The Mobile Technopark Quantorium as a Leading Mechanism for Education Digitalization in Rural Russian Areas

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Summary
The Russian modern education system in the context of active digitalization is saturated with high-tech equipment and advanced models of education. By virtue of the state policy, the processes of creating various types of innovative educational centres have been launched. The article examines the problem of organizing affordable school education in the field of digitalization, knowledge-intensive and high-tech industries of the Russian economy. The innovative educational centres of the system of extracurricular education (the child development centre House of Scientific Collaboration, the centre for technical creativity of children Quantorium, the centre for digital education of children IT-Cube, the centre for the education of digital and humanitarian profiles Growth Point, the mobile technopark Quantorium) are described. The objective of this study is to determine the role of the mobile technopark Quantorium in creating conditions for bridging the “digital divide” and organizing affordable digital education for schoolchildren in rural areas. The challenges and opportunities of the development of the educational system digitalization in Russian rural areas are reviewed. The organizational, technical and pedagogical conditions for educational process realization in rural schools based on a mobile technopark are disclosed. The practical significance of the study lies in the possibility of using the data obtained to improve the learning processes of schoolchildren in the context of digital transformation and the development of modern technologies.

Keywords:
digital transformation of education, “digital divide”, digital educational environment, innovative educational centre, mobile technopark Quantorium.

1. Introduction

Accumulation and synthesis of technological solutions from various fields of economics, manufacturing, science and education lead to a synergistic effect ("convergent modern technologies") [1], contributing to the creation of a high-tech environment and the emergence of innovative products. In turn, the development of digital technologies in all spheres of human life contributes to the invention of new personnel training programs for the global technological leadership of Russia. Currently, innovative educational centres for schoolchildren are being established in all Russian regions: the child development centre the House of Scientific Collaboration, the centre for technical creativity of children Quantorium, the centre for digital education of children IT-Cube, the centre for the digital and humanitarian education Point of Growth, the mobile technopark Quantorium. In innovative educational centres, a learning environment is created for the development of engineering and technological creativity and the formation of competencies in the digital, knowledge-intensive and high-tech branches of economic activity.

High rates of development of information technologies are observed in megacities and large Russian cities where there is a high concentration of industrial enterprises, research centres and higher educational institutions. This point is due to the availability of a broadband Internet channel, a high concentration of ICT, information technology, and the presence of the scientific community. Trend reversal in a high dimension and low concentration of population in some Russian regions (rural areas) affects lower levels of digital skills mastering [2]. The reasons for the diversity in the level of information training of the population are the following: strong socio-economic differentiation between regions, obsolescence of the facilities, accessibility of sound academic background, quality of the Internet [3, p. 3167]. Researchers of the Russian Institute of the Information Society have invented the term "digital divide", which means "a new kind of ... differentiation caused by the possession of various possibilities of using advanced information and communication technologies" [4, p. 16].

The object of this research is the activity of innovative educational centres implementing programs of extracurricular education for children. The subject of this research is the organizational, technical and pedagogical conditions for organizing the educational process based on the mobile technopark Quantorium. The purpose of the study is to determine the role of the mobile technology park Quantorium in creating conditions for bridging the "digital divide" and organizing affordable digital education in rural areas.

The objectives are the following:

1) to identify the methodological foundations of the innovative educational centres' activity;
2) to analyze the peculiarities of the mobile technopark Quantorium functioning;
3) to recognize the organizational, technical and pedagogical conditions for the integration of the mobile technopark Quantorium into the educational ecosystem of rural areas.

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2. Literature Review

To create conditions for staff training in the field of digitalization and knowledge-intensive technologies, a majority of countries use various types of research environment: laboratories, incubators, accelerators, science parks, technoparks, etc. Researchers reveal the relevance of modern technological parks and their influence on the innovative development of society and the economy and, additionally, they draw great attention to a modern technological base creation for the training of future engineers [5,6].

