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# Digitalization as a Purpose and a Means of Ensuring the Efficiency of Inclusive Education

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***Abstract***— *The purpose of the article is identification of categories, principles, methods and technologies of the virtual fund of scientific effects and tasks of inclusive education.* ***Research methods****: retrospective analysis of the development of digitalization of the educational process of inclusive education in Russia and abroad, conversations, analysis of portfolios, situations, experience of the authors of the article, assessment and self-assessment of bachelors, teachers, generalization and systematization of the data obtained; statistical methods, cluster analysis, questionnaires, analysis of parents' opinions on the conditions and quality of inclusive education, analysis of students' opinions on the conditions and quality of vocational training.* ***Research results****: the article provides a theoretical analysis and the analysis of the research results, which made it possible to: clarify the essence of digital technologies as a set of digital devices and information and communication technologies; identify assistive means for solving corrective and compensatory problems; categories of digital devices for solving the problems of inclusive education; identify the principles, methods and technologies of digital learning (e-learning) in the sphere of inclusive education, advantages and disadvantages of e-learning; models of organizing inclusive education using e-learning; free services, paid educational platforms, their capabilities, advantages and disadvantages in inclusive education; to identify the means of intellectual information support in the digital educational environment, the didactic potential of the educational platform; a virtual fund of scientific effects, providing educational and methodological support for the inclusive educational process, its architectural components; to determine the directions of the virtual fund of scientific effects. It is noted that the effectiveness and quality of inclusive education is provided by individual educational trajectories, a methodological resource that includes the best examples and practices, methods of educational activities in an electronic environment, online learning, and access to digital technologies. The experience of organizing distance inclusive education and inclusive group virtual learning has been clarified.* ***Conclusions and recommendations****: it has been proven that digitalization is the goal and means of ensuring the effectiveness of inclusive education; difficulties of students and the role of teachers as professional partners in their elimination were revealed; digital devices for solving the problems of inclusive education were identified. The principles, methods and technologies of digital learning (e-learning) are presented in the context of the interaction of students and teachers.*

***Keywords***— *Digitalization, inclusive education, digital technologies, digital devices; principles, methods, digital learning technologies, e-learning model, digital learning platform, educational portal, virtual fund, scientific effect.*

## I. INTRODUCTION

Inclusive education in modern society still does not sufficiently take into account the personal, psycho-physiological, cognitive characteristics and life needs of children with disabilities. We find confirmation of this in the World Report on Disability. It notes that "more than one billion people (15% of the population) have various forms of disability" [3]. This requires close attention to the development of the education system, which would ensure the realization of the potential of a person with disabilities in the context of modern information, communication and digital technologies. These technologies open up "the possibility of effectively solving life situations, searching for information, learning at any convenient time, building personal educational routes" [10, p. 53]. However, it is required to deeper understand the theoretical and practice-oriented directions of searching for effective models of digital transformation of the social environment of education.

We assume that: a) the use of software platforms and educational digital solutions in a mass school that have proven their productivity in other areas of activity; b) preparation of teachers of educational organizations: to master the new technological capabilities of educational and methodological complexes using electronic educational resources; to the use of interactive, multimedia and game components in the formation of educational tasks; to automated checking homework; c) the introduction into educational organizations of a virtual fund of science effects, that provide training and methodological support of the educational process, and monitoring of its impact will allow to transform the inclusive education optimally.

The purpose of our research is to determine the points of contact between digitalization and inclusive education, as well as digital devices, for solving the problems of inclusive education; to substantiate the principles, methods and technologies of digital learning (e-learning), means of intellectual information support in the digital educational environment and educational and methodological support of the educational process.

The turn of social interest to students who have health features that limit their social adaptation in the modern world is obvious. We are ready to help those who depend on others. We are reviewing norms, responsibilities in relation to each other, we learn to see and accept the other, to take care of the other.

Inclusion is aimed at recreating the disturbed social ecology of people with disabilities, restoring integral life

relationships that provide them with a comfortable "life autonomy", conditions for the most independent (autonomous) life of a student in society.

Inclusion in fundamental international documents, such as the Salaman Declaration on Principles and Policies for the Education of Persons with Special Needs and the Convention on the Rights of Persons with Disabilities, is presented as a chance for the whole society to get an opportunity to put the humanistic values of equal rights, freedoms and dignity of every person in practice. The world community has come to such an understanding of inclusion as a result of many years of struggle for the rights of people, for the rights of children, for the rights of persons with disabilities.

Through the processes of adaptation of the educational environment inclusion has the opportunity today to provide an adequate form of education for learners with special educational needs. Significant changes have occurred not only in the legal status of this category of students, a radical restructuring in the value orientations of the education and upbringing of "special" children is taking place.

