Digital Technologies in Education: Problems and Prospects for "Moscow Electronic School" Project Implementation

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Abstract

The dynamic development of information and communication technologies, the strengthening of the public demand for digitalization of various spheres of life, orient the Moscow education system towards the active introduction of digital technologies and high-tech educational environment development. The purpose of this article is to analyze the advantages and problems of the Moscow Electronic School project implementation, the resources and limitations of digital technology introduction into the learning process of schoolchildren. The main research methods were questionnaires and in-depth interviews with teachers in Moscow schools during the classes teaching electronic skills. The questionnaires were conducted before and after the training process, which made it possible to evaluate its effectiveness, analyze the attitude of teachers to the Moscow Electronic School project, and the readiness to digital technology introduction.

The study identified the problems associated with excessive control over the practices of digital technology use in the teacher's work, which leads to negative consequences: social tension, imitation of activity. The electronic educational environment is perceived as a space with a low level of security, the risks of losing copyright on intellectual activity results. Dysfunctions were revealed in the motivation system, orienting teachers towards the introduction of digital technologies: hard-to-predict performance, distortion of quality assessment criteria, and manipulation possibilities.

The advantages of digital technology introduction in the framework of the Moscow Electronic School project include the following: improvement of material and technical support quality for schools, visualization of educational materials, the ability to exchange experiences and gain access to best teaching practices.

The key limitations of digital technology introduction are the imperfection of the material and technological base, the dysfunctions in the system of control and motivation of teachers, the

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low level of educational content moderation, their incomplete compliance with the requirements of teachers, lack of digital trust and legal guarantees.

Keywords: digital technologies, Moscow electronic school, digital trust, electronic educational environment.

1. Introduction

The modern vector of the Russian school modernization actualizes the search for new tools and teaching technologies that would ensure the growth of students' competencies in the context of digitalization. Active integration of information and communication technologies in all spheres of society actualizes the demand for qualified specialists with computer literacy and skills in the electronic environment. Digitalization of training requires counseling in material, technical, financial and human resources (Parfenova, 2011).

The Moscow school, as the flagship of the Russian education system development, has great resources for the implementation of ambitious goals. The consequence of this situation is the orientation of Moscow educational institutions towards the active introduction of innovations, the creation of a high-tech educational environment, and the development of IT infrastructure (Rogach et al., 2017). Based on the experience of the project implementation, the Moscow Electronic School is being formed and starts to implement the Electronic School project throughout Russia.

Since September 1, 2016, the Moscow Department of Education has been implementing the Moscow Electronic School (MES) project, which provides technological and substantive conditions for schools to enter the global information space. These innovations provide the integration of traditional forms of education and digital technologies, the possibility of lifelong learning using new means of communication. One of the first stages of the project was the abolition of paper diaries and magazines and its replacement by electronic counterparts. An electronic diary provides real-time monitoring of a child's attendance and academic performance, the possibility of direct interaction with a teacher.

The next stage of the project was the creation of high-tech spaces in Moscow classes. The Moscow e-school platform consolidates a variety of educational content – the sets of functional blocks interconnected according to certain principles.

Today, the Moscow electronic school includes two main areas:

1. Project software, which includes: EJD (electronic journal and diary); MES library; MES mobile application.

2. Infrastructure: interactive panels, tablets for students, ultra-light notebooks for teachers, high-speed wireless Internet in all buildings of the educational complex, school servers.

The project provides the equipping of classes by multifunctional interactive panels with a touch screen and built-in speaker. These panels, replacing the classic school blackboards, have a surface for educational material record, a large screen for demonstration presentations, and allow you to view and listen to video and audio-educational materials.

Textbooks and workbooks should be replaced by students' tablets, which will contain all the electronic content necessary for the development of general education. With the full use of MES resources, control measures and tests will completely switch to an electronic platform with an automated verification system.

The implementation of the project will allow a teacher to reduce the time for lesson preparation, search for the necessary information and check its relevance and reliability. The electronic platform of the MES Library provides the opportunity to use ready-made educational material, create your own educational content, and exchange opinions with the teachers of educational institutions of the city of Moscow. At the moment, there are more than 37 thousand interactive lesson scenarios for students from the 5th to 11th grade on the platform of the MES program. An important feature of this project is that all participants of the educational process have access to electronic content: teachers, students and their parents[*].

