal qualities, abilities, interests" (Evladova, Loginova, Mikhailova, 2002).

In turn, L.N. Builova (2011) argues that additional education for children is a multilevel system in lifelong education in Russia, aimed at developing children's abilities and their "interests that affect social and professional self-determination".

A.G. Asmolov (1997) believes that additional education is a new form of education, which is characterized by a certain connection between generations, when "everything is transmitted through the children's subculture and the culture of adults, when the co-creation of an adult and children, their partnership gives rise to a special range of relations, sets a certain specificity education".

B.A. Deich (2011) and O.S. Gazman (1998) define additional education as pedagogical interaction between children and adults, aimed at "satisfying the cognitive interests of children and their needs for social connections, creative self-realization and self-development in a multi-age group of like-minded people".

Supporting the idea of interaction, V.P. Golovanov (2004) considers AEC as a communication process organized in a certain way, aimed at the formation of motivation for cognition and creativity.

It should be noted that several researchers point to the ongoing process of modernization of additional education for children. In many ways, it is connected with the challenges of modern digital society. The rapid development of technologies, primarily digital, defined a new technological revolution, which was called "Industry 4.0" (Gerbert, Lorenz, Rüßmann, 2015). There are several features of Industry 4.0:

1. Digitalization − combining modern technological processes of several enterprises to solve common problems.
2. Virtualization – the use of virtual and simulation models in production technologies.
3. Decentralization − the ability of robotic production systems to independently change the parameters of technological processes to obtain a better final result.
4. The use of big data technologies for the analysis of information flows of automated systems for operational production management (Eberhard, 2016).

Yu. A. Plakitkin, L.S. Plakitkina (2018) and I.V. Tarasov (2018) note that the end-to-end technologies and the basic directions of the Industry 4.0 development are: autonomous robots, industrial Internet of things, additive technologies, digital modeling, augmented reality, big data, cloud computing, horizontal and vertical integration of systems, information security.

The problem of the digitalization of modern education becomes relevant within the framework of our research. The analysis of scientific research in this field shows that the processes of digital transformation of education are influenced by external factors (Uvarov, 2018; Uvarov, Van, Kan, 2019). This is primarily due to the digitalization of the economy; the development of remote, network and mobile means; rapidly growing requirements for digital skills. Therewith, the researchers point to the problem of the lack of a clear vision of ways to update the education system in the new conditions.

In modern research, the digital transformation of education is considered as "the process of transformation of the content, methods and organizational forms of education" and "the process of qualitative improvement of the effectiveness and productivity of educational work" (Uvarov, 2019).

In the context of the development of the digital educational environment in educational institutions, it is necessary to update the goals and content of training, review methods and forms, optimize information resources and tools, and organize the automated use of digital technologies (Testov, 2019; Geibl, 2019; Savina, 2019; Speshilova, Tushkanov, Bunin, 2019).

A.Yu. Uvarov, E. Gable, and I.V. Dvoretskaya (2019), and others believe that the main result of the transformation of education is not the creation of modern computer classes, but the formation and dissemination of new models of the work of educational organizations. The researchers see the essence of the digital transformation of education in achieving the necessary educational results and moving towards the personalization of the educational process based on digital technologies.

As the analysis of the scientific literature has shown, despite a significant amount of research in the field of digital transformation of general education, this problem has not become the subject of study in the field of additional education for children.

Methods

The study used the leading approaches to the study of the problem under study: system-pragmatist, personality-oriented and differentiated. The methods of socio-historical and theoretical-methodological analysis, evaluation and generalization of the best practices of institutions of additional education for children, analysis of normative documents in the field of digitalization of education, and comparative analysis of static data were used in the course of the research.

We used materials presented in the public domain on the portal "Federal State Statistics Service to carry out a comparative analysis of statistical data in the field of organizing AEC. Statistical Data Showcase" (https://showdata.gks.ru/finder).

The information system is designed to work with data storefronts that provide opportunities for searching and preparing official statistical information for publication; support the processes of preparing statistical materials, publications).

Data showcases provide the user with the following features: viewing the catalog of statistical indicators and searching for an indicator; viewing the indicator passport; generating calculated indicators; generating and saving reports; analyzing data; uploading prepared reports to external files; viewing the publication passport. The system contains the main "Overview" sections (working with the catalog of indicators and displaying the passport of the indicator) and "Reports" (building and viewing reports).

