Management of Digital and Intellectual Technologies Integration in Education Informatization

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Abstract **– The aim of the study is to analyze, systematize, and formulate scenarios for managing the integration of digital and intelligent technologies in the informatization of education based on the influence of the factors of the existing external environment. It was shown that digital transformation is a process of digital technology integration into all aspects of business activities, requiring fundamental changes in technology, culture, operations, and principles of creating new products and services. Simulation models of digital and intelligent technologies in informatization of education are proposed. Possible scenarios for the development of the education system are described: inertial and transformational. A new viable base scenario is proposed, which can be called a divergent, or school dilution scenario. It is illustrated that these three rather general scenarios show the possible place and role of digital and intellectual technologies in the changes taking place in the informatization of education today.**

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1. Introduction

The introduction history of digital and intelligent technology has a short period, but we can already identify its main stages: computer literacy, the use of digital and intelligent technology in the educational process and informatization of education. Changes occur not only at the level of concepts, but also shift the emphasis in the use of technology. If the digitalization of the production sphere has clear directions of development, the education sphere raises a lot of questions and problems.

A characteristic feature of the education informatization system is the emergence and use of formed concepts, which have many meanings and interpretations. Quite free interpretation of concepts is not only a semantic problem, but also causes didactic problems in education, when teaching methods and techniques are developed that do not solve pedagogical problems, but exacerbate them. In the world of digital technologies there is a tendency to define new concepts, that is, to form a general idea of something with group responsibility for the results of theoretical generalization. Thus, digital transformation can be defined as the process of integrating digital technologies into all aspects of business activities, requiring fundamental changes in technology, culture, operations and principles to create new products and services.

If we talk about the possibilities of digital and intellectual technology integration in informatization of education, they can be formulated in the format of principles: accessibility, expanding the visual range, expanding the spatio-temporal continuum, etc.

Then the correctness of the definition of digitalization as the improvement of existing processes by implementing IT, optimization and reengineering, as well as data analysis for decision-making is not in doubt [1].

It makes sense to cover possible risks more broadly. The existing risks can override all the advantages of widespread implementation of gadgets in educational practice. Researchers propose distinction of informatization and digitalization. They formulate a correct definition, different from most other approaches: informatization of education is the provision of training, education and development processes with relevant information and effective means necessary to work with it [2].

Informatization changes the content and activity aspect of the educational process. Adaptation in the information society requires the formation of personal qualities that will allow:

- critically relate to incoming information;
- structure and systematize information;
- reduce the time for searching for necessary information using computer and network technologies; etc.

Unresolved problems of integrating digital and intelligent technologies into the informatization of education can exacerbate the systemic weaknesses of the existing education system. The emergence of the concept of digital divide demonstrates the growth of inequality in education, which may subsequently lead to social inequality as well. This problematic is seen as the need to expand access to the Internet, while the main risks arise not in access to content, but in the ways of doing things. On the one hand, the illusion of equality in education is created by opening access to content; on the other hand, there is an escalation of primitive content, which entails a decline in human intellectual capacity.

2. Methods

The relevance of the issues under consideration determined the choice of the conducted research topic, the formulation of its goal and the impact on the methods used. Thus, the study purpose is the analysis, systematization and formulation of integration management scenarios of digital and intellectual technologies in informatization of education based on the factors influence of the existing external environment.

The achievement of this goal is carried out by solving the following tasks:

- conducting an analysis of scientific publications on the introduction issue of digital and intelligent technologies in the educational system;
- presentation of scenarios to describe the education system development;
- development of three scenarios of digital transformation of education;
- justification of the proposed scenarios for managing the integration of digital and intelligent technologies in the informatization of education;
- justification of transitions between scenarios of management of integration of digital and intellectual technologies in informatization of education;
- development of an algorithm for the transformational scenario on the basis of anticipatory research and development.

The principles of dialectical logic, unity of logical and theoretical, system analysis, problem-target approach, methods of classification, expert evaluations were used to solve the problems of the study.

3. Results

Until recently, the process of computerization and informatization of the education system was dominated by inertial changes, a closed educational architecture and the chronoscope of the class-lesson system, which supported the traditional organization of the educational process. The introduction and use of the integration of digital and intelligent technologies in the informatization of education took place at the level of replacement and/or improvement, which did not provide noticeable improvements in educational results.

3.1. Scenarios to Describe Development of Educational System

It is important to note that today the $165 billion global EdTech market is also growing at more than 5% per year [3]. The consequence of this process is the development of the script as a tool. The scenario as a tool for describing the processes of development of large systems is well known to researchers in the field of education. Currently, it is a recognized tool for studying and consolidating various ways of implementing pedagogical innovations. Abroad, scenarios are widely used in planning the development of education and assessing the prospects for its development [4].