The implementation of this project provides for the phased technical equipment of Moscow schools, an extensive consulting and information support for the implementation of innovations,

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[*] The official website of the Mayor of Moscow. [Electronic resource]. Access mode: URL: https://www.mos.ru /city/projects/mesh/

where a special role is given to the teacher's continuing education system, and the development of his digital competencies.

2. Literature review

The active use of information and communication technologies and the general orientation of Russian society towards digitalization create the prerequisites for cardinal transformations of the educational system (Kirillov et al., 2016). Modernization of teaching tools for schoolchildren and new pedagogical practices of ICT inclusion in the educational process can be considered today as new trends in the development of the Russian education system (Vinichenko et al., 2018).

The studies conducted in developed countries that have positive digitalization experiences in education illustrate a number of patterns (Hietajarvi et al., 2019; Nguyen, 2019). In particular, it has been established that the use of digital technologies in education contributes to the growth of academic performance, the increase of interest in learning due to the active inclusion in the process of new knowledge generation. The fact that the transfer of digital technology to education transforms not only the role of a student, but also the position of a teacher is of interest. According to B. Berry, the digitalization of education, not only increases the enthusiasm of teachers, but also pushes the boundaries of leadership by developing the competencies of working with digital media, and sharing experience in online network space. In some cases, the digitalization of education can provide a solid foundation for a teacher empowering in school management (Berry, 2019).

In the Russian education system, the introduction of information and communication technologies can create the conditions for individual learning path development for schoolchildren, the variability of educational programs and study scenarios (Ryabova, 2018). According to T.N. Noskova, the electronic environment contributes to the enrichment of key subject activities of the educational process, including the educational space expansion by creating new channels of communication between a teacher and a student (Noskova et al., 2016). An additional factor providing the advantages of the electronic educational environment is the expansion of the boundaries of "self-directed learning" and the increase of the student's personal responsibility for learning outcomes (Gibbons, 2002). M.V. Patz believes that a student's role activation is possible in the context of digitalization of education, supported by the possibility of setting personal educational goals, choosing learning paths, designing the content of educational activities (Patz, 2015). The traditional perception of knowledge through passive listening is supplanted by self-education, in which the success of information mastering depends on the students of the educational process (Kabanova, Vetrova, 2018: 517; Salaeva, 2014).

Education in the electronic environment allows us to solve the previously impossible task of education individualization and differentiation. Conclusions characterizing the positive results of the electronic environment development were obtained during the study by Regina Schmid and Dominik Petko. According to the survey of 860 students (8th grade) from 31 Swiss schools, the widespread use of digital technologies, open teaching methods is an important aspect of personalized learning. The results of the study illustrate the positive consequences of digital technology introduction in the learning process: the development of digital skills, the formation of information trust and a positive attitude towards the information and communication environment. It is interesting that the "freedom" or the expansion of variability in the choice of educational activity areas, considered as the most important aspects of personalized learning, did not have a decisive weight in innovation evaluation (Schmid, Petko, 2019). The variability of educational paths is an additional, but not the main advantage of digital technology used in learning. A much more significant effect is the increase of education quality by expanding the boundaries of self-education, and education individualization.

The availability of educational services is considered as one of the indisputable advantages of digitalization (Vinichenko et al., 2016). Digital technologies provide the ability to obtain the required information at the moment of their request. In the context of the growing pace of life, the widespread use of mobile applications, when more and more people own smartphones, the residents of megacities are focused on personalized information right receiving at the moment of this need actualization, that is, "at that moment and in the place where they need it" (Missaoui et al, 2019). The introduction of digital technologies provides the transition from "classroom training to training anywhere and anytime", expanding the role of trainees who can be not only consumers of electronic resources, but also their creators (Akhmetzhanova, Yuriev, 2018).