Currently, we are witnessing the improvement of national education systems in the aspect of convergence systems for special and general education, in "schools for all children", due to the official acceptance of the idea of inclusive education the Salamanca Declaration (1994), which was developed as an innovative educational paradigm in most countries of the world. Thus, the concept of an "*inclusive school"* receives a status of an educational institution whose activities are aimed at introducing children with disabilities into the process of joint education with children of the norm in order to ensure their effective socialization and rehabilitation.

An example of such schools in Germany are the schools named after Roland (Bremen), Paul and Charlotte Knise (Berlin), that provide overcoming of dependence of school performance on social background; creating equal opportunities for students through long-term joint learning; combination of joint lessons in heterogeneous classes and individual forms of education; organization of school environment as a democratic space for learning and life; implementation of social interaction with all participants involved in the educational process.

In England, there are three main models for teaching disabled children:

1. "School activity" – involves changing the curriculum for a student with special educational needs.
2. "School activities plus" – implies the involvement of specialists to provide students with the necessary support. The training is built on the basis of the recommendations of a psychologist, speech therapist, defectologist and other specialists.
3. "The Act" – the student receives the "act on special educational needs", i.e. a document indicating the needs of the child and the special assistance that will be necessary for him in the learning process (in the event that a formal assessment has taken place). In this case, the child can study in a special school or choose a general education public school for himself [8, pp. 153-160].

In America, inclusive education is implemented in interactive and alternative schools, based on individualized programs for students with special educational needs.

The leading trends in the development of inclusive education abroad are revealed: the number of countries that have assumed new obligations in the field of inclusive education is increasing, large-scale projects are being initiated in these countries to implement inclusive education through educational reforms; foreign countries seek to overcome parental rejection of inclusion by implementing partnership programs to help and support the family of a student with disabilities.

Scientist outside Russia argue that a wide range of diverse needs of learners should be considered in terms of their pedagogical value, contributing to the choice of optimal measures to support and assist the learners, their individual progress and improve the level of professional competence of the teacher; there is a growing awareness of the need to design individual trajectories of education and upbringing of students with disabilities, aimed at making them progress in a broad context that is not limited to academic achievements.

Improving the quality of inclusive education is determined by how productively the early learning period is carried out and what preventive measures are taken. Modernization of educational programs involves the reflection of the specifics of work in an inclusive classroom, a practice-oriented character of the formation of the readiness of the entire school staff for inter-professional cooperation and continuous reflection [15, p. 299].

The development of inclusive education in Russia is often implemented in partnership between government agencies and non-governmental organizations. The initiators of the inclusion of children with disabilities in the learning process in the system of general educational institutions are associations of parents of children with disabilities, organizations that defend the rights and interests of people with disabilities, professional communities and educational organizations that work in an experimental and project mode.

Analysis of the current state of inclusive education in Russia makes it possible to distinguish four main models: "Regulation" (network interaction between educational organizations participating in the project is established). "New school" (the model assumes the creation of an existing school inclusive educational space, education which is built on fundamentally new approaches to teaching children with developmental disabilities. The initiative to create such a space can come both from representatives of the parental community and from a non-governmental educational organization, that provides educational services to students with disabilities. An important feature of the model under consideration is the presence of a *board of trustees* in the new school. It is a public organization of parents of students with disabilities. Its main function is to assist the school in solving the problems of inclusive education through the attraction of additional funds, participation in grant programs, supplementing the educational environment of the school with new objects, etc. One of the main conditions for the effective implementation of this model is the formation of an inclusive

school culture, ensuring support teachers, promoting their professional growth, disseminating the experience of the school). "Initiative" (the organization of an inclusive environment is implemented as a project of a public organization, specializing in the protection of the rights of persons with disabilities. After receiving a positive decision, a school is selected for the implementation of the project. The decision is agreed with the teaching staff of the educational institution. Further work is carried out in stages). "Director" (involves the creation in a general education school of an integration space for students with special needs to provide them with access to education. The initiators in this case are the principals of schools and directors of rehabilitation centers for working with children with special educational needs. On their initiative, a local experimental site opens on the basis of the school. A separate class "Special child" is created, a school premises are allocated for it. Third-party specialists and teachers with special skills are invited to work in the classroom, and training seminars are held for the teaching staff. The educational process for children with disabilities is carried out in an equipped separate classroom, and at break time interaction is organized between "ordinary" and "special" students. Parents of the "Special child" class actively participate in the work of the class, provide comprehensive support).

Analysis of domestic and foreign experience allows us to note that digital resources and technologies in inclusive education are still being implemented sporadically.

Our research assumes the solution of the following tasks: identification of digital devices for solving the problems of inclusive education; substantiation of the principles, methods and technologies of digital learning (e-learning), means of intellectual information support in the digital educational environment and educational and methodological support of the educational process; turn of social interest to students who have health features that limit their socialization in the modern world. We are ready to help those who depend on others. We are reviewing the norms and responsibilities in relation to each other. We learn to see and accept the other, to take care of the other.