Traditionally, scenarios of educational development are usually considered as a narrative of possible directions of development of this or that phenomenon [5]. They are used for the purpose of shaping public opinion and are rarely used as a tool to support decision-making.

Several years ago, four possible scenarios were proposed during the discussion of possible directions of educational development: restorative, stabilizing, modernizing, and innovative [6].

The authors discussed the changes that could occur in the informatization of education. At present, the development of a scenario approach to study changes in education has formed into an independent technique [7].

Scenarios are used as a tool to:

- forming a common (shared by all) vision of the processes developing in complex systems;
- supporting (formation) the public discourse;
- decision making, description of the emerging contexts and preferable ways of their implementation.

The first step in scenario development is to map (outline) the subject of analysis as carefully as possible in order to focus properly the entire development. The next stage is the selection of problems such as:

- identifying the changing object;
- key actors identification or parameters affecting (reinforcing, inhibiting) the changes taking place;
- comparison of the dynamics of these parameters to identify undesirable trends and analysis of the real situation to identify signals of change;
- definition of the strategy of the main actors.

The next phase is the scenarios development - their description and identification of possible action plans.

Development of a detailed scenario to analyze possible directions of integration of digital and intellectual technologies in informatization of education is a large in volume and quite complex research project. Its preparation and implementation is critical for education. The purpose of the proposed generalized qualitative scenarios is to fix possible basic trends of digital and intellectual technologies in informatization of education. Their highlighting should help in the formation of a common vision of the processes of the ATC, serve as a tool for public discourse, understanding of emerging problems and discussion of the ways to solve them. It is hoped that the emergence of such a discourse will make it possible to realize the importance of works on the construction of full-fledged simulation models of digital and intellectual technologies in the informatization of education. Such models make it possible to analyze scenarios of educational development in those or other specific conditions using quantitative data, to identify the possible consequences of individual projects of educational system development.

Simulation models of digital and intellectual technologies in education informatization can be built using big data technology, collected from all sources of information in the digital educational environment.

The emergence of such models will help transform management based on willed decisions into management based on data. The development and implementation of such models in the work of educational authorities at all levels (together with the automation of data collection and processing) is the main contribution of digital and intelligent technologies to the development of educational policy and improvement of educational management.

The construction of practically meaningful mathematical models of digital and intelligent technologies is a promising research task. The proposed consideration of scenarios is one-step in this direction. Identification of the changing object for construction of generalized qualitative scenarios of digital and intellectual technologies integration in education informatization is considered in the first three sections of this work. Various scenarios are discussed including in connection with the paradoxical inconsistency between the intensive development of the EdTech market and the lack of noticeable influence of the introduction of digital and intellectual technologies on the educational organizations performance. Let us assume that the formation of the digital economy and digital and smart technology is inevitable. This transformation can be managed if educational policy makers competently lead this process, or, otherwise, through a disaster. The formation of discourse in discussing how likely and desirable the proposed polar scenarios are is the expected outcome of this paper.

3.2. Three Scenarios for Education Digital Transformation

We consider it important to note that the main object in the construction of scenarios is an educational organization with an established traditional system. An interesting fact is that since its inception in the early 17th century, taxpayer-subsidized education has constantly changed following and with changes in society itself. However, all this time, the system of general education has been extensively developing, keeping at its core the classroom-training model of education. The volume and duration of education grew; universal compulsory education was consistently introduced in primary, then basic and secondary schools. At the same time, the traditional organization of education was reproduced without significant changes. As a result, a large hierarchical (bureaucratic) system was formed, which ensured the fulfillment of the tasks of universal compulsory education. Despite the constantly renewed criticism (see, for example, [8]), this system somehow solves the access problem to universal education.

In developing possible scenarios, it is logical to proceed from the fact that there are two main options for the development of the system:

1) inertial, in which under conditions of scarce resources in providing transformational processes dominates the desire to centralize decision-making to preserve the existing achievements in terms of universal education and equal access for all to quality education. In this case, the necessary and inevitable changes will take place gradually, by themselves at the expense of the efforts of school employees in the field;

2) transformational, in which educational organizations new models or systems are purposefully developed, tested and disseminated, which should:

- solve the problem of the quality of general educational training of each and every learner;
- provide the solution of the problems of education, formation of the ability to self-education (development of learning activities), as well as key competencies required for participants in the digital economy, as well as to create conditions for continuous education of the general population.

It is natural to expect that tensions in the traditional educational system will increase if the inertial scenario is realized. Energetic actors from the knowledge industry, which is forming today in the digital economy, will integrate into the education market in order to relieve growing tensions, compensate for deficiencies in traditional education, moreover, form the required competencies in students outside traditional educational programs. Thus, the third basic scenario is formed, which can be called the divergent or school blurring scenario (Table 1).