When analyzing the factors that ensure the effectiveness of digital technology introduction into the educational space, most researchers emphasize the importance of working with pedagogical staff (Gundry et al., 2014; Fleisch et al., 2016), electronic skill training, and management support (Bullock, 2013), logistics and infrastructure support for innovation (Kabanova, Vetrova, 2018a: 712). The process of transition to "digital maturity" requires the consolidation of efforts on the part of all subjects of the educational space in the transition process (Badikov, 2018).

No less important factor is digital trust, overcoming stereotypes and the formation of a conscious attitude, loyalty to the processes of digital technology implementation (Matsiola et al., 2019), the development of partnerships and sustainable organizational ties (Mueller-Oppliger, 2010).

Despite the considerable amount of scientific materials on the problems of digitalization of education, the studies of the limiting factors and resources for digital technology introduction into the education of schoolchildren are presented insufficiently.

3. Materials and methods

In international practice, the gap between theoretical innovative IT developments and their implementation is shrinking rapidly, and therefore, the reduction of digital innovation introduction time becomes an urgent need (Kravtsova, 2018). In this context, the studies of the resources and limitations of digital technology introduction, the analysis of the factors ensuring the effectiveness of this process, the optimization tools that fully meet the needs and interests of all interested parties are particularly relevant.

The purpose of this article is to analyze the problems and prospects of the Moscow Electronic School project implementation, the resources and limitations of digital technology introduction into the learning process of schoolchildren.

During the training courses for teachers, the authors conducted a number of studies (questionnaire survey and in-depth interviews). In particular, during the first lesson, teachers were asked to answer questions of a short questionnaire (N = 90). The objectives of this intelligence research were the following ones: self-diagnosis of digital competencies, the assessment of readiness level for organizational changes, trust in them, general perception and assessment of digital technology introduction consequences in school education. At the end of the questionnaire they proposed to express their attitude to the Moscow Electronic School project in the form of an open question. During the last lesson, teachers filled out questionnaire (N = 86) repeatedly to evaluate the tutor's work, analyze the effectiveness of the learning process, its role in digital technology popularization, and the study of value judgment transformation in relation to the project. An additional research method was an in-depth interview of teachers (N = 28) to clarify a number of positions, to understand the essence and content of the changes taking place in Moscow school better, to analyze the interests, motives and stereotypes of the pedagogical community regarding the digitalization of the educational environment, resources and limitations of digital trust development, the introduction of digital technology in the school system.

The study also used the Pearson's χ^2 test. Statistical significance was set at $p < 0.05$.

Research hypothesis: the low level of readiness of the main subjects of the educational space to digital technology introduction, the lack of digital trust, the problems in the system of motivation and control significantly reduce the effectiveness of the Moscow Electronic School project. As an additional hypothesis, the authors put forward the assumption that the teaching staff is the factor in overcoming stereotypes regarding the use of information and communication technologies, the formation of loyalty to digital innovations.

Limitations: An in-depth interview was conducted using an informal questionnaire, which can be considered as some limitation of this study. Unformalized toolkit is characterized by minimal standardization of the interview procedure, and was used to identify reference points of the research problem. The data obtained during the in-depth interview requires further detailing and study, relying on formalized tools. The in-depth interview materials outline a range of problems that can be considered as promising areas of research within the framework of the issues raised.

4. Results

The comparative analysis of teacher self-assessment results on the level of digital competence development before and after training, showed a positive trend quite expectedly. Almost all respondents gave high marks to the tutor's work (Table 1). Positive comments noted such qualities as "stress tolerance", "attentiveness", "goodwill", and "patience".

Table 1. The relationship between evaluations of the tutor's work and the usefulness of training within the framework of the Moscow Electronic School project and the attitude to the project as a whole (based on the results of the survey during the last lesson, respondents N = 86)

Assessment of training usefulness in the framework of the project "Moscow Electronic School"	Assessment of the tutor's work during training		
	unsatisfactory	satisfactory	excellent
Yes	0	2	75
No	1	5	3

The results obtained illustrate the very expected relationship between the tutor's work and the assessment of teacher training usefulness in the framework of the Moscow Electronic School project. The number of freedom degrees is 2. The value of the χ^2 test is 39.968, $p < 0.001$. This circumstance demonstrates the dominant role of tutors, his personal and professional qualities in the development of loyal attitude of teachers to the digitalization of education.