In Russia, an essential role of children's technoparks Quantorium in the development of a new society type, where intelligence becomes an innovation driver of the country's economy, politics, education and the citizens' life, is noted [7,8]. The uniqueness of the educational system of children's technoparks for the self-determination of students and the future specialists training in the field of information technology, that have an effect on the development of various spheres of society, is observed [9].

Researchers highlight the primary role of innovative educational centres in the formation of regulatory and communicative learning activities, the development of special engineering thinking skills (hard skills) and meta-subject competencies (soft skills) [10-12].

At present, the role and place of an innovative educational centre in the education system are being considered from various points of view:

- a business incubator and a business accelerator for engineering and technology schoolchildren teams [13];
- a component of the educational and production cluster, integrating the organizations of formal, non-formal education and the economic sphere [14];
- the stage of implementation of the multilevel principles, versatility and variability of the educational system, taking into account the requirements of the strategic economic development and the individual demands in professional identity and self-determination [15];
- an integrative educational platform of the surrounding ecosystems, where the formation of the active learning value is carried out [16].

Many researchers study the peculiarities of project activities in the children's technopark Quantorium and the effectiveness of the project teaching method, that allows to involve the student in the problematics of the subdiscipline, solve major aspects and form purposeful competencies [17]. Special attention is paid to the increasing demand for innovative educational centres both in terms of the growth in the number of technoparks and the transformation mobility of the internal educational environment of children's technoparks [18]. Thus, in modern scientific researches, the leading role of innovative educational centres in creating a scientific, engineering and intellectual basis for effective economic growth and new approaches to teaching schoolchildren is regarded.

3. Innovative Educational Centres

Within a package of measures aimed at overcoming the "digital divide", it is conceivable to single out the activities of the national priority project "Education" on the establishment of innovative educational centres in the educational system of the Russian Federation. Innovative educational centres are being created in urban and rural areas based on universities, schools and organizations of extracurricular education for children (Fig. 1).

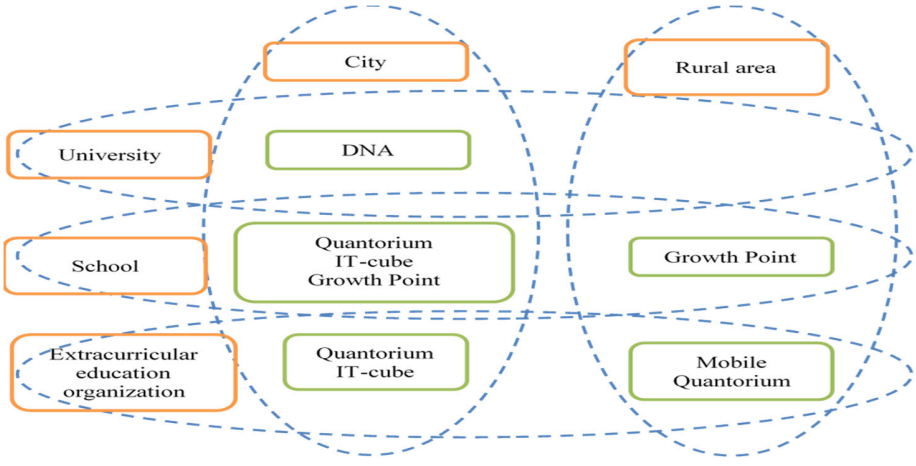


Fig. 1. Russian innovative educational centres

1. The child development centre House of Scientific Collaboration is created based on universities and is aimed at developing modern competencies of students by providing them with educational services using modern teaching methods and digital technologies; the formation of a new mindset of students who share the value of self-development throughout life and a conscious approach to education; development and maintenance of advanced