Table 1. Three Basic Scenarios of Integration of Digital and Intellectual Technologies in Education Informatization

Name	Peculiarities of the scenario
Inertial	The traditional (averaged) model of education organization preserved, supported by a centralized bureaucratized education management system, whose work is increasingly formalized. Digital and intellectual technologies help implement solutions made from above, increase control, and guarantee the uniformity of tested educational materials and methodological solutions.
Transformational	Educational institutions are becoming cultural centers for local (and/or professional) communities, mobile schools, and places of lifelong learning and personal development. Digital and intellectual technologies help overcome formalism in education, expand the framework of the classroom-task work system to result-personalized organization of the educational process.
Divergent	Networked educational services, local and networked educational communities are developing. Digital and intellectual technologies help to expand educational opportunities outside of traditional educational organizations, using family education and networking educational services.

These three rather general scenarios show the possible place and role of digital and intelligent technologies in the changes taking place in the informatization of education today.

Highlighting several competing scenarios shows that the future is not predetermined. Comparison of the scenarios of digital and intellectual technologies in informatization of education with the scenarios of the package of key measures [9] shows that, unlike the latter scenarios digital and intellectual technologies are not recommendatory, but analytical in nature (Table 2).

Table 2. Comparison of scenarios of digital and intellectual technology integration in informatization of education and scenarios of the key measures package

Scenarios of digital and intellectual technology integration in informatization	Scenarios of the key measures package [9]
Inertia	Restorative. Stabilization .
Transformational	Modernization. Innovative
Divergent	—

Scenarios of integration of digital and intellectual technologies in informatization of education are highlighted on the assumption that there are many variants of educational system development.

As shown in Fig. 1, each of these scenarios describes a whole class of possibilities (variable scenarios).

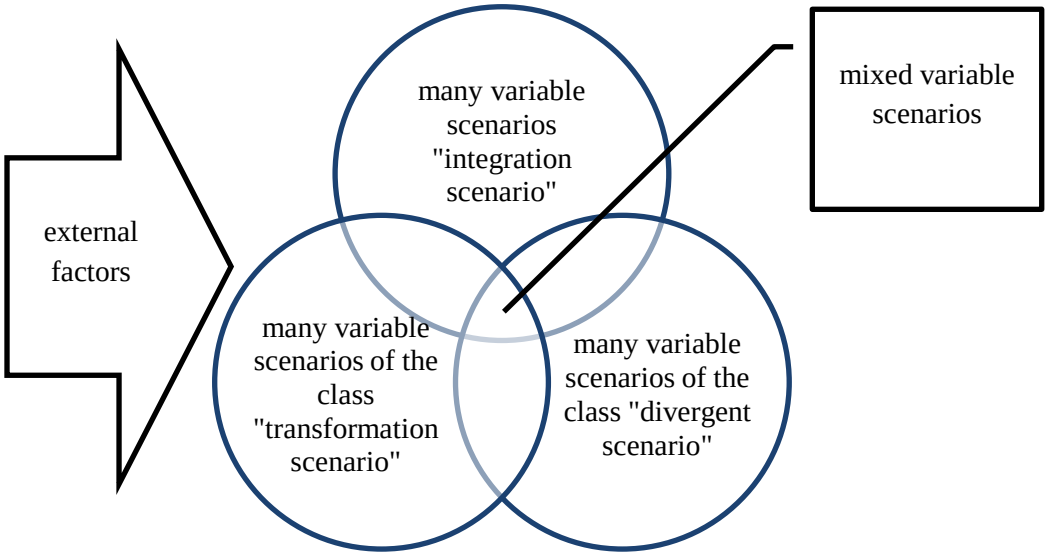

Figure 1. Three groups of variable scenarios

It is important to note that researchers and leaders in education, unlike researchers and leaders in other industries, pay little attention to the development and use of serious (non-speculative) tools for assessing the long-term consequences of decisions. The development and discussion of limiting scenarios can become a tool for identifying (forming) a unified picture of strategic goals and long-term changes in the educational system, for identifying the desired and possible future in the context of the integration of digital and intellectual technologies in the informatization of education. When preparing the scenarios, the following groups of subjects were taken into account:

- politicians, education officials, local communities (local leaders, executives, entrepreneurs, activists, etc.), families;
- suppliers (individual entrepreneurs, developers and manufacturers) of educational materials and educational services (digital technologies, tools, materials, services, etc.);
- teachers (teachers, administrators, support staff) and students.

