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**ANALYTICAL REVIEW OF EDUCATION POLICIES ON
DIGITAL TRANSFORMATION OF SCHOOL EDUCATION
WORLDWIDE**

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Abstract

The article reflects on the changes of educational landscape worldwide connected with the sustained development of society and introducing ideas of modernizing school education, as well as the “shock digitalization” triggered by the challenges of 2020. The aim of this research is to compare education policies of different countries in the field of digital transformation of school education by means of studying state programme documents on digitalization, and digital learning services and resources for students. The studied material includes open sources of information: articles, websites of state education authorities, content and tools of digital learning platforms and services available to registered users. The article features a characteristic of digital learning resources and services in the selected countries, a descriptive analysis of national policies and trends in digital transformation of education in each country. The authors have come to the following conclusions: school digital learning systems are used as a means of transporting values, languages, cultures and maintaining a unified learning space; school digital learning systems of different countries become interconnected due to the expansion of supranational digital learning resources and services, translation of learning content into different languages. The evolvement of the new model of school education is characterized by removed geographical and time barriers, openness of the learning process, customized training programmes, using mass network educational formats. To overcome the digital gap, measures are taken at different levels, from states to individuals who start their own educational blogs. Repositories of learning content are created in collaboration of users.

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Keywords: Digital education, digitalization of school, distance learning, digital gap, education policy



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1. Introduction

The issues of digital transformation of school education are the focus of attention of researchers from different countries. The issues studied include the impact of using IT technologies at home, the socio-economic status of the family and the social status of parents on the development of students' digital literacies and the efficiency of distance teaching and learning (Gonzalez-Betancor et al., 2021). The studies by Ansari and Khan (2020), Beck (2020), Blut and Wang (2020), Guan et al. (2020), Huang et al. (2020), Yawson and Yamoah (2021) describe five factors that influence the readiness of students to study remotely, namely, technological readiness, unaided learning, students' monitoring, motivation to study, efficiency of online communication. Tang et al. (2021) in their research studied the readiness of students from Hong Kong, Macau and China to distance learning, as well as the impact of gender on their motivation to study online. The authors argue that student motivation depends on the level of education (school, college, university): the higher the level of education the higher the motivation to study, and vice versa. Another research dedicated to the study of education accessibility during the lockdown in Moscow allowed defining the key challenges to the school system, the difficulties that families experienced when arranging the conditions for their children to study at home, the attitudes of students of different ages and their parents to remote learning (Vachkova et al., 2021).

Another strand of research is teachers' digital literacies. The importance of new approaches to training teachers with regard to including the component of developing their IT competencies has been emphasized even before the critical situation of the forced digital transformation due to the pandemic (for example, Mikhaylova & Kuleshova, 2018). The findings of the study by Saikkonen and Kaarakainen (2021) showed that the level of teachers' digital literacy is defined by sociodemographic factors, as well as their digital activity, self-efficiency and the digital skills level. Different groups of teachers have been identified that needed customized instructional guidelines and training approaches of how to work in the online format (e.g. at-risk group – teachers of 55-60 years of age, most competent group – teachers of 30-39 years of age).

The experience of teachers shifting to the distance teaching mode has been analyzed in the study by HSE University (2020) in Russia. The study showed that despite the difficulties teachers were able to acquire the necessary digital skills and adapt to the new working format within a short time period. These conclusions are in line with the UNESCO report on the progress of distance education during the pandemic (UNESCO, n.d.).

The third strand of research focuses on the international and Russian experience of school transformation with the aid of digital products and solutions, and informational and communication technologies. A noteworthy research within this field is Transformation for School-Age Children Education: International Experience, Trends, Global Recommendations developed at HSE University (Gaible, 2019). This analytical report interprets the digital transformation of school not only from the point of view of achieving the current learning outcomes, but from the point of view of content – how digital solutions are integrated in the modern pedagogical approaches and technologies, such as in personality-focused (personalized) education, empirical education (based on experience), phenomenon-focused education and others.

The influence of digital transformation on the development of e-mobilité of learning ecosystems in the context of globalization is studied in the paper by J.-F. Ceci (2021), who argues that due to the active usage of digital technologies there are shifts in the cognitive, pedagogical and social behavioural patterns of both students and teachers.