*Theoretical bases of research*

Expanding the infrastructure of inclusive education in the context of the digitalization resources of the educational space requires a theoretical substantiation of the mechanisms of this area, the introduction of digital tools that ensure: *firstly*, the acquisition of skills and competencies in digital technologies; *secondly*, prompt reflection of changes in society in educational programs; *thirdly*, increasing the availability and quality of educational services. This is possible if, at the system level, the potential benefits of digital technologies for education and children with health limitations (disabilities) are used, and teachers act creatively in the digital environment (Yerevan Communiqué 2015 Web, International Council for Open and Distance Learning ICDE, European Research Institute of Economics of Education and Social Security).

Flexible and personalized support for the education of children with disabilities is created by training in educational institutions by using various web tools and platforms (ZOOM, Google Classroom, Microsoft Teams), elements of the play space (Discord platform). Analysis of the experience of introducing digital elements into the educational process requires solving the problem of developing digital literacy skills for children with disabilities and ensuring their sufficient access to an adequate digital infrastructure.

"In the current situation of forced online transfer of all levels of education, including secondary vocational education, it is necessary to promptly resolve issues of ensuring the quality of training teachers of secondary vocational education for the implementation of the educational process using digital technologies. The solution to this problem is planned to be realized within the framework of the projects "Creation of a system of interaction between secondary vocational education and higher vocational education, which meets the principles of the Bologna process, based on increasing the potential of teachers of secondary vocational education" (ALLVET)" [19, p. 91].

Let's turn to the theoretical foundations of digital technologies for the development of inclusive education.

According to K. Abbott, *the use of digital technologies for the development of inclusive education* is *"e-inclusion"*, [19, p. 71] i.e. digital technologies are a combination of digital devices and information and communication technologies.

Assistive (auxiliary) means in inclusive education are used to solve correctional and compensatory problems. Technical devices and software, alternative formats, for example, accessible HTML, audio-books, DAISI systems, etc. facilitate the perception of educational material, promote equal participation in the educational process of students with developmental disabilities [2, p. 134-135].

It has been proven that digitalization creates an accessible, adaptable learning environment in inclusive classes, eliminates certain barriers associated with sensory, motor, and behavioral disorders, and ensures the successful integration of students with developmental disabilities into the environment of healthy peers.

Let us single out the categories of digital devices depending on the solution of the *problems of inclusive education*: digital devices for training and revising; digital assistants in learning; digital devices to enable learning (K. Abbott).

*Digital devices for training and revising* provide the solution of certain problems (creation of special word processing programs designed for people who have difficulties in learning to write, programs for persons with intellectual disabilities to produce narrative statements, including the greeting, the main content and the conclusion). "Integrated Learning Systems", which are designed to develop children's arithmetic skills and literacy, are combined with diagnostic tools. These technologies help to: overcome the problems of violations in grammatical structure of speech by children with mental retardation; learn to express their thoughts in writing and see the grammatical errors made in specially designed programs. These programs offer several correct options, from which the child chooses the truly correct one. Such a program

allows tracking the progress of each student and prevents any opportunity to admit gaps in knowledge.

Today the digital devices have changed significantly. Hearing-speech simulators have been developed for corrective work on the development of auditory perception and for practicing the rhythmic-intonational expressiveness of children's speech. Hearing and speech training devices are also designed for children with visual impairments. The braille display translates the text from a specific font to a regular one, and it has a voice guidance.

*Digital assistants in learning* are designed to help and to create conditions for learning. These are means of alternative communication and communication amplifiers. For example, Hedo Reha Technik GMBH has developed the Hedo Scan K device for children with visual impairments. This device scans printed text and reproduces it through the built-in speakers. The device adapts to a variety of fonts and recognizes English, German, Italian, French and Spanish. One of the Mexican institutes has developed "smart glasses" that can work for about 4-5 hours without recharging and accurately recognize visual information, as well as the geographical position of a person. It should also be noted that today there are many applications that can help a child navigate in space and recognize objects around him.

For children with hearing impairments (deaf, hearing impaired, late deaf), there is a wireless sound transmission technology – a radio class. In one of the schools in Sydney, a new system is now being successfully tested. The essence of it is that the teacher wears a chest microphone that transmits sound to a special device, and then a special program converts speech into text and displays it on a laptop screen. Experts believe that this learning model is capable of revolutionizing the teaching of deaf children.

For children with speech impairments, scientists at the Norwegian University of Technology and Science have invented a device that allows children with voice impairments to speak. The technology is based on the electronic voice of the world famous physicist Stephen Hawking, who has lost the ability to speak as a result of an illness. Moreover, the Norwegians developed an electronic voice and, with the help of a computer, tuned it to make sounds like a child.

For children with musculoskeletal disorders, membrane keyboards with increased sensitivity and keyboards with enlarged keys were created [7, p. 105].