To simplify the comparison of scenarios with each other, each of them is considered in five aspects and compared according to a common set of characteristics that seem to be decisive for the development of the integration of digital and intellectual technologies in the informatization of education:

1) attitude towards education in society:
- expectations/requirements for the goals and results of the educational system;
- activity of the education management system;
- activity of suppliers of educational materials and educational services;
- position of local communities, parents, teachers;

2) learning objectives and teaching practice:
- learning objectives, which are guided by educational authorities, teachers, parents, students;
- organization of educational work;
- used educational and methodical materials;

3) organization of the education system:
- regulation of educational work;
- development of additional education;
- development of network educational services;

4) teaching staff:
- social status;
- professional development;

5) educational environment:
- conditions for the implementation of the educational process;
- availability of digital educational resources and services.

3.3. Management Scenarios for Integration of Digital and Intellectual Technologies in Education Informatization

The given data confirm that today there are two scenarios for managing the integration of digital and intellectual technologies in the informatization of education, integration and transformation. It is important to conduct a more detailed study of them.

3.3.1. Inertial scenario

The modern education system has existed for more than a century, is widespread in all countries and may be considered as one of the most stable and successful social institutions. This is evidenced by the fact that almost all countries, despite differences in cultural traditions and social conditions, have come to a unified solution for the education, upbringing and education of the younger generation.

If the traditional system of education were incompetent, it could not have survived so long and spread so widely. Existing is reasonable: this is the main argument of the proponents of the inertial scenario of educational development.

The inertial scenario is based on the assumption that due to certain reasons (lack of funds for education development, weak involvement in innovative processes of local communities, lack of advanced scientific and pedagogical developments, lack of mechanisms for effective dissemination of evidence-based practices, lack of interest or neglect of responsible persons, etc.) the traditional model of education system continues to remain unchanged. The situation does not change, despite the policies of policy makers and limited criticism of the essentially unchanging work of the bureaucratized education system. Therefore, in the inertial scenario, the priority in the introduction of digital technologies becomes the large-scale centralized information systems creation (at the country and/or regional level) that automate the collection and processing of reports, help control the work of teachers, and support traditional forms of educational work.

The environment is increasingly filled with digital and intelligent technologies. However, the technologies that are used outside the school walls are in little demand in the school itself, as they disrupt the educational system that was built according to the old canons. Developers of educational materials offer educational organizations mainly digital educational resources that support traditional educational work. Innovative digital learning tools, materials and services for general education they direct mainly to the market of additional and family education. This is due in part to the fact that over the past twenty years the school has failed to provide sufficient digital competence of subjects, despite efforts to improve computer science teaching, as well as numerous programs and projects in the field of computer literacy. When the traditional educational system cannot cope with new challenges, alternative ways of meeting them begin to emerge. Despite the fact that the bureaucratized educational system slows down decisive changes in the educational process, the status quo is disturbed by emerging developments in new forms of educational work, including privately funded supplementary education organizations, technical creativity competitions, independent digital educational services, etc. The growing EdTech market, which offers solutions for restructuring the learning process both inside and outside educational organizations, is beginning to play an increasingly important role. Under these conditions, eventually the inertial scenario of development should exhaust itself, and the inability of the educational system to transform will lead to the implementation of a divergent scenario.

It is difficult to expect that the system, which impedes qualitative changes in the school, will be able to adapt to new conditions in the same way as it managed to do earlier in the course of extensive development.

3.3.2. Transformation Scenario

The transformational scenario proceeds from the assumption that society makes purposeful long-term efforts to update the educational system, to bring it in line with the requirements of the emerging digital economy (the fourth industrial revolution). Here the integration of digital and intellectual technologies into the informatization of education is seen as a large-scale managerial task of qualitative change in its work. This task goes far beyond the introduction of digital technologies, tools, materials, and services into the educational system or student's digital competence formation. Its ultimate goal is to solve the problem:

- provide education for all, when every child who has mastered the school program achieves all required (subject, supra-subject, personal) educational results;
- implement the didactic principle of individual characteristics in education, making it education for everyone and ensuring the full development of each student's personality.

In the digital economy, customization has already become the norm. All successful manufacturers of goods and services provide it. The spread of the latest digital technologies (unlimited mobile Internet, powerful mobile digital devices, cloud computing, virtual reality technologies, artificial intelligence, etc.) create technological conditions for the successful development of customization in general education. However, learning customization is not so much a technological as a pedagogical problem, which for many decades' educational theorists and practitioners have been trying to solve, creating various systems of learning organization. Teachers have never been fully satisfied with the classroom-lesson system of learning, which has dominated the school since its inception. Attempts to improve qualitatively this system were made in the 19th century. In the second half of the last century, the method of complete assimilation was proposed [10], but, like previous developments, this model of educational work was not widely spread in practice.

The main problem is to coordinate many different learning trajectories of students with the work of teachers in the available space of the educational organization with a large variety of teaching materials and forms of learning work. In the last decade, there is growing evidence that digital technologies and approaches, which are successfully used for customization in business, can be successfully used in education as well.