It is expedient to support the research strands mentioned above with a comparative analysis of education policies of different countries to identify and describe national and public priorities in the field of digital transformation of school education.

2. Problem Statement

2020 was a year full of challenges to educational systems of the countries worldwide: the forced shift to massive distance schooling was a shock even for those countries where digital transformation of learning environments has been pursued for many years in a consistent and progressive manner. The ‘pandemic’ digital transformation lead to the development of new norms common for all educational systems, such as massive broadcasting of lessons from best teachers, large repositories of learning content open to common creation and usage, online training of adults based on the school curriculum, common services for collaborative work, classes that unite students from different regions or even countries, etc. Concurrently different countries choose their own solutions of combining face-to-face and online learning, education accessibility, and overcoming the digital gap.

3. Research Questions

The key questions addressed by this paper are the following: How do different countries carry out digital transformation of school education? What are their priorities in this area? What solutions they use to the problem of combining face-to-face and online learning? What digital learning resources and services are developed and used by schools? How are they integrated in the process of schooling? To what extent are these services accessible to students? What are the newly-emerged models of school teaching and learning? What are the challenges experienced by countries during digital transformation of schools, and what are the solutions to these challenges?

4. Purpose of the Study

The aim of this research is to compare education policies of different countries in the field of digital transformation of school education based on state programme documents on digitalization and analysis of digital learning services and resources for school students.

5. Research Methods

The main research method used in this study was a comparative analysis of publicly available data on digital transformation of education in different countries. The data analyzed included scientific and educational articles, official websites of state ministries, strategic national programmes and projects in the field of digital transformation of education, open statistics of digital learning platforms and services,

websites of educational institutions. The additional research method was studying the learning content and tools of digital learning platforms and services available to registered users.

The countries were selected for the study based on the different levels of digital transformation: from leaders in the field to developing countries who have only recently launched the processes of digital transformation of education. In total, 10 countries have been selected for the study representing 4 different continents: Eurasia, Africa, America, Australia¹.

The first stage of the research was the selection of keywords in Russian, English and French to conduct an efficient search on the Internet and scientific databases. This stage also included definition of the common approaches to analyze and describe digital learning resources, policies and practices. The second stage comprised collection, translation, analysis, and recapitulation of data.

6. Findings

6.1. The overall characteristics of digital learning resources and services

The research data comprised 103 digital learning resources and services for school education in 10 countries of the world: Russia, The United States, The United Kingdom, France, Australia, Singapore, Kazakhstan, Latvia, Canada, Tunisia. The number of digital learning resources and services by country is shown in Table 1

Table 1. The number of analyzed digital learning resources and services

Country	Number
Russia	41
The U.S.	13
The U.K.	4
France	9
Australia	5
Singapore	3
Kazakhstan	6
Latvia	11
Canada	10
Tunisia	1

¹Besides the above mentioned criteria, the choice of the research material was defined by the institutional linkages between Moscow City University and educational institutions of the selected countries, as well as by the personal scientific interests of the research team.

The studied digital learning resources and services have different scale of disseminating their activities. Figure 1 shows the distribution of digital learning resources and services by their outreach broken down by country.