In addition, after the completion of the learning process, Moscow teachers became less wary of the proposed digital innovations, the share of respondents who believed that the implementation of the project would interest students increased. There is a slight increase of teachers who see the optimization of working time and material incentive increase as the advantages of digitalization in education.

It should be noted that when you compare the results of the first and second measurements of teacher attitude evaluation to the Moscow Electronic School project, insignificant dynamics is observed: only 15 % of teachers changed their minds for the better. These findings are confirmed by the studies of other authors. In the survey of Bulgarian teachers, only 7 % of respondents considered that the use of information and communication technologies in teaching would be useful for work in view of their high efficiency (Donev, 2018).

In the course of the interview, teachers noted "increasing confidence in the use of new electronic services", as well as the appropriateness of their use in the educational process. The illustration of the electronic educational environment possibilities during training made it possible to transform a number of stereotypes, change the negative attitude towards digital technologies and the need for their implementation in everyday practice of the educational process. Before the start of training, the answers to the open question about the attitude towards the project were centered in the aspect of digital technology perceiving as an extra load ("very difficult", "distracting from the main thing", "no one needs it", "nothing will help", "window dressing"). Repeated measurement showed that a number of teachers have undergone the transformation of evaluative characteristics. The answers included the following comments: "this will help to make the lesson interesting", "if you debug technical defects, MES will become a good assistant."

During the interview, the following opinions were expressed: "there is some cautious optimism", "if earlier I thought that digital technology was only an additional burden, now I am interested. Maybe the project will help me in my professional activity". Similar results were obtained in other studies. Thus, the survey of primary school teachers in Australia showed the importance of theoretical and practical training, providing familiarity with innovative ideas, the methodology of information and communication interaction, and digital technologies. During the training, a significant increase in teachers' confidence and enthusiasm was recorded. The results show the importance of focused vocational training in combination with a collegially supported

implementation phase, as well as the support from school leaders and industry partners to facilitate significant pedagogical changes in technology-mediated learning (Stevenson et al., 2019).

Support from the leadership is of the greatest importance in the system of school teacher motivation. The vast majority of respondents, during the evaluation of the factors that prompted them to start training, chose the option "by management decision". The obligation to take advanced training courses, on the one hand, caused a sharp rejection in the pedagogical environment, the increase of social tension, but, on the other hand, integrated the entire contingent of the teaching staff in the process of digital competence mastering.

The results of the interview showed that the work of teachers on electronic content creation is evaluated by respondents in the following epithets: "extremely difficult", "unnecessary", "difficult". Respondents noted that content development requires a considerable amount of time, which, in a busy schedule terms, requires teachers to take excessive physical and emotional efforts. The current situation may become a catalyst for professional burnout of teachers, the outflow of teaching staff in view of the high intensity of work at school. The situation exacerbates the pressure exerted on a teacher by the leadership of the educational institution. A significant proportion of respondents indicated tight control of the teacher's work in the electronic environment; continuous monitoring of platform content use during the lesson.

Excessive control by the leadership contributes to professional deformations of a teacher, which is manifested by such negative consequences as imitation of activity, reduction of the teacher's personal responsibility for the lesson quality. Teachers noted that a large number of errors in the downloaded content, its poor quality filling requires additional work. Respondents noted: "sometimes during the lesson you have to include the presentation in the background, I tell the students not to pay attention, but I give the material myself"; I do this in order to be noted in the system."

During the study, respondents noted unsatisfactory technical support for the MES project (see Table 2).