Digital platforms (PLP - Personalized Learning Platforms) to support personalized learning organization have emerged and are actively developing. PLP automate the creation of individual schedules, the selection of teaching and learning materials (play-sheets) from the digital archive, formative assessment, monitoring the implementation of personal study plans, etc.

The transition to a personalized or more precisely, a personalized-result-oriented educational system (often referred to as person-centered learning) is not only about mastering new digital and intellectual technologies. It is a qualitative change (transformation) of educational work to improve the performance of each student. In a personalized and result-oriented system of educational work, the main thing is to achieve a high level of academic (including professional) results, the formation of the required competencies. Creative research work of teachers and students, striving to achieve the desired results becomes a norm of life. Subject specialists, educators, mentors, administrators are well-trained and highly motivated professionals who work in a welcoming environment. They are respected in the community. They are mobile and use all available teaching and learning materials, recommendations, research, and other sources. Continuous professional development, communication with colleagues in online professional communities, pedagogical research, exchange of experience, teaching materials and developments, and mutual provision of educational services in the network community are becoming the norm in school life. Schools are becoming full learning organizations with results-based, personalized learning. They use digital tools, teaching materials, and services that are publicly available in a digital learning environment. This allows them to develop and constantly improve their work. These schools receive sufficient funding from various sources, including research grants, purchase and develop their own teaching and learning materials as needed.

These educational systems are leaders in continuing education. They establish close links and collaborate with, encourage, coordinate, and support additional education organizations, online communities, and services where their students participate, including the use of PLP.

Learning, sports, and cultural activities of students outside of school are included in their personal curricula, which become personal development plans. Thus the main requirement of innovative concepts of educational system activity is realized - personal development is put in the first place among the goals of educational work.

Transforming school closely interacts with its social environment, becoming the center of the local community. It is the coordinator and the main subject of cultural and educational work in its surroundings, coordinating its work with the local community and significant local institutions. Her environment becomes the main site for the project work of the trainees. This scenario brings back the tradition of forming close ties between the community and the school, which was established in the era of general education renewal. With «soft modernity» [11] and fragmentation developing in many families and local communities, the adequate socialization of children is at risk [12]. A transforming school could be a pillar in meeting this challenge because of its high educational achievement, developed infrastructure, and belief in the values it stands for.

Thus, in contrast to the inertial scenario, in the transformational scenario the school guarantees every student equal access to quality education, turns into a center of educational work in the local community. Implementation of the transformational scenario of school modernization is impossible without specialized digital tools. Key among them is the platform of personalized learning - PLP. Training of personnel for the digital economy and the formation of new competencies are declared as a priority direction of general education development. The development declared directions are actively supported locally; the school is recognized as the center of education and the formation of competencies for the digital economy.

The implementation of the transformational scenario, despite its attractiveness, requires radical changes, because the described model is still too far from the typical one. To achieve success, we need pilot projects to develop and test in practice various models of the transforming school, which is impossible without coordinated action at all levels of education management. It will be necessary to go beyond established models of teaching, which requires a wide range of professional skills and competencies that most teachers do not possess and are not taught today in pedagogical universities. It is necessary, in fact, to redevelop practice-oriented research, bringing it up to the level of the world's best examples. Implementation of a transformational scenario is a long-term national program, which will require steadily increasing funding over many years.

Such a program should be based on not only digital capabilities and recognized research results, but also broadly use methods of planning, management and financing, which have been developed and proven successful in creating large technical and organizational systems.

3.3.3. Divergent Scenario

The divergent scenario assumes that society's deliberate and systematic efforts to transform schools are absent, or have failed for some reason.

See Table 3 for a detailed description of the divergent scenario.