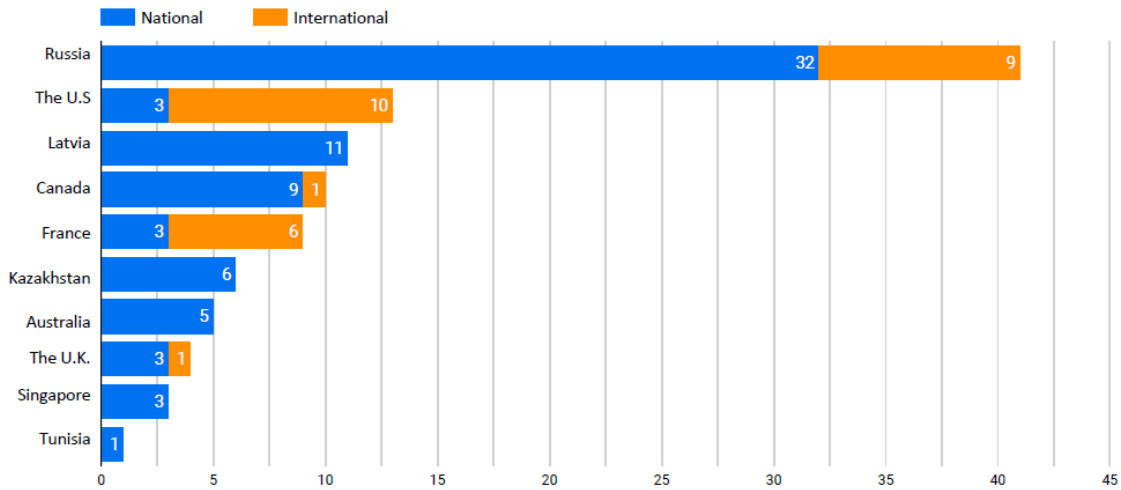


Figure 1. The distribution of digital learning resources and services

In total, 58.3% of the digital learning resources and services are privately owned, 41.7% – state-owned. 48.5% offer their services and resources to schools on a free basis, while 51.5% charge a fee for using the services. Table 2 shows the distribution of digital learning resources and services by their accessibility broken down by country.

Table 2. The accessibility of digital learning resources and services

Country	Free of charge	Paid
Russia	6	35
The U.S.	8	5
The U.K.	3	1
France	8	1
Australia	5	0
Singapore	3	0
Kazakhstan	3	3
Latvia	7	4
Canada	6	4
Tunisia	1	0

In the course of research, various digital learning resources and services of these countries have been analyzed, including electronic schools, online schools, databases and libraries of learning content, training simulators, LMS, support services, aggregators of resources, video channels, network games, video conferencing services. The types of digital learning resources and services by country is shown on Figure 2.

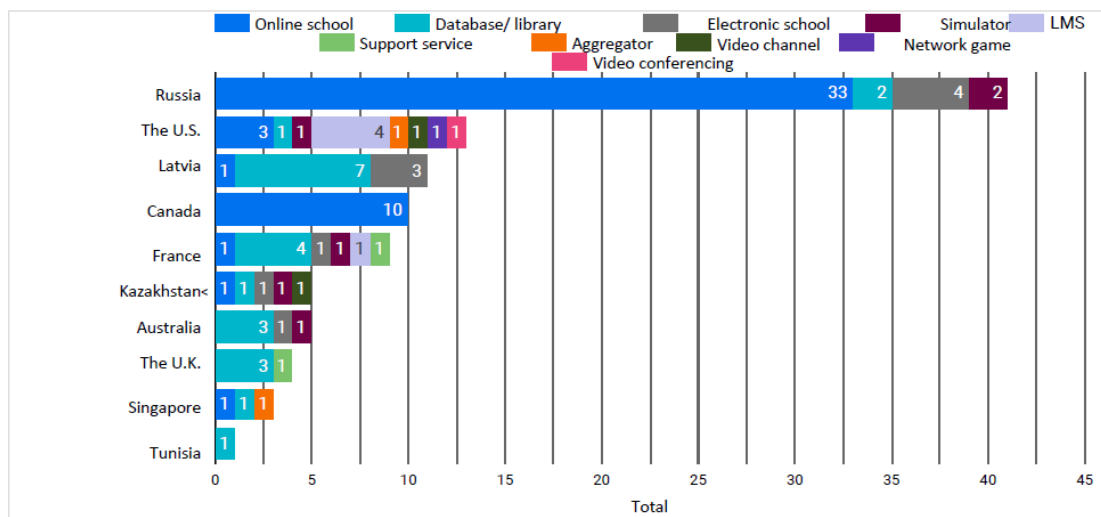


Figure 2. The types of digital learning resources and services analyzed in the study

60% of the analyzed practices are electronic and online schools. They use all formats of remote interaction with students: synchronous (18.3%), asynchronous (30%) and blended formats (51.7%).