Table 2. Relationship between satisfaction ratings with the technical support of the Moscow Electronic School project and the attitude to the project as a whole (based on interview results, N = 28 respondents), (χ^2 = 14,339; *the number of degrees of freedom* is 2; p < 0,01)

Attitude to the project "Moscow Electronic School"	Satisfaction with the technical support of the Moscow Electronic School project		
	yes	partially	no
positive	4	2	0
negative	1	6	15

At that, one cannot fail to note other difficulties that arise when they work with software components of the Moscow electronic school. So, for example, some educational materials contain both spelling and substantial errors. According to most educators (22 out of 28 *respondents*), educational content stored on the MES electronic platform can not be used often for demonstration during classes. This is due to the low level of their moderation. During the interview, there was a fairly common position that the composition of educational content does not meet quality standards. Doubts were expressed about the correctness of the universal orientation of schools towards "disparate electronic materials", "containing a lot of mistakes", instead of the established practices of holistic methodological development application prepared by large groups of authors. Teachers noted that "any textbook always has a methodological manual containing a plan and materials for the lesson." In this situation, the creation of their own electronic content is considered by teachers as "extra workload", "duplication of work", "the use of teachers as free labor to convert printed materials into electronic ones."

A significant amount of low-quality material acts as a limiting factor in the selection of information for a lesson. During the interview, the following opinions were expressed: "It's difficult to find something worthwhile and worthy", "You spend a lot of time while watching low-quality material, and empty presentations".

A separate difficulty in the implementation of the Moscow Electronic School project is the low level of digital trust among teachers. According to interview materials, 70 % of respondents expressed concern about the open placement of their materials on the Internet. Legal guarantees in the field of intellectual property protection could compensate for these problems. However, during the interview, teachers emphasized that "the copyright agreement is not concluded", "the issue of copyright observance remains open".

The research materials illustrate the interdependence of teacher age and their relationship to digital technology. The respondents under the age of 35 show a higher willingness to use digital technology in the educational process. This trend is conditioned by a higher level of computer literacy among the respondents of this age group, an active position in the use of digital technologies in everyday life. In addition, the majority of respondents under the age of 35 do not associate the development of digital technologies with the risks of their professional status reduction. In the case of respondents of the older age group, the situation is different. In particular, they are characterized by a warier attitude to the use of information and communication technologies in their activities.

With a long term experience of working at schools without the use of ICTs, the respondents noted the increase of stress and tension. For this group of respondents, it is common to associate the introduction of digital innovation with the loss of stability, and professional well-being. These risks must be taken into account during project further stage planning.

The results of the study are in line with international practice of digital technology implementation. In particular, Rachel Carpenter and Tracy Alloway consider it is necessary to pay special attention to the workload specifics, the level of computer literacy, media competence and the individual characteristics of teachers (Carpenter, Alloway, 2019).

It can be assumed that the individual characteristics of teachers should also be taken into account during the development of measures to motivate the pedagogical corps of Russian schools to digital technology introduction. According to the majority of respondents, the teacher's motivation system adopted nowadays does not provide positive support for the practice of digital technology use in the educational process. Payments are not provided for the development of quality content, but for the number of downloads. According to respondents, this practice is populist in nature and does not guarantee high-quality filling of the electronic platform with the required materials. At the same time, during the study, the relationship between the assessments of the work motivation system and the attitude of the teachers to the project was not established (see Table 3). The number of degrees of freedom is 2, $\chi^2 = 0.778$. The critical value of χ^2 at the significance level of $p < 0.05$ is 5.991. The significance level is $p = 0.678$.

Table 3. Relationship between assessments of the work motivation system in the framework of the Moscow Electronic School project and the attitude to the project as a whole (based on interview results, N = 28 respondents)

Attitude to the project "Moscow Electronic School"	Distribution of answers to the following question: "Does the system of motivation for the teacher's activities within the framework of the Moscow Electronic School project suit you?"		
	yes	partially	no
Positive	1	4	1
Negative	2	8	12

5. Discussion

The Moscow Electronic School project is the driver for digital innovation development, an instrument for material and technical support improvement in respect of educational process, and education quality improvement. Teaching the skills of work in the electronic educational environment for teachers has become one of the essential elements of the project, ensuring its success.