Table 3. Divergent Scenario

Aspects	Characteristics	Description
Attitudes toward education in society	Expectations/requirements for the goals and results of the educational system	Training of personnel for the digital economy and the formation of new competencies are declared as priorities for the development of the education system.
	Activity of the education management system	The resources allocated to education are insufficient and are supplemented by the resources of families who purchase the necessary additional (including digital and intellectual) educational services for their children. Organizations of additional education are created and supported to compensate for deficiencies in the work of a school incapable of change.
	Proactivity of providers of educational materials and services	Digital educational services (including those from global vendors) for solvent users are being developed. More and more budget tools are offered, using intelligent chatbots for individualized learning work. Cooperation in research and development to create new and improve the quality of existing educational products and services is expanding.
	The stance of local communities	Public members have lost confidence in the educational system ability to take decisive steps to update its work to improve fundamentally the education quality.
Learning goals and pedagogical practices	Learning goals	Emphasis on the demands of the changing job market, meeting the demands for certifications to successfully find a job and/or continue education. Descriptions dissemination of expected outcomes and methods for competencies objective assessment. Reputable extensive use, independent professional assessment centers.
	Organization of learning activities	Much of the learning takes place within the framework of the integration of digital and intelligent technologies in the informatization of education, which bring together the recipients and providers of educational services. A market for digital tools, teaching and learning materials and services is in operation, which responds to fragmented customer requests.
	Used educational and methodological materials	Materials of the market of digital tools and educational services which are focused on support of work of participants of forming educational networks (learners, tutors, parents, experts, etc.) and traditional educational systems are used.
Education system organization	Regulation of educational work	Regulation of educational work is determined by providers of educational services, which operate in the legislative field.
	Development of additional education	Supplementary education organizations dominate as providers of high-quality educational (including online) services. They undertake the family education support, the formation and support of broader learning networks, the provision of individual and group services (e.g., network learning projects) in the programs of general, pre-professional and professional education. Large providers of digital learning services compete in local and international markets for digital learning services.
	Development of online educational services	Web-based educational services dominate the learning process, transforming traditional forms of educational work. Digital maintenance are diversifying services, serving groups, individuals, educators, parents, and educational institutions. Custom consulting platforms, hotlines, home delivery, intelligent software tools, and virtual reality are being used for educational work.
Teaching staff	Public status	The outflow of successful professionals to work in the field of additional education, the provision of network educational services, where the level of payment is constantly increasing. Specialization is deepening. The need for specialists who are in demand in the digital educational environment is increasing. The competences of such teachers are also in demand in other transforming areas, so we have to compete for their attraction in the labor market.
	Professional development	Under the conditions of the fragmented system of network education professional development of teachers is also fragmented. Network providers facilitate the professional development of their staff in the workplace. Independent providers provide professional development for educators, preparing them for success in networking.
Educational environment	The conditions for the educational process	Paid educational services, online services, additional education, independent certification outside the school are distributed. The school system is fragmented, organizations for elitist education and education for the poor with different conditions of the educational process are allocated. More and more students are doing their educational work online, using online services.
	Availability of digital educational resources and services	Consumers of educational services have access to a wide range of solutions for traditional and innovative practices. Internet services using broadband channels and providing educational services for family education, networked educational structures, supplementary education organizations, and fragmented school systems dominate. Digital tools, materials and services (including those using VR and AI) for independent certification, for the provision of end-to-end educational services are widely represented.

Dissatisfaction with the school prompts parents to look for additional/alternative solutions. This search is becoming more common as the market for relatively low-cost online educational services develops. As research [13] shows, parents today are actively involved in their children's education. They make efforts to choose a good school for them, help prepare lessons, monitor progress, communicate with teachers; 42.9% of parents choose (encourage the child) and pay for attending additional circles and sections; 25.9% of families hire tutors; 13.2% pay for additional classes in school. All of this has no effect on the determination of the content and organization of educational work with these children in school lessons. Parents' dissatisfaction with general education is constantly growing, forcing them to become more and more involved in school affairs. Integration of digital and intellectual technologies in informatization of education (including network schools) allows expanding opportunities of family education. In recent years, quite a few home and other networked schools have been added to the long-established network (correspondence) schools that provide networked educational services.

Network educational communities are often not connected to specific educational organizations, although they can interact with them (as well as with additional education organizations) to conduct, for example, laboratory works, exams, final certification, etc. At present, the developers of intelligent learning systems around the world are working to commercialize computer-based learning.

All the giants of the digital industry are involved in this work [14]. Along with Google, Microsoft, Apple, IBM, and other giants that have been in the education market for a long time, new successful players are emerging. In India, the $6 billion education app Byju has been backed by Facebook and Chinese Internet giant Tencent. The British company Century Tech signed an agreement to deploy an intelligent education platform in 700 Belgian schools and dozens of schools across the U.K. Chinese company Squirrel AI, which began offering its online smart learning platform for math and English three years ago, has already registered 2 million individual users. It has opened 2,600 learning centers in 700 cities in China and has raised $150 million from investors to develop new smart education services. The mass market launch of new developments in virtual reality is expected to shake up education once again. The low educational performance of digital and intelligent technologies in the traditional educational system does not prevent the developers of online educational services, which are devoid of the burden of tradition and limitations, from achieving high educational results outside the walls of traditional classrooms with the help of these services.

For example, Squirrel AI showed live on TV the academic work of students in traditional classrooms and students who used a smart learning system. When the results were compared, it was found that the children who worked with the learning system mastered the material faster and deeper than the kids who were in a traditional classroom with experienced teachers [15].