6.2. Russia

In Russia, the digital transformation of school education is an important task of the state policy which is regulated by the national project Education (The Ministry of Education of the Russian Federation, n.d.). The Federal project “Digital Learning Environment” is dedicated to developing and introducing digital learning environments in educational organisations, as well as supporting the digital transformation of the national educational system. Within the framework of the project, educational institutions are provided with modern equipment, digital services and content are developed for educational purposes (The Ministry of Education of the Russian Federation, n.d.). The key directions of digital transformation of school education are:

- Modernisation of equipment of educational institutions;
- Connecting teachers to the informational and service-based learning environment;
- Establishing centres for digital education of children, i.e. “IT clubs” in all regions of Russia;
- Expanding the access of schools to broadband Internet.

To maintain a unified national learning space, *the Russian Electronic School* has been established for educational purposes. One of the largest state school digital systems is *the Moscow Electronic School*. In general, within the digital learning environment of Russia many digital learning resources, services and schools are functioning. It can be confirmed that today in Russia there are large repositories of learning content on every school subject, training simulators, as well as developments on digital student portfolios,

and blended learning formats. The Moscow Electronic School has shifted to a single Topical Framework for structuring of learning content, which has been integrated with the distance teaching services, and digital homework has been introduced. Currently the Learning Outcomes Framework is developed that will be used to structure the learning content of the electronic schools repositories. The registration and access to the state educational services is available through the State services networks.

Due to the pandemic, the online schooling of students in Russia boosted expansively: there have been developed many private services and online schools that provide support to distance instruction. Their services are generally available to the wider Russian-speaking community around the globe. Distance instruction features different formats: asynchronous, synchronous, as well as combination of asynchronous and synchronous instruction.

Asynchronous instruction is mainly represented by online courses in the form of video recordings of lessons. This model is based on self-study. There are 3 possible combinations of video recordings and tasks. The first combination is when video lessons are followed by assignments which are checked automatically. This model solves the key tasks of education where the main learning outcome is acquisition of knowledge. The educational products of this type are offered on a conditionally free basis when students pay only in case they want to pass a final attestation and receive a certificate confirming the acquisition of a certain learning outcome. The second model comprises video lessons, test assignments, as well as practical or project-based assignments. In this case the learning outcome depends on the combination of elements, content and feedback from the teacher or expert. To check the open assignments, crowdsourcing services are used that are aimed at analysis of student work. Here students pay for the certificate or final attestation. The third model features video instructions on how to do a certain task. Courses of this type which are offered free of charge or for a small fee are aimed at developing specific basic skills and used to lure students to buy a full-fledge training programme.

Synchronous instruction is a live interaction between a teacher and a student mediated by the digital environment. During the full-time distance instruction teachers used the following software and tools:

- LearningApps to create exercises and training aids, Kahoot to create assignments;
- Digital pen to write notes on the screen, Epic Pen application to check assignments;
- LetsView software for PC or tablets to draw and write;
- Tools of Google Earth to organize network projects;
- Tools to arrange test assignments (Google Class, Online Test Pad, Classtime, CORE, Testograf.ru, Master-Test, Vizia, TEDEd lessons worth sharing, Online Test Pad);
- Virtual boards (Padlet, Explain Everything, Miro, Classtime);
- Services to create infographics (Canva, Infogram, etc)
- Services to create common folders for homework assignments;
- Social networks.

Teachers indicate that to ensure efficiency of synchronous online lessons, it is important to use the following teaching technologies and methods: interactive and collaborative work with attention given to each student, work in pairs and peer learning, giving different-level assignments; withdrawing from giving reproducing tasks with easy-to-find answers; writing down and collecting feedback after every

lesson; using small meeting rooms; engaging in collaborative project-based activities and creative work that enables students to try out their own ideas.

We have collected a list of newly-developed instructional practices by teachers:

- Lessons as quests that were developed using, for example, the Mind Factory learning tool;
- Types of assignments for group work during an online lesson and outside the classroom: watching and discussing a movie, creating a website of an artwork or literary characters; proving or refuting scientific information (confirming authorship, discovering plagiarism, etc.); creating timelines (on paper or using endless boards), creative work;
- Visualisation of acquired knowledge and skills of students: creating graphs, collages, clamshell albums, etc.; shooting videos (of poem recitals, performances), radio performances, etc.;
- Project-based and creative assignments: creating shared documents or presentations using Google Docs or Google Slides (selection of cases on a topic, compiling reference books, etc.), creating or playing a web-quest based on a book; writing fairy tales or short stories followed by discussions, writing scripts for a historical series.