techniques, technologies and educational programs in collaboration with international and Russian companies.
2. The centre for technical creativity of children Quantorium is created based on schools and extracurricular education organizations and implements the main tasks: system implementation of scientific-technical education through engaging students in learning and practical application of knowledge-intensive technologies; ensuring the labour pool training for knowledge-intensive and high-tech sectors of the Russian economy; development and implementation of a new format of extracurricular education for children in engineering; providing systematic identification and further support of gifted children in engineering.
3. The centre for digital education of children IT-Cube is created based on schools and extracurricular education organizations and solves the following tasks: assistance in solving the problem of providing high-tech sectors of the economy with highly qualified staff; providing accessible IT education to students; interests cultivation in IT innovations through the implementation of new educational projects in cooperation with partners- enterprises and IT companies.
4. The centre for digital and humanitarian education Growth Point is created in schools located in rural areas and small towns and enables the following: the introduction of new teaching and upbringing methods at school, educational technologies that provide the digital, scientific, technical and humanitarian learning of students; updating the content and improving the teaching methods of the Technology and Informatics.
5. The mobile technopark Quantorium is established in schools located in rural areas and is aimed at providing accessibility to modern engineering programs for children from remote Russian areas; formation of project case studies integrated with several branches of education, possessing a completed product lifecycle, actualizing with the involvement of the business community resources.

4. Mobile Technopark Quantorium

To overcome the differentiation of development level of digital, engineering and technological education in rural Russian areas, centres for digital and humanitarian education Growth Point and mobile children's technoparks Quantorium are being created. Taking into account special aspects of the educational process organization, its equipping with high-tech facilities and engineering staff, the mobile children's technopark Quantorium becomes the primary tool for the formation and development of digital and technological skills of future engineers.
Researchers observe the overriding concern of the mobile children's technopark in overcoming digital educational differentiation between urban and rural schoolchildren [19] and reveal the uniqueness of the mobile technopark Quantorium as an engineering educational environment for the accelerated development of technical abilities [20]. The purpose of creating the mobile children's technopark Quantorium is to guarantee equal terms for the development of engineering creativity of children throughout Russia (in rural schools and schools located in remote areas) based on network interaction. The mobile technopark Quantorium is a mobile educational laboratory built on the basis of the KAMAZ truck (Fig. 2).

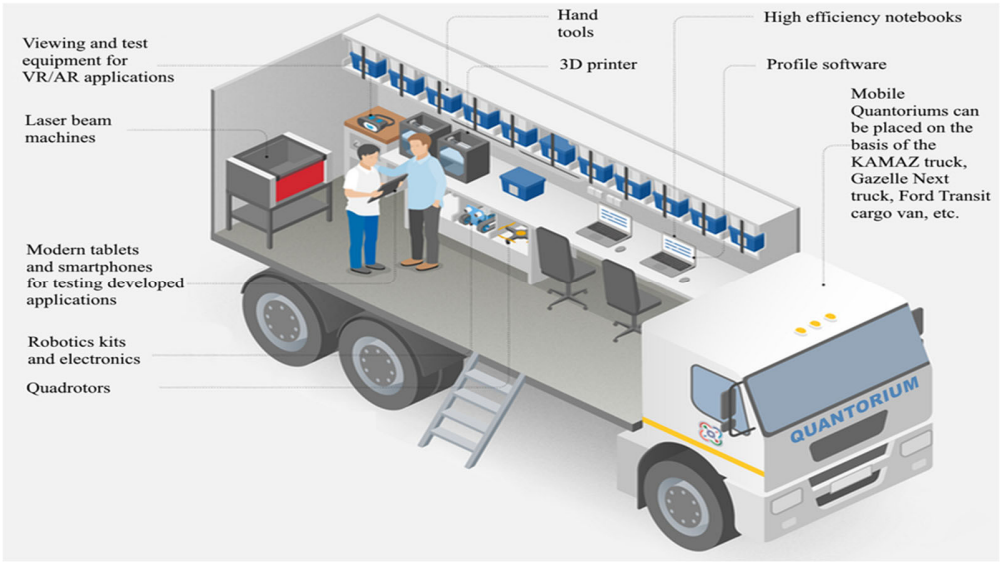
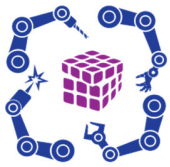


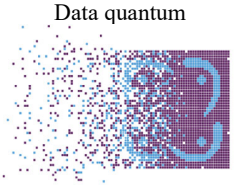
Fig. 2. The mobile technopark Quantorium

The mobile laboratory can reach out to children from remote areas with modern programs of engineering creativity. Annually, the mobile technopark's coverage involves 6 municipalities where training sessions of 36 days are implemented. Educational programs are made in a manner that distance work with students is organized between educational sessions. The equipment of the mobile technopark consists of a laser beam machine, 3D printers, a milling and engraving machine, soldering stations and electric engravers, jigsaws, measuring instruments and other hand-guided tools. Inside the laboratory, there are 6 workplaces equipped to perform the essential work related to the high-tech workshop, places are tooled up for transporting and storing computer equipment, construction kits, virtual reality systems, instruments and other equipment.