Many fear that the proliferation of intelligent educational services will return society to the educational practices that dominated the eighteenth century, before the emergence of mass schooling. They remind us that the solutions offered by digital educational service providers in the divergent scenario do not address the hidden challenges of the modern school (babysitting, equalizing access to education, bridging the digital divide, etc.). But we can assume that the divergent scenario will be implemented not so much in its pure form, but in conjunction with other scenarios, and the blurring of the school will go simultaneously along many trajectories.

The divergent scenario is being actively promoted by forward-looking EdTech leaders. They rightly point out that the modern system of general education institution faces a number of serious problems, the solution of which is hindered by the most conservative player - the state administration bodies [16].

They control educational policy, curricula and materials, financing and daily work of educational organizations. Without their active support, radical changes in the school will face serious difficulties. Today, most citizens view school as a social value and are convinced of its inviolability.

However, a modern school incapable of digital transformation may disappear just as it emerged centuries ago. It is unlikely that the divergent scenario has a chance of happening.

This scenario implies development through disaster, and its implementation will mean the failure of the managed digital transformation of the school with all the negative consequences for sustainable socio-economic development.

3.4. Transitions Between Scenarios for Managing the Integration of Digital and Intellectual Technologies in the Informatization of Education

The inertial scenario is the maintenance of the status quo. In the conditions of transition to a digital economy it has no long-term perspective. It is inevitably replaced by a transformational scenario.

If for some reason this does not happen, the protective forces of social development will replace (displace) the degrading traditional school with other structures for the training and education of the younger generation in a divergent scenario, as shown in Fig. 2.

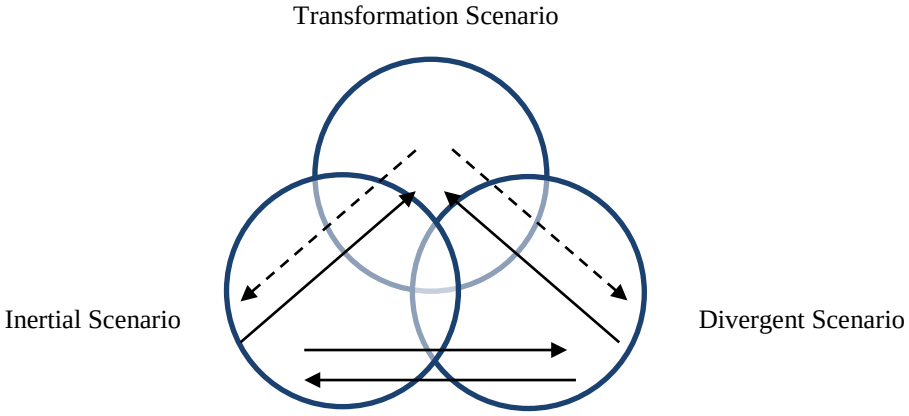

Figure 2. Transitions between scenarios of digital transformation

There are many reasons to believe that the divergent scenario of education will be unsustainable. So far, we cannot say whether networked communities are able to resist the temptations of social Darwinism. Perhaps latent threats to the social world will stimulate a transition from the divergent scenario to the transformational one. The very threat of the actual or potential realization of a divergent scenario may contribute to this. The extent to which the transition to a transformational scenario from an inertial scenario will be evolutionary or revolutionary (through a divergent scenario) will be seen in the future.

Transitions are naturally viewed as strategic. They are determined by the macrodynamics of social development. In addition, at some time intervals there may (explicitly or implicitly, under the influence of various circumstances) emerge other options of transitions: rollback to the inertial scenario, or dumping of the unsuccessful transformation to the divergent scenario. These transitions are marked in Fig. 2 with dotted lines. Such transitions will not necessarily be conscious. They can be implemented on the ground under the pressure of circumstances. Identifying them, correcting potentially disruptive trends, and/or supporting desired changes require constant monitoring of educational transformation processes. The data collected in the course of such monitoring will also be needed by educational policy-makers and managers at all levels. They will help to work out and implement plans for the development of the educational system on the ground.

The time for change in the educational system is a time for qualitative change. As Michel Serres states: The Greeks invented pedagogy when writing appeared and spread; pedagogy changed during the Renaissance, with the invention of printing; in the same way, it is radically changing under the influence of new technologies. For several decades now, we have been living in the period comparable with the beginning of payday when Greeks learned to write and prove and with the Renaissance when book printing appeared and the book reigned [17].

It is easy to see that in the previous decade education was developing according to the inertial scenario. There is every indication that the inertia scenario continues. In a number of countries attempts to transform schools have continued. In the U.S., the bet on the transformational scenario was made quite a long time ago. Over the years there have been many studies and projects that have led to the development of practice-oriented models of personalized learning organization and their dissemination. Today, all school leaders are reporting on the integration of digital and smart technologies in personalized learning [18]. The transition to the new model of work has helped to beat dropout rates, bringing the number of successful high school graduates to nearly 100% [19]. However, not everything is going smoothly. The introduction of personalized learning in U.S. schools has only recently begun, and although researchers believe it can improve education, the very patterns of its operation and distribution are far from fully understood. All of the cause-and-effect relationships that lead to improved learning outcomes have not yet been identified. Enthusiastic practitioners are forced to operate with anecdotal evidence and not fully tested learning techniques that may not always produce the expected results.