Combinations of synchronous and asynchronous instruction are widely used on large-scale online learning platforms and by online schools. In this model, the elements maybe combined in different ways.

Firstly, video recordings of lessons, lectures, practical and test assignments are combined with live online meetings which can be arranged both for fixed groups of participants and for groups with non-fixed membership: for example, during a course a student can join different groups depending on the topic of interest and preferred schedule. A student works on assignments and studies course content by a customized programme.

Secondly, micro-lectures and exercises are collected into knowledge maps covering different subjects. Platforms are equipped with intellectual algorithms that support students during their studies along the programme, and build individual learning routes. There are functions such as tutor or curator support who hold counselling meetings with students to discuss the results of their work on the programme.

One of the focus points in the analysis of teaching and learning practices was the issue of organising group work and homework assignments.

When studying by the asynchronous model, group work is not arranged or is held only from time to time. The synchronous model engages group work activities more often. In this case students are given a practical task that must be solved within a team.

In the studied cases the types of assignments for group work include test assignments with automated check of results, games, exercises; tasks from digital textbooks; topic-based examination assignments for attestation; test or control assignments during online lessons; work with exercisers; tasks for student projects; work with prototypes; interactive tasks. The most widely used type of assignments is a test assignment.

Feedback from students is another issue considered when analysing distance teaching and learning practices in Russia. Feedback during online instruction can be received/given by means of comments to videos; cross-check of tasks or discussions of unclear points on special communication forums between students and teachers; a personal curator or mentor who gives necessary recommendations, answers

questions and solves all incoming issues, supports students and monitors their achievements; a common chat between teachers, administrators, and mentors of the course and students (e.g. communities in Slack or Telegram); online group meetings (groups of 5, 2 times per month); student achievement monitoring, preparing reports and sending them to parents of students by email.

One of the fundamental problems of remote learning is student engagement. Various methods are used aimed at solving this problem: personal consultations for students who hand in their home assignments in time; questions on the learned content; using various forms of presenting the learning content; timely reminders; background music; sound and video effects; non-standard presentation of the learning content; references to external resources when a course stimulates students to search for data and work with it independently; a system of points and statuses; using show and gamification elements.

The learning outcomes are usually evaluated by means of test assignments. As a rule, at the end of a course, students receive a certificate provided that they have successfully passed all interim assignments and the final examination. During the final attestation of students, their IDs are confirmed and the conditions of taking the exam are monitored. User ID check is performed by means of proctoring or biometric technologies. Some systems collect analytics for each student: transcript of student progress, reports, deadlines, proctored exams, as well as adoption of LTI, restricted number of tries, issued course certificates. However, this is not a very widespread practice alongside with collecting portfolios of student achievements on the learning platforms.

6.3. The United States of America

The U.S. is the country that drives the digital transformation in the world and develops new learning environments that are exported to other countries, being engaged in digital system engineering for a substantial time. E-learning platforms have been developed and used in the U.S. long before the pandemic. The major platforms used in education are *Zoom*, *Google Classroom*, *Microsoft Teams* and others. There emerge communities of digital volunteers engaged in translating content into different languages, developing new tools for state-of-the-art methods of teaching and learning. The basis of digital didactics is collaborative work, communication, exercisers, results assessment and personalization of the learning process based on Big Data, libraries of short instructional videos. This study considered the following digital learning resources and services: *Zoom*, *Microsoft Teams*, *G Suite for Education*, *iLearnNYC*, *TeachHub*, *PBS Social At-Home Learning*, *Khan Academy*, *Duolingo*, *CrashCourse*, *ABCmouse*, *Edmodo*, *FutureLearn*, *Minecraft*. Based on the analysis of these platforms alongside with the education policies of the U.S. on digital transformation, several inferences have been made.