Results

The study on the selected problem was carried out in several stages:

1. Conducting a comparative analysis of statistical data in the field of organizing additional education for children.
2. Identification of end-to-end technologies of the digital industry based on the analysis of trends in the modern industry.
3. Determination of the influence of modern digital technologies on the models and content of educational programs of additional education of children.

4. Study and generalization of the experience of educational activities in modern centers of additional education of the Komi Republic: "Kvantorium", "IT-cube", "House of scientific collaboration".

Six regions of the North-Western Federal District (the Republics of Karelia and Komi; Kaliningrad, Murmansk, Pskov, and Novgorod regions) were selected for a comparative analysis of statistical data on the organization of additional education for children in Russia. This is since these regions are located in the same geographical part of the Russian Federation and have relatively the same population and the same trends in changing its number.

A comparative analysis of statistical data was carried out in the course of the study on the following indicators: the number of organizations engaged in educational activities in additional general education programs for children; the number of students in the areas of additional general education programs; the number of students in the natural science direction of additional educational programs; the number of students in the technical direction of additional educational programs.

Let us consider the statistical data on the number of organizations engaged in educational activities for additional general education programs in the selected regions of the North-Western Federal District for 2015, 2018, and 2019. (Figure 1).

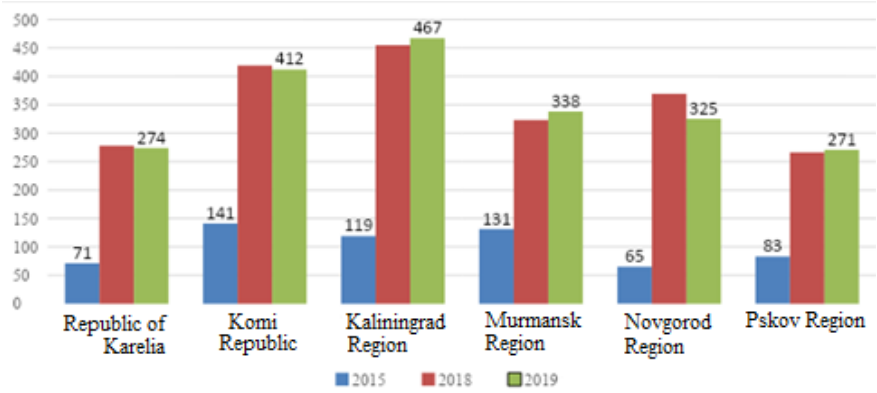

Figure 1.

The number of organizations that carry out educational activities for additional general education programs for children (2015, 2018, 2019)

The presented data clearly show the trend of significant growth of additional education organizations for children in all the studied regions of the North-Western Federal District. If in 2015 this indicator had a value in the range of 71 (Republic of Karelia) − 141 (Republic of Komi), then in 2019 this value was in the range of 274 (Republic of Karelia) − 467 (Kaliningrad Region). The largest growth is observed in the Kaliningrad region − from 2015 to 2019, the number of organizations increased by 348.

Next, we will analyze the number of students in the areas of additional general education programs (Figure 2).

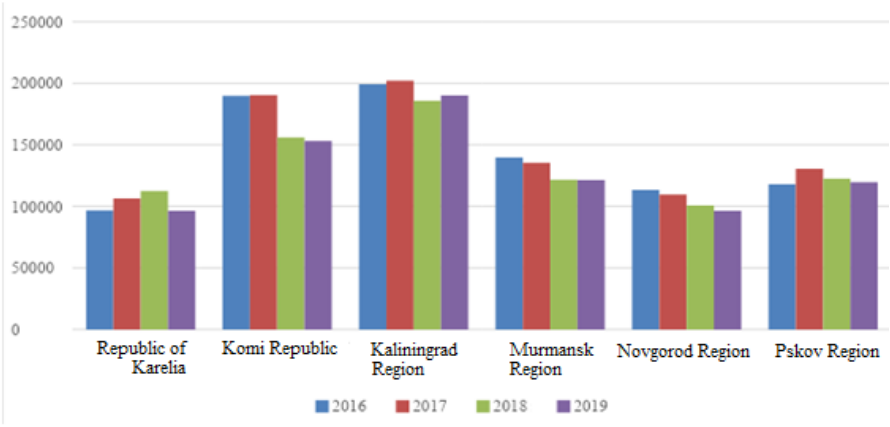

Figure 2.