*Digital devices to enhance (enable) learning opportunities.* Inclusive education has the ability to "include" a child with a severe form of disability in the educational process with a group of students online, using modern information and communication tools (Skype, Avaya, Whatsapp, Viber, etc.). The Internet is a natural habitat for the modern generation. This is the generation of visual learners, and YouTube is their primary source of information that they believe is reliable and safe. The only way to help students is to teach how to search and process information. On his page in the social network, the teacher can recommend students to look at interesting information on their subject. You can give homework in a format that is interesting for children, for example, by posting it on Instagram. The main thing is to give clear instructions (explain what exactly must be done and what result we want to get from them).

Today, inclusion is reaching a new digital level. We can observe robots sitting down at the desks with ordinary students. This is a development of one of the companies Skolkovo (Russia). It allows children with disabilities not only to be present in the classroom, but also to walk along the corridor and communicate with classmates during breaks. Somatically weakened learners or those who cannot go to lessons every day use robots that replace them at the desk and at the blackboard, and they are controlled from home via a laptop. The robot has two cameras, so the children can see everything, what is happening in the classroom, and teachers see their face on the screen. The robot can "attend" any event and even participate in group work.

Digitalization involves the achievement of *educational and social effects* for inclusive education:

- *in the development of students* (personal orientation of the process);
- *in achieving a new quality of education* (digital skills, competencies for the adaptation of a disabled person in the modern world);
- *in the development of the learning environment* (a large number of communication ties with others, the influx of new acquaintances, knowledge, values);
- *in meeting the needs of society* (mobility and readiness for "lifelong learning") [1, p. 145];
- *cognitive* (when perceiving educational material through digital technologies);
- *content barriers* (the language of the work device or software does not match the student's native language);
- *didactic* (students are not ready to learn using digital technologies, and the teacher does not have the skills to facilitate in inclusive education);
- *financial* (costs for the latest technologies and software);
- *psycho-physiological* (loss of writing skills, creativity, ability to perceive large texts, screen addiction, decreased social skills).

The terms *"digital learning"* and *"e-learning"* are viewed by scholars as synonymous. In the Federal Law "On Education in the Russian Federation", *e-learning* is understood as the *organization of educational activities using information contained in databases and used in the implementation of educational programs that provide processing of information technologies, technical means, as well as information and telecommunication networks that provide transmission of communication of the specified information over lines, the interaction of students and teaching staff* [16, art. 16].

That is, *digital learning* is *teaching and learning using digital technologies.*

In our study, we adapted the principles of digital learning developed by T.N. Noskova [13, pp. 189-191].

*1. Principles associated with the person's activities:*

- *the principle of personalization of educational and cognitive activities* implies the ability of the student to choose the strategy of the educational process, the pace

and level of mastering the educational program in accordance with special educational opportunities and special educational needs. This approach will allow the teacher to track the personal development indicators and learning outcomes of the student;

- *the principle of the instrumental nature of the activities of the subjects of the educational process is* carried out on the basis of electronic educational resources;
- *the principle of interaction character of working with electronic educational resources* determines the resource's ability to respond to certain student actions in the process of mastering the content of the educational material. Interactive electronic learning resources (ELR) are aimed at the implementation of active forms of learning. In the simplest case, interactivity manifests itself already when you click on hyperlinks. More complex ELR allow people to make a virtual geographic journey with the choice of an individual route, to conduct a natural science (physical, chemical, biological, etc.) experiment with the ability to influence the objects and phenomena under study and receive responses.

*2. Principles related to the prospect of creating ELR:*

- *the principle of sensory multimodality of ELR* is a more detailed didactic principle of visibility and deals with visual, auditory and motor (kinesthetic) methods of perception in the educational process. For this, various devices are used, such as sensors, simulators, as well as VR-technologies;
- *the principle of semiotic polyphony of information in a digital educational environment* requires an excess of information resources to build an individual learning strategy. Such redundancy can be realized with the help of a network educational resource – a unified information educational environment;
- *the principle of cognitive compression with an increase in the amount of information in the digital educational environment* implies the elimination of information redundancy using hyperlinks, diagrams, tables, models, etc.

*3. Principles due to the peculiarities of the functioning of the digital educational environment:*

- *the environmental principle of teaching* determines the activity of an integrated model, which includes the internal objects of the environment and their relationship with the outside world.
- *the principle of open educational environment* is expressed, first of all, in the policy of accessibility. The ability to use information and educational resources regardless of the location of both the student and the educational resource or service that he needs, using modern information and telecommunication technologies.
- *the principle of complementary influences on the development of the subject of the classical and digital educational environment* implies strengthening the interaction and mutual influence of the subjects of the digital educational environment between themselves or the subject and the digital environment. That leads to positive effects, such as increased motivation for learning, cognitive activity and, as a result, the effectiveness of learning. The aggregate (collective, group, network) product is revealed here. It is characterized by a commonality of emotional-value, semantic and activity attitudes, new ways of thinking, increased reflexivity, involvement, as well as a high level of self-management of one's own educational and cognitive activity.

The need for psychological and pedagogical support for the student personality formation in a digital environment and the training of a teacher for the implementation of digital education becomes challenging.