The education system of the U.S. is highly decentralized, the key role in it belongs to the states and local school councils, while the role of the national Department of Education is relatively small. As in most countries, before the Covid-19 lockdowns schools in the U.S. held in-person classes only. During the shift to the remote learning in 2020, the decentralized educational system of the U.S. allowed for each state to choose its individual trajectory of transition to online education. Additional instructional tools that were introduced during the pandemic have been mostly developed at the state level. For example, local TV channels launched series of educational shows for school students.

The digital record keeping of student progress was already introduced in the U.S. educational practices; the choice of LMS platforms was defined at the state level and by local school councils. For example, the city of New York introduced *iLearnNYC* that provides students with personal accounts on schools' websites and incorporates tools for student achievement monitoring. After the shift to the distance mode due to the pandemic, the model of student achievement monitoring has not changed. Schools kept working with the platforms they were used to and expanded them by uploading new learning content.

The information on the final attestation of students and other learning analytics is traditionally provided by schools to the Department of Education at the state level. The Department of Education shares the cumulative data in the open access. On the platform of the Department, users can have access to the analytics of different time periods and compare data of various schools.

One of important findings of this study is that the data available on the digital learning platforms of the U.S. is highly structured. Users can run target-based searches of content by topic, complexity level, type of activity, and even communication channel (for example, one of the portals offers learning content that can be either listened to, watched or read).

6.4. The United Kingdom

The Department for Education (2019) of the United Kingdom defines 5 key areas of education where digital technologies drive the development and increase efficiency:

- Administration processes – reducing the burden of ‘non-teaching’ tasks;
- Assessment processes – making assessment more effective and efficient;
- Teaching practices – supporting access, inclusion, and improved educational outcomes for all;
- Continuing professional development – supporting teachers, lecturers and education leaders so they can develop more flexibly;
- Learning throughout life – supporting decisions with regard to work or further study and helping those who are not in the formal education system gain new skills.

The Department for Education of the U. K. supports the EdTech sector of economics, the enterprises that are engaged in developing hardware and software for education aimed to improve its quality, introduce new teaching practices and increase the learning outcomes within the following directions:

- Choosing high-quality information products and solutions that satisfy the needs of teachers and administrators;
- Integration of new ideas and technologies developed by startups;
- Support of efficient EdTech providers.

In the Industrial Strategy, the Government of the U.K. (2017) suggested investing an additional £406m in maths, digital and technical skills to ensure the leading position of the nation in the artificial intelligence sector and the availability of high-skilled professionals in this field. Another £9m was planned to be invested in a new Centre for Data Ethics and Innovation that would review the existing governance landscape and advise the government on how to enable and ensure ethical, safe and innovative uses of data, as well as lead a global dialogue on data ethics.

The Strategy of 2017 has been built upon The Science & Innovation Investment Framework 2004-2014 (Department for Education and Skills, 2004) that offered specific measures to strengthen scientific, engineering and maths education by means of the school curriculum, continuing education, higher education, in-service training of teachers, etc. These strategies emphasize strong investments into STEM education as Global Digital Education in Action (Wang et al., 2019).

The activities aimed at organising distance teaching and learning in the U.K. have been undertaken in several directions:

- a large-scale work has been carried out on developing innovative teaching and learning technologies, several educational platforms have been launched (Hungry Little Minds campaign; BBC “Tiny Happy People campaign”, National Literacy Trust Family Zone);
- a reform of the state approach to the school educational system as a whole has been implemented;
- a constant monitoring of ensuring the children's right on education has been conducted at the government's level; data is collected on the operation of online platforms;
- monitoring of the operation of mobile and Internet providers.

Here is the list of significant online platforms dedicated to developing digital education in the U.K.: Blog “DfE Digital and Technology” by Department for Education (<https://dfedigital.blog.gov.uk/>); Service for teachers that provides support on remote education (<https://get-help-with-remote-education.education.gov.uk/>).