The study revealed that the teaching process, in which Moscow teachers were involved, made it possible to transform their attitudes towards the introduction of digital innovations to some extent. The most positive changes have affected the self-esteem of digital competencies. To some

extent, the attitude to the electronic educational environment has also changed for the better. The development of teacher loyalty is limited by the technical problems, and methodological flaws. The quality of electronic content is criticized. Loaded lesson scripts often have meaningful errors and do not fully comply with pedagogical methods. These shortcomings indicate the need to shift the focus of control, which at the moment focuses solely on tracking the teacher work: his use of digital technologies in educational practice. The monitoring and substantive moderation of electronic content, the elimination of technical problems is more relevant.

The results of the study demonstrated positive dynamics in the perception of digital competence teaching process. The share of respondents critical of the need for continuing education within the framework of the Moscow Electronic School project has decreased. The teachers evaluated their knowledge and skills positively; the most significant contribution to the transformation of their position belongs to the tutor. There is the decrease of tension and a negative attitude towards the expected innovations, in view of information distortion reduction around digital education.

The popularization of the ideas of digital education made it possible to modify a number of stereotypes of the teacher's work in the electronic environment. They decreased the proportion of respondents who believe that the use of digital technology is an extremely complex activity that distracts from the main functions. "Perceived utility" is a key factor which determines the willingness and effectiveness of digital technology (Matsiola, 2019).

The research materials allowed us to put forward the conclusion according to which, the decisive factor in the formation of teachers' readiness for the introduction of digital technologies is the organizational impact of the educational institution authority. The current situation illustrates the established trends in the Russian education management system associated with a high level of distrust in innovation, and resistance to organizational changes (Rogach et al., 2018). At the same time, redundancy of control and organizational pressure from the leadership initiates the negative consequences of education digitalization: imitation of activity, growth of anxiety, stress, etc. An effective motivation system for the teaching staff, the introduction of the principles of group collaboration, and digital trust can serve as a compensating factor (Bodsworth and Goodyear, 2017; Slama, Choukir, 2019).

Assessing the prospects for digitalization of the educational space of Moscow schools, a number of factors should be taken into account:

- Predictable changes and risks; unintended or poorly predictable destructive consequences; stereotypes; new skills, practices and values determined by the introduction of digital technology (Waelbers, 2011)

- Predictable changes and risks of digital technology implementation. The positive changes include the following: saving a teacher's working time, exchange of experience, expansion of access to education, and efficient use of technological equipment. The most significant risks are the following ones: imperfection of the material and technological base, low level of interest and support from the teaching staff. Social risks are burdened by dysfunctions in the motivation system, and the gaps in the training of personnel.

- Unintentional or poorly predictable destructive consequences. These include: the redundancy of control and organizational pressure, practical imitation of activity, low quality of educational content.

- Social stereotypes that limit the processes of digital partnership, and exchange of experience. The electronic educational environment is perceived as a space with a low level of security, the risks of losing its intellectual property. The lack of digital trust limits the teacher's willingness to share experiences and share the results of their intellectual activity on an electronic platform.

- New skills, practices and values determined by the introduction of digital technology. Under the conditions of a dynamically changing world, it is rather difficult to predict trends in the transformation of educational space. Digital technologies, on the one hand, expand its capabilities, reduce time costs during preparation to a lesson and information search. But, on the other hand, the risks of ousting teachers who do not have new digital competencies, working skills in the electronic environment, readiness for self-education and self-development, flexibility and a high level of adaptability during interaction with a new generation of students from the educational space become more relevant.

6. Conclusion

Digital technologies are one of the mechanisms to enhance the cognitive needs of a student, a tool of interest increase to learning. The advantages of the Moscow Electronic School project are the following ones: quality control of the educational process, the effective use of technical equipment during a lesson, visualization of teaching materials, optimization of the teacher's working time, the ability to exchange experiences and gain access to the best teaching practices. Significant shortcomings in the resource support of the MES project were represented by technical flaws in the system, a low level of educational content moderation, and a significant number of substantial errors in electronic materials.

The introduction of digital technologies in the educational process is a very ambitious task, which involves overcoming teachers' resistance to organizational changes, developing the ideas of digital trust and cooperation, as well as overcoming a number of stereotypes. Promising trends for the introduction of digital technologies are the following: the motivation system improvement, control practice modernization, elimination of information distortions around the problems of education digitalization, and taking into account the individual characteristics of a teacher during his training.

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