The number of students in the areas of additional general education programs (2016−-2019)

Statistical data show a downward trend in the number of students studying in the AEC in all the studied regions of the North-Western Federal District. If this indicator decreases slightly in the Republic of Karelia, Kaliningrad, Murmansk, Novgorod, and Pskov regions, there is a significant decrease in students in institutions in the Republic of Komi.

Since the end-to-end technologies of the digital industry are mostly studied under additional programs of natural science and technology, let us consider the number of students in these areas from 2016 to 2019 (Figures 3, 4).

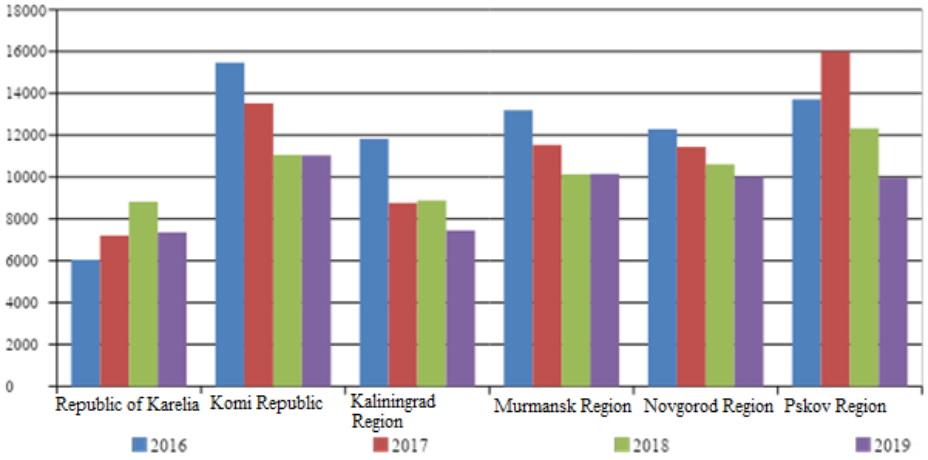

Figure 3.

The number of students in the natural science direction of additional educational programs (2016-2019)

The analysis of statistical data shows that the number of students studying in the natural science direction in the Komi Republic, Kaliningrad, Murmansk, Pskov, and Novgorod regions has been significantly decreasing for 4 years. Therewith, there was an increase in the number of students in the Pskov region in 2017. There were more students in the natural science direction in the Republic of Karelia from 2016 to 2019.

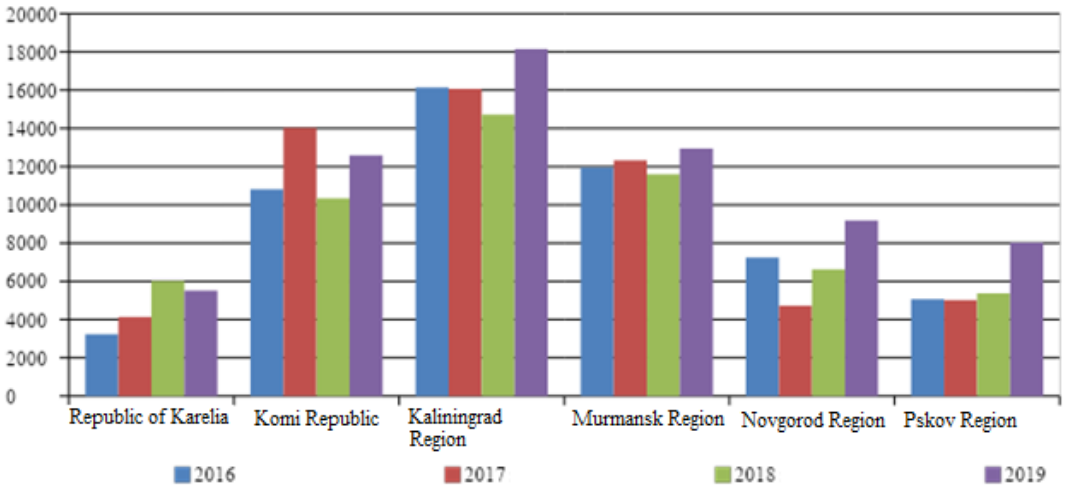

Figure 4.

The number of students in the technical direction of additional educational programs (2015−2019)

The analysis of the data shows that a greater number of students studying in the technical direction is observed in the Kaliningrad and Murmansk regions and the Komi Republic. At the same time, we can observe how students' interest in technical programs is growing in all the regions under consideration. On average, the growth is 2-3 thousand students in 4 years.