The before-mentioned facilities with high-tech equipment make it possible to implement educational programs based on it in the following areas: Roboquantum, Cosmoquantum, Aeroquantum, IT Quantum, Autoquantum, Data quantum, Data quantum, Geo quantum, Bio quantum, Energy Quantum, Hi tech, Industrial design, Virtual reality/ Augmented reality (Table 1).

Table 1. Directions of educational programs of the Quantorium mobile technopark

Educational program	Program summary
Roboquantum 	Students learn the basics of industrial robotics: mechanics, mechatronics, application programming, mathematical modelling, computer science (machine learning, technical vision, operating systems).
Cosmoquantum 	The students' immersion in diverse engineering fields of astronautics and the development of space system simulation models, studying the overall lifecycle of spacecraft creation.
Aeroquantum 	Studying the principles of aircraft operation, quadrotor engineering, air route development and its programming.
IT Quantum 	The acquisition of fundamental knowledge by students in the field of information technology as well as in promising areas: the Internet of Things (IoT), machine learning (ML), blockchain, information security and others.
Autoquantum	Studying the design features of vehicles, intelligent transportation systems, road traffic regulations and shipping rules, road safety management, design and programming of unmanned vehicles.

	
Data quantum 	Students gain skills in research planning and investigating the World Wide Web, quantitative and qualitative data analysis, identification and systematization of newsbreaks.
Data quantum 	Students' acquaintance with nanomaterials, methods of obtaining nanopowders and nanolayers, research and modification of material surfaces via close control equipment.
Geo quantum 	Students work with space images, aerial photography, GPS/GLONASS data and all the variety of spatial data, they develop 3D cities, face up to the challenges of ecology, history, marketing, urban environment, agriculture.
Bio quantum 	Students master modern methods of studying biological objects, learn to work with advanced equipment inside biological laboratories and in wildlife.
Energy Quantum 	Development of students' design skills on the example of energetics, familiarization with the primary energy sources and the energy system structure, energy projects development in the domestic region.

Hi tech 	Immersion of students in the basics of engineering, inventiveness, CAD/CAM systems, laser technologies, additive technologies, mastering CNC machines, electronic components, the basics of technopreneurship.
Industrial design 	Students learn to design the surrounding object world and interact with it, work at the intersection of engineering and art, solve applied problems and form a new perception, integrate manufacturability and aesthetics in one product.
Virtual reality/ Augmented reality 	Students master volume rendering, work with virtual (VR), augmented (AR) and mixed (MR) reality, develop educational applications, design simulators for future engineers, conduct virtual tours of cultural and historical sites, etc.

The distinctiveness of the equipment of the mobile technopark is the variability of the deployment of the educational process:

– based on traditional classes of rural schools, which requires making changes in the school's working hours and exempting some of the classrooms from the educational process to accommodate high-tech equipment in them;

– based on a mobile educational laboratory van, which requires its connection to the school's power supply network;

– a mixed-mode where both modifications of the educational process organization are used simultaneously.

It is essential to mention that under the conditions of deploying a mobile technopark based on rural schools, it is unavoidable to provide a whole range of organizational, technical and pedagogical conditions.

Organizational conditions include the following:

1) alterations in the school timetable for students (technology lessons should be held in the first half of the day, extracurricular educational programs of scientific and technical orientation should be held in the second half of the day);

2) grouping students in the fields of extracurricular education of the mobile Quantorium and enrollment them in extracurricular educational programs of scientific and technical orientation;

3) distribution of training facilities of the mobile Quantorium among the classrooms of the educational organization (as a consequence, several classrooms fall out of the school timetable);

4) scheduling for teachers of extracurricular education of the mobile Quantorium (fieldwork in the form of a business trip).