There is a risk that attempts to disseminate such models early in their development have the potential to cause failures, leading to the abandonment of promising new pedagogical solutions [20].

Transforming how schools work faces many challenges at the dissemination stage. For example, the Summit Learning model of personalized schoolwork, based on Stanford University's research on project-based learning, has been practiced for years. The model proved successful. It interested Facebook Corporation, which helped develop a specialized PLP for it. Facebook Corporation allocated $100 million to distribute the model, which began in 2016. A goal was set: 50,000 schools across the U.S. should be running the new model by 2025. However, meeting that goal will not be easy.

In the 2019/2020 school year, 380 schools are using the model, a number almost unchanged since last school year, and a quarter of the schools that began adopting the new model before the 2018/2019 school year have abandoned it [21]. Year-over-year gains in student achievement in math and language arts were in line with what was required. At the same time, data on overall achievement under the new model were not available in the regular annual report. It has been noted that the greatest effect of using the new model is achieved where parents work more closely with the school and provide support in mastering the model. All of this gives cause for competitors to question the effectiveness of the model being disseminated. Project leaders declined to conduct it using a program developed by Harvard University researchers [22] because the program made it difficult for participants to engage with local communities. The project's ambitious goal of introducing Summit Learning to half the schools in the United States by 2025 is now in doubt [21].

As we know, large-scale dissemination of new pedagogical practices (reform) is a very complex, time-consuming and costly undertaking, which requires special professional training. The experience of the spread of personalized learning models in the United States confirms a well-known position: the development and implementation of a new model of work in a single school is much cheaper and easier than preparing such a model for widespread distribution and the work on its dissemination is even more expensive and difficult.

In China, as far as one can tell from the available data, there are some signs of movement in the divergent scenario. The education system is too vast and varies markedly by region to implement a single scenario of change throughout the country. The presence of successful commercial developments like Squirrel AI, the implementation of which in education is supported by the state, indicates that digital technologies and new organizational and methodological solutions are used primarily to solve the most pressing problems of the educational system.

Today, the digital transformation of education has begun in almost all countries around the world, which is recorded in the declaration signed at a meeting of ministers of education organized by UNESCO [23]. The study of the experience of different countries is of undoubted interest to teachers and educational leaders in our country. The experience of the European Union, where the SELFIE system (Self-reflection on Effective Learning by Fostering the Use of Innovative Educational Technologies) has been developed and put into effect, is interesting.

This is an information tool, which is designed to help schools to introduce digital technologies in the educational system. It helps the school staff see their strengths and weaknesses in using digital and intelligent technologies in informatization of education, and to set priorities in planning for the future. The tool is available free of charge in 24 official languages of the European Union and can be used by schools.

One important trend of digital transformation is the transformation of schools into learning organizations. An OECD-supported study [24] highlighted eight aspects that describe such a school [25], [26], [27]. The resulting 65-item scale showed high psychometric qualities, is reliable, valid, and can be used for self-assessment of school improvement.

4. Conclusion

These examples show that the scope of work on the digital transformation of education, including research and development, is very broad around the world. However, pedagogical research is extremely underfunded. Very few valuable developments can form the basis of educational organizations work new models. Experimental work is carried out by educational organizations, as a rule, at the expense of basic activity funds and voluntary donations. Therefore, comprehensive study and reasonable use of research and development results can become a significant resource for educational system successful digital transformation. Another important conclusion is that a transformational scenario is impossible without advanced research and development. It takes many years of collective efforts of researchers, educators, and developers of digital solutions to:

- developing new, truly effective models for educational organizations based on the integration of digital and intelligent technologies in the informatization of education,
- testing and bringing these models through practical use in schools to the point where they can be recommended for dissemination,
- development, testing and delivery of evidence-based dissemination of new models.

The above conclusions are fully consistent with the practice of integrating digital and intelligent technologies in enterprises in real business.

The experience of pedagogical developments shows: creation of acceptable methodological basis for updating the content of education, formation of required subject, meta-disciplinary and personal educational results can take decades. It takes at least five years to develop new models for organizing the educational process and to bring them into conformity with the existing model of education before it is possible to think about their widespread dissemination.

The experience of dissemination of such models today is still being accumulated, and it will take many years before their evidence-based-results dissemination in a saturated digital environment becomes a mass practice

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