The results of the statistical data analysis allow stating that there had been a tendency to reduce the number of students in these organizations during 2016-2019 in the Republics of Karelia and Komi, Kaliningrad, Murmansk, Pskov, and Novgorod regions, with a significant increase in AEC. The analysis of the number of students enrolled in additional programs revealed a tendency to reduce the number of students in the natural science direction and increase in the technical direction. In general, the presented data indicate the trends in the development of the system of additional education and the increasing interest of students in technical programs.

Before considering the impact of modern technologies on the models and content of AEC educational programs, we will analyze which technologies are current trends in the modern industry.

Let us consider the generally accepted end-to-end technologies of Industry 4.0 (Seledtsova, Nikonova, 2017) and the corresponding technologies that are the priority in Russia and are presented in National Technological Initiative projects and the Digital Economy (Table 1).

Table 1.

End-to-end technologies of the digital industry

Industry 4.0	**Digital economy**	**National Technological Initiative**
Robotics	Robotics and sensor components	Sensorics, Mechabiotronics, Bionics
Industrial Internet of Things	Industrial Internet	
Additive technologies	New production technologies	Additive technologies
Digital modeling		Digital modeling
Augmented Reality	Virtual and augmented reality technologies	
Big Data	Big Data	Big Data
Cloud Computing	Distributed registry systems	
Horizontal and vertical system industrial integration		
Cybersecurity		
	Neurotechnologies and artificial intelligence	Artificial intelligence, Neurotechnologies
	Quantum technologies	Quantum communications
	Wireless communication technologies	
		Genomics
		New materials, New energy sources, Element base

The Industrial Internet of Things is a combination of production lines, machine tools, sensors, technologies into a single cloud system available to all participants in the technological process, which allows quickly managing production processes in real-time.

Augmented reality allows combining digital data and models with real images obtained from video cameras. This addition of virtual objects to reality gives greater information content when analyzing technological production processes.

Big data is the designation of technologies for working with digital information that has a large volume, a large variety in formats and representations, and can spread at a high speed. These technologies allow effectively conducting business analytics of various technological, social, and educational processes.

Cloud technologies make it possible to combine the computing power of various companies to solve common problems in various sectors of the economy and the social sphere. Cloud services are also necessary for the implementation of big data technologies, working with which requires their storage for general use.

Autonomous robots have long been standard technologies in modern production. The rapid development of artificial intelligence technologies, the implementation of algorithms on neural networks, machine learning gave an impetus to the use of robots in almost all technological production processes.

Horizontal and vertical integration of systems implies close interaction of technological processes within the enterprise and between enterprises, between producers and consumers, as well as the active influence of

consumers on the production of products, which allows talking about the individualization of the production of goods.

Information security has become a technological breakthrough due to the need to protect digital production data, complete control of production management information networks.

Additive manufacturing has become an alternative to subtractive manufacturing, in which parts are made by truncating blanks, which leads to large consumption of the source material. Additive manufacturing in the form of 3D printing is used for full-scale modeling, prototyping, and manufacturing of individual parts from various materials.

Digital modeling has recently become an integral stage in the design and engineering of devices and technologies, which significantly speeds up the preparatory production processes and increases their efficiency.

As the analysis of pedagogical practice has shown, modern educational programs are being developed and implemented directly related to the end-to-end technologies of the digital industry with the development of the technical direction in the system of AEC (National Technological Initiative, Industry 4.0, Digital Economy). We have analyzed the educational programs implemented in the additional centers "Kvantorium", "IT-cube", "Point of Growth", "National Technological Initiative Circle Movement" of large cities of Russia and the Komi Republic and developed a matrix with the correspondence of educational programs to end-to-end technologies of the digital industry (Table 2).

Table 2.