## II. Research Methodology, Methods and Algorithms

The development of the strategy of inclusive education is carried out according to the system and activity approaches, the starting points of which were the ideas about:

- the integrity of the inclusive education system and its digitalization through the concept of "connections", which are systemic in accordance with the UN Convention "On the Rights of Persons with Disabilities", which calls for ensuring access to education without discrimination and on an equal basis with others [11, p. 5, art. 24];
- world trends in the informational support of the educational process;
- a set of connections, models of the educational process organization with the use of e-learning and their properties that determine the integrity of the structure and organization of inclusive education.

The methodological foundations for developing a digitalization forecast for inclusive education were skills that occur in the field of science and innovation. We considered "Prognosis of scientific and technological development of the Russian Federation until 2035", approved at a meeting of the Interdepartmental Commission for Technological Forecasting of the Presidium of the Council under the President of the Russian Federation for Economic Modernization and Innovative Development of Russia (December 17, 2013).

According to the purpose of our study, the leading methods as ways of orderly interconnected activities of students with disabilities and teachers have been identified methods that reflect the degree of independence and creativity in the electronic subject-content environment (information, communication, methods of management–self-management) of educational and cognitive activities.

The research procedure required a theoretical analysis of domestic and foreign psychological and pedagogical literature and analysis of the results of individual conversations, consultations, portfolio analysis, questionnaires, situations, the experience of the authors of the article, the assessment of teachers and experts, self-assessment, observations, feedback on practice, data systematization, as well as content analysis of the motivating digital environment, digitalization, Internet resources, online courses; crowd sourcing method for the formation of a model of digital transformation of inclusive education.

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Let us clarify the system of the level indicators of digitalization of inclusive education: the provision of an educational institution with modern computer and information resources; methodological, organizational and scientific support for the professional training of teachers; the level of professional informational and communicative competence of teachers; the degree of integration of digital technologies into inclusive education.

The digital transformation of inclusive education is a significant process of preparing students with health problems for life in the domestic and global digital reality.

The main idea of the study is that digitalization is the goal and means of ensuring the effectiveness of inclusive education in the interaction of technological innovations, pedagogical practices, methodological, organizational and technical readiness of a pedagogical college for digitalization.

## III. Research results

The essential characteristic of the concept of "teaching method" is consistent with the idea of the ways of educational interaction with students. When organizing synchronous communications in an electronic environment, a certain reduction in teaching methods was required, since communication is technically vicarious. Transferring their professional experience to the electronic educational resources of the environment, the teachers transferred their teaching functions to it. Therefore, classroom teaching methods have been transformed into pedagogical methods of the electronic educational environment. The center of the practical implementation of e-learning methods was not the teacher, but the student who independently interacts with the resources of the environment and its subjects in solving the planned learning problems.

*The e-learning method in our study was a way of organizing pedagogical experience in an organized, created and supported electronic information environment for students' independent activity in achieving the set educational goal.*

The general scientific concepts of an electronic educational environment focused on the intersection of informatics, pedagogy and psychology were: *information* (transmitted experience captured in electronic educational resources); *communication* (information exchanges through telecommunication channels); *management of* educational and cognitive activities.

According to these concepts by T.N. Noskova, we identified three groups of methods: *information methods* (implemented by means of electronic subject-content resources of the environment); *communication methods* (implemented by means of electronic communication); *methods of management* (management (self-management) of educational and cognitive activity) [14, pp. 127-131].

Let us dwell on their brief description.

*1. Information methods* provided design and creation of subject-content electronic resources (subject content, algorithms of educational activities of students). Didactically, the content of training was enriched, transformed through the use of software and hardware: multimedia capabilities, interactive human-machine interaction, VR, etc.

*2. Communication techniques* provided the organization of information exchange and communication interactions between learners, set algorithms for actions in solving the assigned tasks (communication on the interpretation of knowledge, the formation of teamwork skills, in solving situational problems).

*3. Management methods* contributed to the quantitative and qualitative analysis of the educational activities of students in the process of creating conditions for feedback in the electronic environment of interactions.

According to our experience, digital (e-learning) technology is a learning system using information and electronic technologies through the Internet and multimedia tools. E-learning has provided a special organization of the educational process with the help of:

- information contained in databases and used in the implementation of educational programs;
- information technologies that facilitate information processing;
- technical means and information and telecommunication networks that ensure the transfer of information, the interaction of participants in the educational process, an independent search for means, methods, learning ways.

This allowed: to expand the use of e-learning and distance learning technologies in all areas of training; to form open educational resources; to create multiplatform and open resources of information and educational electronic environments; to transit from LMS systems to TMS educational management systems.

*E-learning technologies* in inclusive education have included a wide range of applications and processes that provide learning based on the use of information, telecommunications and web technologies. It covered the whole range of activities, from supporting the learning process to delivering educational content to educators, in particular, and distance learning technologies.