The technical conditions include:

1) connecting the electrical equipment of the mobile laboratory based on the KAMAZ truck to the power supply system of the educational organization (in case of studying inside the laboratory);

2) allocation of classrooms of an educational organization for temporary placement of educational equipment;

3) providing a functioning Internet channel for the students' and teachers' work;

4) ensuring the operability of equipment, its maintenance, content preparing for the educational process;

5) ensuring the safety of equipment and the security of students and teachers.

Pedagogical conditions include the following:

1) diagnostics of the formed subject and meta-subject skills of students and empirical identification of pedagogical tools for working with students;

2) formation of educational routes of students' progress depending on diagnostic results;

3) procurement of full-time and distance forms of the educational process, its psychological, pedagogical and methodological support;

4) development of digital educational resources following the curriculum and the needs of educational routes;
5) analysis of learning outcomes and adjustment of an academic program, etc.
In furtherance of these goals, teachers of the mobile children's technopark Quantorium are supposed to use various effective teaching methods, such as brainstorming, the method of holistic learning, the case method, the method of motivating immersion. The leading method of teaching in the mobile children's technopark Quantorium is the project method, which allows combining the above methods into a unified effective methodological system.
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It is worth mentioning that the mobile Quantorium works in close technical and pedagogical cooperation with the stationary technopark Quantorium and the centre for digital education of children IT-cube. As an effect of collaborative work, students and teachers develop and test the resources of a unified digital educational environment, guidance papers become the result of the teamwork of the whole teaching staff. For example, teachers of the training program "VR/AR application programming" of the mobile Quantorium and the centre for digital education of children IT-cube conduct collaborative masterclasses for teachers ("Holograms", "Acquaintance with the hardware of the training program of virtual and augmented reality", etc.), develop and provide expert evaluation of competitions (for example, in the activity areas of 3D modelling, programming of virtual and augmented reality applications), organize regional stages of the All-Russian WorldSkills and JuniorProfi competitions using the facilities conjointly. Furthermore, collective methodological events are held for teachers, specifically: seminars and masterclasses on the subjects "VR/AR and other incomprehensible letters", "Learning the basics of Unity to create an augmented reality application", etc. Intrinsically, informal methodological associations have been formed based on stationary and mobile technoparks Quantorium, and the centre for digital education of children IT-cube, where integration of teachers of educational programs of technical orientation is manifested.
Given the integrative association of teachers involved in various aspects of educational activities makes it possible to achieve high results in collective technical creativity with students. These are not only professional victories in competitions at the regional and federal levels, but also significant creative growth of students, expressed in the creation of innovative technical projects, as well as students' choice of further education in academic fields related to the successfully completed technical programs.

5. Conclusion

The creation of a training system based on the Quantorium mobile technopark stands at the beginning of the development of digital and engineering-technological education in Russia. The results of the study confirmed the high potential of the mobile technopark Quantorium in the implementation of the challenges aimed at ensuring equal conditions for the development of engineering creativity of children in rural schools, schools located in remote areas based on network interaction.

The mobile technopark is a unique educational environment for the self-determination of students, where special pedagogical conditions have been created (a modelling pedagogical environment - the technosphere, the structure of educational and developmental modules, project work in various group forms).

Students acquirements obtained during their stay in the mobile technopark Quantorium can be used in developing progress, improving and promoting the economy, politics, education of the country and life of citizens. The information and educational environment, including high-tech and digital equipment, plays a significant role in this process. A practical focus on the information study and knowledge-intensive acquirements will create a scientific, engineering and intellectual basis for further students' growth and their education at the university.

In the time following, to fully unleash the potential of the mobile technopark Quantorium, it is needed to improve the methodological system of the educational process, assess the effectiveness of pedagogical conditions for the development of children with creative engineering thinking, search for new forms of network interaction, and develop the integration of pedagogical resources.

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