Compliance with the directions of educational programs in modern AEC centers with end-to-end technologies of the digital industry

End-to-end technologies of the digital industry	**Directions of educational programs in modern centers of AEC**			
	Kvantorium	**Points of Growth**	**IT Cube**	**National Technological Initiative Circle Movement**
Robotics/ Sensorics, Mechabiotronics, Bionics	Promroboquantum, Autoquantum, Aeroquantum, Cosmoquantum	Quadrocopter technologies, Practice-oriented design	Programming robots	Flying robotics, Autonomous transport systems, Unmanned aircraft systems, Intelligent robotic systems
Industrial Internet of Things				Smart City, Internet of Things
Additive technologies	High-tech	Additive technologies		
Digital modeling	IT-quantum, Geoquantum		Fundamentals of algorithmics and logic, Programming in Python	
Virtual and augmented reality technologies	VR/AR-Quantum	VR technologies	VR/AR development	Augmented Reality, Virtual Reality
Big Data	Data-quantum		Cyber hygiene and Big Data	Big Data and Machine Learning, Financial technologies, Analysis of satellite images
Cloud Computing / Distributed Registry Systems				
Horizontal and vertical system industrial integration	Promdesignquantum		Mobile development	Advanced production technologies
Cybersecurity			Cyber hygiene and Big Data	Information security
Neurotechnologies and artificial intelligence				Artificial Intelligence, Neurotechnologies, and cognitive sciences
Quantum Technologies/ Quantum Communications				
Wireless communication technologies				Wireless communication technologies
Genomics	Bioquantum			Genomic editing
New materials, New energy sources, Element base	Energy quantum			Intelligent energy systems, Nanosystems and nanoengineering Composite technologies

The presented matrix shows that most of the trends of modern digital technologies are represented in the educational programs of the AEC. Let us take a closer look at how end-to-end technologies are taught in modern centers of additional education.

One of the indicative technologies of Industry 4.0 is robotics. This technology in the Digital Economy program is defined in the "Robotics components and sensors" direction. The development of robotics is described in the National Technological Initiative in the Technet market, where sensors, mechatronics, and bionics are considered. The basics of these technologies related to robotics are presented in modern areas of additional education. Thus, students master the technologies of robotics in the quanta "Promroboquantum", "Autoquantum", "Aeroquant" in the "Kvantorium" technoparks. The direction "Programming of robots" is popular in the "IT-cube" digital centers. A whole network of Olympiad directions is associated with robotics in the National Technological Initiative Circle Movement: "Flying robotics", "Autonomous transport systems", "Unmanned aircraft systems", "Intelligent robotic systems".

Internet of Things technologies are not yet considered on such a large scale in the educational programs of the AEC. There are directions in the National Technological Initiative Circle Movement – "Internet of Things" and "Smart City", where these technologies are presented. It should be noted that the Internet of Things is beginning to be introduced into the educational environment at the level of mobile devices and cloud services (Zaslavskaya, Kirillov, 2017), and there is also experience in using the Internet of Things in general education school lessons (Galchuk, Sergeev, 2017).

Additive technologies are becoming the basic technologies in the system of additional education. Students study these technologies quite thoroughly in the "Kvantorium" technoparks in the "High-tech" direction, but in other areas 3D prototyping allows children to design complex technical devices and models. Also, the standard set of equipment of the "Point of Growth" centers will include 3D printers, which allows considering additive technologies both in technology lessons and in additional education.

Digital modeling is closely related to additive technologies, which is necessary for building 3D models. Students study digital modeling in the AEC more thoroughly in the "IT-quantum" and "Geoquantum" directions. The design of digital models is also considered when mastering the basics of algorithmics and logic in the "IT-cube" digital center.

Virtual and augmented reality technologies are presented in many educational programs of the AEC. "VR/AR-quantum" is popular in technoparks, and students are taught to program virtual models for games and educational applications in the "VR/AR-development" direction of the "IT-cube" center. The profile "Development of virtual and augmented reality applications" in the National Technological Initiative Olympiad is dedicated to the development of VR/AR applications focused on a wide range of areas, including games, education, medicine, and industry.

Big data technologies and cybersecurity are important areas in modern AEC. These technologies are studied in the "Data-Quantum", "Quantrotroimum" centers. The profile "Big Data and Machine Learning" in the National Technological Initiative Circle Movement immerses participants in performing real tasks related to the analysis of large amounts of data and application development.

The analysis of existing directions (primarily technical) and models of additional education of children shows that students study the most advanced end-to-end technologies used in modern industry and economy.

The study of the experience of the educational activities of the additional education system in the Komi Republic has been carried out since 2016. The analysis of additional educational programs in six centers of additional education in Syktyvkar showed that the most popular directions were drawing, painting on fabric, modeling, artistic processing of decorative materials, and embroidery. Therewith, only two institutions implemented programs on the basics of computer technology, radio electronics, and robotics (Novikova, Rumyantseva, 2017).