Let's single out the significant advantages of using e-learning and distance learning:

- clear structure of the educational material and ample opportunities for the presentation of educational information;
- the use of color, graphics, sound, all modern multimedia tools allows to recreate the real environment of activity;
- a computer can significantly increase the motivation for learning. Motivation is increased through the use of adequate encouragement for correct problem solving;
- multimedia tools (for example, gamification) involve students in the educational process, contributing to the widest possible disclosure of their abilities, enhancing mental activity;
- effective feedback. Multimedia tools allow us to qualitatively change the control of students' activities, while providing flexibility in managing the educational process.

Along with the wide possibilities of e-learning, its limitations have been identified:

- the need for a student to have minimal knowledge of computer technology and the ability to use the Internet;
- motivation of students in order to improve the quality of mastering the material;
- dependence on technical infrastructure (technical failure can lead to disruption of training);
- lack of a sufficient number of specialists in the field of e-learning;
- complexity of compilation and high investment in electronic educational content.

Among the models for organizing the educational process using e-learning, we highlight the following: training with web support; blended learning; online training.

*Web-supported training* required up to 30% of the time to master the discipline in an electronic course environment, in addition to the main traditional educational process to solve the following tasks*:*

- organization of independent work in an electronic environment (electronic materials for self-preparation, preparation for laboratory work using virtual laboratory complexes, self-testing, etc.);
- conducting consultations using forums and webinars;
- organization of current and intermediate control of students;
- organization of students' project work in an electronic environment.

*Blended learning* was based on the integration of classroom and extracurricular learning activities using and complementing traditional and e-learning technologies. 30–80% of the time for mastering the discipline was devoted to work in the environment of the electronic course, including lectures, practical exercises, laboratory work.

*Online learning* (full electronic, distance) required that 90-100% of the educational process was carried out in an electronic environment through the interaction of students, both with the teacher and with each other. Classroom meetings were used to conduct consultations on the discipline, individual work with trainees, laboratory workshops, current and intermediate certification.

Distance learning was carried out on educational platforms:

- https://resh.edu.ru (The Russian Electronic School) – a product of the "Education" project. The service was loaded with 120,000 video lessons, a virtual laboratory, tests, assignments, a library;
- Yandex Textbook – a service with 45,000 tasks on Mathematics and Native language with assessment of tasks;
- Uchi.ru – an educational platform with all school subjects, programming, preparation for the State Exams and Olympiads, online lessons on the air;
- Foxford – an online school with teaching materials, courses, tutoring, and the ability to become an extern student;

In the course of inclusive education, TOP-10 platforms for free distance learning were used:

- https://your-study.ru/ – a Russian platform for conducting lessons at a distance. To start the educational process, it was necessary to register. Each company hosted training materials and exercises. The service was focused on practical work. A convenient grading and resting systems, the ability to upload and comment on files, a register, a forum, an event feed and a resume were used.
- Moodle – a platform with an advanced toolbar. Teachers could monitor the progress of students, work with the service on the phone. If there were any questions about the site, parents could instantly get answers. Moodle helped to track the achievements of students, supported multimedia mode. The teacher could create courses, work on the phone. There is also a community of users that can be used during educational process.
- ATutor – a system with simple and understandable tools, notifications and grading for teachers, the ability to keep statistics, use assessment tools, enable the integration of questions.
- Eliademy – a partially free platform, including premium accounts for students, a smartphone application for the use of various gadgets. The process of uploading files and creating courses is simplified.
- FormaLMS – a rich remote learning platform with classroom, managers and calendars, it provides detailed knowledge analysis, statistics and reports on lessons and progress.
- Dokeos – a service with templates, authoring tools for conducting classes in small groups, individual lessons. The system helps to easily and quickly create lessons, there are training videos also.
- ILIAS – a universal and open system that allows remote or electronic lessons.
- Opigno – a platform with a class schedule, forum, authoring e-learning tools and online lessons.
- OLAT – a system with a student home page, timetable and notification. A platform with advantages in the form of bookmarks, file storage, browser compatibility.
- iSpringOnline – a platform that allows to create e-courses with various files, edit them, upload a lot of information, carry out detailed statistics and a desktop demonstration.

In the course of operational control, students had the opportunity to characterize digital devices depending on the objectives of inclusive education: they determined the rules arising from the principles of digital learning; clarified the advantages and disadvantages of e-learning for students with disabilities.

Here are some data from a mass survey of college students (300 people), characterizing the essence of the educational platform. According to the method of the unfinished sentence about the students, it was suggested to add: "The educational platform is ...". The task was to reveal the nature of knowledge about the educational platform, as well as the principles of constructing practical and controlling materials (interactivity, adaptability, informational openness and remotability).

It was found that 50.3% of students noted that the educational platform is a personality-oriented information platform on the Internet; 15% wrote that it is specially created for the interaction of teachers and students; 10.2% wrote that it ensures the continuity of the learning process; 8.1% pointed that it contains practical and control materials. These data were obtained in the first year of study, when students were just beginning to get involved in Internet practices. The level of occurrence of the concept "educational platform" in the everyday life of students was recorded using various methods: included observation, conversations with teachers and students, self-diagnostic ladder scales. Thus, at this stage, insufficient knowledge of the phenomenon of "educational platform", its weakly expressed methods of remote interaction, procedures for creating and placing educational materials, checking and evaluating assignments were revealed.

Considering that one of the main requirements for educational platforms was the competent organization of its architecture, we suggested that students add the following sentence: "The architecture of the educational platform is aimed at ..." and answer the question "When did you first get to know the platform?".

Analysis of the answers showed that 64% of students note that the architecture of the educational platform is aimed, first of all, at ensuring equal accessibility to educational resources; 28% emphasized that they understood the direction of the architecture of the educational platform, but found it difficult to explain why and how. And only 18.3% noted equal accessibility to educational resources for students with disabilities.

As for the first acquaintance of students with the platform, 71% noted that the platform was familiar to them, 71% noted acquaintance through the perception of their interest; 22% demanded that it be modern and understandable; 72% emphasized the importance of the attractiveness and simplicity of the interface in management.

The digital platform of the college bit-education56, realizing educational functions, at the same time made it possible to track the individual trajectory of development through measuring the progress and effectiveness of learning by means of point-rating, share and percentage scales. As a result, each user of the system in his personal profile had the opportunity to view the current learning results.

One of the interesting points of the digital educational platform was its multimedia content. All types of lessons were divided into two logical groups: theoretical (requiring no additional actions from the user, except for familiarization) and practical (requiring the user to perform certain actions after acquaintance).

The theoretical lessons contained not only textual information, but also images and video resources. The theoretical lessons provided for the possibility of downloading educational resources for further work with them. The theory was usually presented in audio formats, *Portable Document Format (PDF), Google Document, Web page.*

Informational and methodological support of the educational process in our experience was the *virtual fund of scientific effects*. This is an educational, methodological and reference tool implemented on the basis of modern Internet technologies. Substantially, the virtual fund was a collection of productive knowledge describing various scientific effects as indicators of the possibility of meeting the needs of subjects for new information and its repeated use in the form of heuristic strategies, tactics, methods, techniques, laws and patterns of development of modern technology [4, p. 121].

The virtual fund as an automated information retrieval system, functioned in the global Internet, contained a set of systematized descriptions of scientific effects, representing a large-scale information array (database), a kind of Internet storage that includes means of formation, presentation, search, and selection of descriptions on the basis of modern information and communication technologies.

In our experience, the virtual fund was used in the educational process in training in various scientific disciplines in the framework of educational and extracurricular activities in self-preparation and preparation for control and certification materials.

For the convenience of using the virtual fund of scientific effects, it contained a user-friendly navigation panel that allows to enter search formalized and extended queries, call up a general alphabetical catalog of scientific effects.

Any scientific effect was necessarily accompanied by an animation formed according to unified rules that visualized the essence of the effect in an information model, accompanied by a graphic illustration with text descriptions and was necessarily supported by links to printed and electronic sources.

Conventionally, the virtual fund of scientific effects was subdivided into two spaces: a common terminological space for experts preparing formalized descriptions of effects, and the space of users of the fund who make inquiries to search for scientific effects.

For the first type of space, special software was used to support the formation and execution of search queries, as well as collect statistics on queries and calls to descriptions of effects.

For the second type, traditional search tools were implemented, which made it possible to find documents whose indexed components contained words or phrases specified in the query.

From a functional point of view, the fund played the role of an educational and methodological system containing a systematic and organizational system of theoretical and practical materials. That is, the virtual fund was a modern reference system describing a variety of scientific effects and phenomena.

The implementation of the virtual fund was multi-platform. It was run with the use of open source software. Initially, the software and information components of the foundation were formed in the database and then converted into HTML format to ensure the interaction of the end user with the resources of the foundation through a web browser.

It was revealed that the use of the virtual fund in solving educational problems contributed to an increase in the effectiveness of inclusive education and an improvement in the quality of training of students due to the systematic

presentation of a variety of scientific effects related to different sections of scientific disciplines, establishing links between scientific productive knowledge traditionally acquired in isolation from each other, and also in the process of using modern information and communication technologies, providing new didactic opportunities.

Let us point out the directions of the development of the virtual fund of scientific effects of the college: continued filling of the fund's knowledge base in various scientific disciplines; inclusion of the fund in the components of the educational portal on natural sciences (http://en.edu.ru); implementation in the virtual fund of the function of generating educational-training tasks to support their implementation and an automated mechanism for controlling knowledge.

In our experience, the virtual fund was used as a unified information system and as a repository of high-quality educational content.

## IV. CONCLUSION

The paper presents the results of a study of digitalization processes in the system of inclusive education. The practical application of e-learning methods for children with disabilities has been substantiated.