The development of modern AEC institutions began in October 2017 with the opening of the "Kvantorium" technopark in Syktyvkar, where programs on basic quantum are being implemented today (Table 2). The "Security Laboratory" is working, there is the initial training of future engineers in the "Initial technical modeling" project group and "Uniquantum", "Quantumstart" quantum (Novikova, Kuznetsova, Konov, 2020a). Currently, there are technoparks in Syktyvkar and Ukhta in the Komi Republic, in addition, two high-tech centers "Mobile Kvantorium" are used to develop the digital and technological skills of students from rural areas.

The "IT-cube" center for digital education for children opened its doors in the Komi Republic in 2019 as part of the implementation of the Federal project "Digital Educational Environment". The purpose of the center is to massively teach children from 10 to 18 years old basic programming and digital modeling skills. Students conduct educational research, create

digital developments commissioned by IT industry partners in the process of project team activity (Novikova, Kuznetsova, Konov, 2020b).

A unique institution for the republic is the key center "House of Scientific Collaboration named after V. A. Vityazeva," created as part of the implementation of the Federal project "The success of each child" based on Syktyvkar University named after Pitirim Sorokin. Students can develop their abilities within the framework of studying additional educational programs: "Microbiology", "Introduction to Microbiology", "Biotechnology and cell Engineering", "Robotics"," Media Education in the 21st century: Adult media", "Programming in C++", "Development of computer games and multimedia". An important feature of the organization of the educational process in the "House of Scientific Collaboration" center is training in the creative space with leading university teachers and the development of research and engineering design works in cooperation with students (Murtazin, Istomin, 2020).

Twenty-two "Point of Growth" centers were created to implement the tasks of the Federal project "Modern School" in 12 municipal organizations of the republic, aimed at improving the material base and developing new methodological approaches to the study of mathematics, computer science, technology. It is planned to open 146 such "Point of Growth" centers in the Komi Republic by 2024.

Summing up, we note that new additional education centers allow preparing children for the effective and expedient use of modern digital technologies due to the developed digital high-tech educational infrastructure, as well as creating an initial base for advanced engineering education.

Conclusion

The digital transformation of AEC is currently taking place due to two factors.

First of all, this is the rapid development of end-to-end digital technologies in the modern industry, most of which are almost immediately introduced into the education system. The results of the study showed that many projects of the National Technology Initiative and the ideas of the "Digital Economy" National Project were reflected in the models and content of educational programs for the additional education of children.

The second factor of the digital transformation of additional education is the implementation of program initiatives of the Federal projects "Digital Educational Environment", "Modern School", "Success of every child" of the "Education" national project.

It was these factors that led to the formation of new AEC models, such as: "Kvantorium", "Point of Growth", "IT Cube", "House of Scientific Collaboration", "National Technological Initiative Circle Movement", etc.

We believe that the prospects for the digital transformation of additional education are associated with the advanced development of modern AEC resource centers and the creation of technical, methodological, and pedagogical conditions for achieving high educational results.

The results of the study allow concluding that the promising areas of digital transformation of the system of additional education are:

- Development of infrastructure of AEC institutions and digital educational environment with high-tech equipment;
- Modernization and updating of the content of educational programs following the directions of development of end-to-end technologies of the digital industry;
- Improvement of methodological approaches with the use of a team project approach, problem-based learning with a focus on success and achieving goals;
- Training and retraining of teaching staff with high professional competencies in the field of pedagogical and digital technologies.

Acknowledgments

The research was carried out with the financial support of the Russian Foundation for Basic Research within the framework of the scientific project 19-29-14169 "Development of regulatory and communicative educational actions of students in the conditions of digitalization of general and additional education".

References

Asmolov, A.G. (1997). Additional education as a zone of the nearest development of education in Russia: from traditional pedagogy to the logic of development. *Vneshkolnik, 9,* 7.

Builova, L.N. (2011). The essence and specifics of additional education for children in the modern education system of the Russian Federation. *Mir nauki, kultury, obrazovaniya, 6*(31), 134.

Deich, B.A., & Yurochkina, I. Yu. (2011). *Formation and development of out-of-school work in Russia: regional aspect: monograph.* Novosibirsk: NGPU.

Eberhard, A. (2016). *Industry 4.0: the computerization of manufacturing.* http://www.tekniker.es/en/industry-4-0-the-computerization-of-manufacturing

Evladova, E.B., Loginova, L.G., & Mikhailova, N.M. (2002). *Additional education for children.* Moscow: VLADOS.

Galchuk, A.A., & Sergeev, A.N. (2017). Using IoT technologies in computer science lessons at school. *Nauchnyi rezultat. Pedagogika i psikhologiya obrazovaniya, 4*(14), 25−29.

Gazman, O.S. (1998). *Play as a systemic need of childhood, in: Philosophy and pedagogy of vacations.* Moscow.

Geibl, E. (2019). *Digital transformation of school education. International experience, trends, global recommendations.* Moscow: Higher School of Economics.

Gerbert, P., Lorenz, M., & Rüßmann, M. (2015). *Industry 4.0: The future of productivity and growth in manufacturing industries.* http://image-src.bcg.com/Images/Industry_40_Future_of_Productivity_April_2015_tcm9-61694.pdf

Golovanov, V.P. (2004). *Methodology and technology of work of a teacher of additional education.* Moscow: VLADOS.

Murtazin, I.A., & Istomin, Yu. N. (2020). *Methodological features of teaching schoolchildren in the key center "House of Scientific Collaboration", in: Basic university in the regional education system: a new vector of development: materials of the All-Russian scientific conference.* Syktyvkar: SSU named after Pitirim Sorokin.

Novikova, N.N., Kuznetsova, T.A., & Konov, A.B. (2020). Technopark "Kvantorium" as a platform for the development of regulatory and communicative actions of students. *Shkola i proizvodstvo, 4,* 3−12.

Novikova, N.N., Kuznetsova, T.A., & Konov, A.B. (2020). *Features of the organization of educational and cognitive activities of students in the Center for Digital Education of Children "IT-cube",* in: Basic university in the regional education system: a new vector of development: materials of the All-Russian scientific conference. Syktyvkar: SSU named after Pitirim Sorokin.

Novikova, N.N., & Rumyantseva, A.I. (2017). Features of technological training of schoolchildren in the system of additional education in the city of Syktyvkar. *Scientific-methodical electronic journal "Concept,* 27, 124-128. http://e-koncept.ru/2017/574024.htm

Plakitkin, Yu. A., & Plakitkina, L.S. (2018). Programs "Industry 4.0" and "Digital Economy of the Russian Federation" – opportunities and prospects in the coal industry. *Gornaya promyshlennost, 1*(137), 22-28.

Savina, A.G. (2019). Trends in the development of the education system and science in the context of digitalization of society, *in: Digitalization of modern society: transformation factors, problems and prospects: monograph. Oryol: OryollGUET.*

Seledtsova, I.A., & Nikonova, V.A. 2017. Comparative analysis of the key features of the Industry 4.0 development in Europe, Asia, the USA and Russia. *Innovatsii, 11*(229), 15-21.

Speshilova, N.V., Tushkanov, V. Yu., & Bunin, N.S. (2019). Development of additional education in the Orenburg region in the digital economy, in: *Pedagogical skills: collection of articles of the 6th International scientific and practical competition. Penza: Science and Education.*

Tarasov, I.V. (2018). Industry 4.0 Technologies: Impact on Increasing the Productivity of Industrial Companies. *Strategic decisions and risk management, 2*(107), 62–69.

Testov, V.A. (2019). On some methodological problems of digital transformation of education. *Informatics and education,* (10), 31-36.

Uvarov, A. Yu. (2018). Digital Education: Towards Digital Transformation. Moscow: VShE.

Uvarov, A. Yu. (2019). From computerization to digital transformation of education. *Informatika i obrazovanie, 4,* 5−11.

Uvarov, A. Yu., Gable, E., & Dvoretskaya, I.V. (2019). *Difficulties and prospects of digital transformation of education.* Moscow: Higher School of Economics.

Uvarov, A.Y. (2019). Problems and prospects of digital transformation of education in Russia and China. *In II Russian-Chinese Conference of Educational Researchers" Digital Transformation education and artificial intelligence",* 38.

Zaslavskaya, O. Yu., & Kirillov, A.I. (2017). New Opportunities for Informatization of Education – "Internet of Things". Vestnik RUDN. *Seriya: Informatizatsiya obrazovaniya, 2,* 140−147.

Cesur, M.S., & Odluyurt, S. (2019). An investigation of the opinions and suggestions of parents and teachers about the teaching of play skills to children with autism spectrum disorders. *International Journal of Early Childhood Special Education, 11*(2), 128-140.