The e-learning technologies have been identified, which made it possible to form open educational resources, multi-platform and openness of information and educational electronic environments, to ensure the transition from LMS systems to educational management systems TMS.

The functioning models of the organization of the educational process (learning with web support, blended learning, online learning) successfully fit into inclusive education, e-learning, as a component of an accessible environment, determine the individual trajectory of learning, an assessment of the achieved learning result, taking into account its specifics in persons with disabilities.

The use of the Top 10 platforms for free distance learning provided students with the reception and transmission of information in accessible forms.

The means of intellectual information support in the digital educational environment helped to overcome the psychological discomfort of students with disabilities, provided their motivation for learning.

The author's model of a digital educational platform (Fig. 1) is a pedagogical guideline for modern and safe inclusive education of students with disabilities.

We have learned to educate the mind of children with disabilities well. How can we help their hearts beat in unison with the spiritual world, which uplifts and ennobles personal needs, opportunities and abilities? This is a problem that we need to solve as a priority, relying on domestic and foreign experience.

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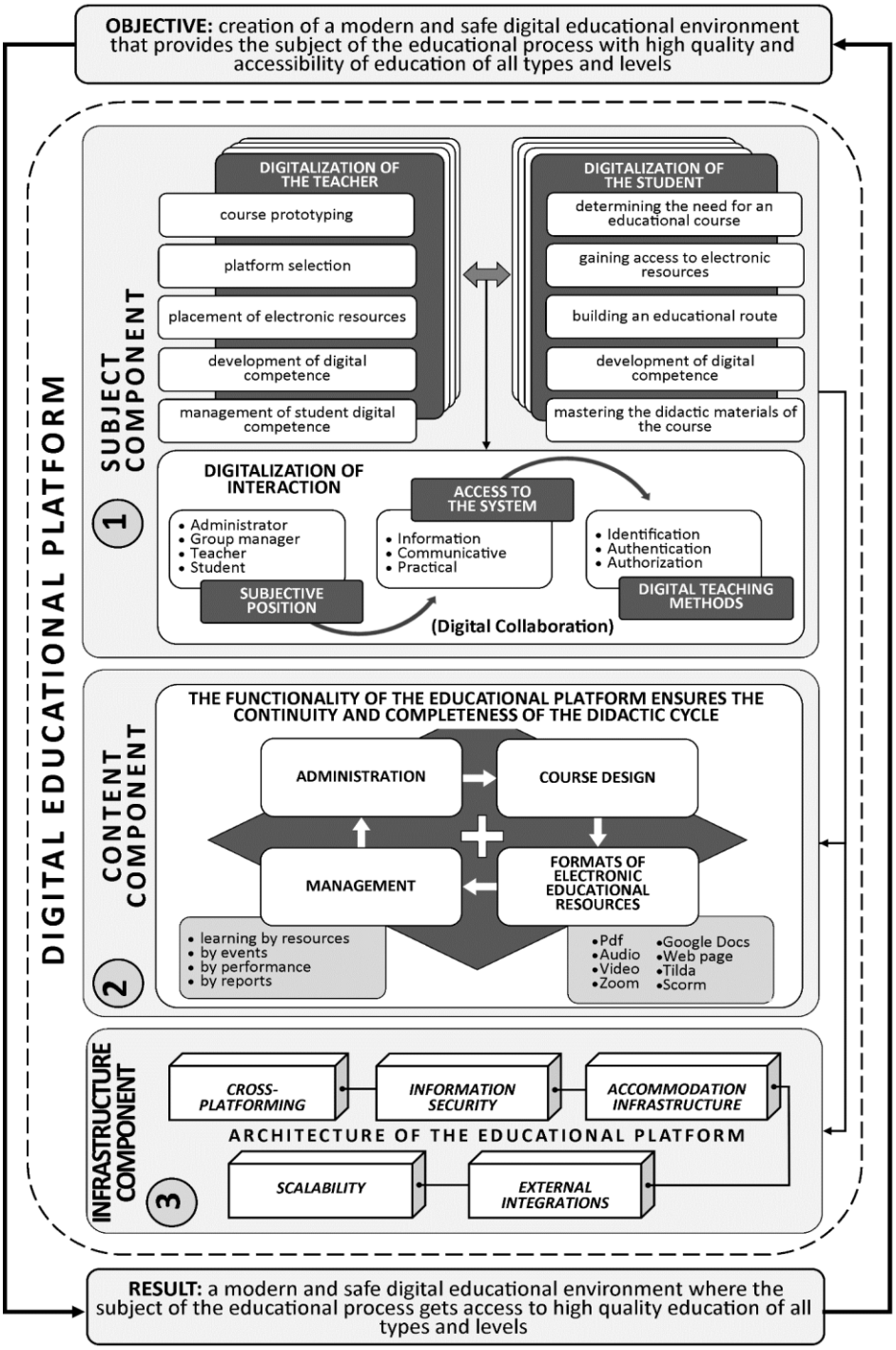


Fig. 1. Model of a digital educational platform