This service is state-funded and is aimed at providing information, guidance and support for teachers and leaders on educating pupils and students who study remotely during coronavirus. The experience of remote learning shared on the platform helps to improve the communication between the school and parents, to articulate more specified expectations from the students, to decrease the pressure of school on the students with regard to homework assignments, to provide psychological counselling, to include more lessons on creativity in the curriculum. The software solutions offered by the U.K. EdTech companies is mostly focused on preparing students for exams. In the course of this research, the following e-learning services have been analyzed: *Libraries Connected*, *LendED*, *British Council*, *Remote education*. The study of the processes of digital transformation of school education in the U.K. allows making the following conclusions:

- The learning content is structured according to the topical framework that corresponds to the levels of the school curriculum or builds upon the developed competencies;
- In the beginning of 2021, the U.K. gradually returned from remote to offline learning at the key stages 1–3 and pre-school education;

The experience of the U.K. in the transition to remote learning allowed defining the measures and points of growth that will ensure the quality of online education, such as:

- Improving communication between school and students/parents (regular online meetings and discussions with teachers, students, parents);
- Clearly articulated expectations from students, elevating school's pressure on students and their parents especially with regard to homework assignments;
- Offering psychological counselling services at school;

- Providing support on transition back to face-to-face learning;
- Incorporating more art lessons and activities into the school curriculum aimed at improving students' emotional and physical condition (BBC, 2021.; Connected Learning Center, 2020; Weale & Pidd, 2021).
- Engaging digital systems to monitor learning outcomes of students;

The cases studied indicate that teachers in the U.K. are provided with the software (applications) that allows them to automate checking of standard homework assignments. Software for students is mostly focused on preparing them for exams of different levels, including samples of test assignments. Based on the results of these assignments students are provided with individual learning trajectories and recommendations on how to better prepare for exams.

6.5. France

Digitalization of school is one of the priorities of the Ministry of National Education, Youth and Sports of the French Republic. Digital transformation of school education in France is carried out through close collaboration between teachers and researchers. Digital didactics is based on adaptive tools, including accelerators for homework, self-assessment, family support, as well as mentoring of high school students. State support for schools that have not reached the "minimum level of digital education" is a priority. In France, much attention is paid to bridging the digital gap. In December 2020, the results of the project contest "*Label Digital Schools 2020*", launched at the beginning of the year, were summarized. There were identified 3,433 schools that did not reach the "minimum level of digital education" (*socle numérique de base*). The amount of 15 million euros was additionally allocated to these schools. Within the contest, co-financed by the local authorities, the state in partnership with the General Secretariat for Investments (*Secrétariat général pour l'investissement*), following the Program of Investments for the Future (*Programme d'Investissement d'Avenir, PIA*), supports the schools in procuring additional digital hardware. The hardware will facilitate and improve the learning and teaching process, maintain communication with the students' families, and promote school education, especially in remote agricultural regions. The state identified the difficulties in procuring the hardware necessary for the development of digital innovations, which are faced by the municipalities of the villages and towns, where the maximum number of inhabitants does not exceed 3,500. In 2020, the state defined funding and supplemented 17.8 million euros, allocated in 2017 and 2019 to support the municipalities with a maximum population of 2,000 people. Besides, the total number of schools supported by the project was increased to 7,200. The state does not limit the support to this action but will increase it shortly by mobilizing additional resources (Ministère de L'éducation Nationale De La Jeunesse Et Des Sports, 2021b).

Although state and individual institutions, such as schools, IT companies, etc. take active measures to introduce efficient online learning, the "*digital underachievement*" in France has remained by the beginning of 2020, especially increasing in the remote, countryside, and highland areas. Personal interviews with French teachers revealed that during the first pandemic period, French schools worked remotely with significant difficulties, and teachers used *Zoom* or *Skype*. Sometimes, a camera was set in the classroom and lessons were broadcast as a video conference via the school's online support.

The state has planned to prolong the measures for education digitalization in 2021 and allocate 105 million euros to support all primary schools that have not reached the minimum level of digital education. The state's share of the funding was supposed to be from 50% to 70%, and the regional authorities took the rest of the expenses (Ministère de L'éducation Nationale De La Jeunesse Et Des Sports, 2021a).

It is expedient to indicate a case of regional initiatives of the central region Île-de-France. There, before the 2020/21 academic year, President *Valérie Pécresse* decreed to supply each student who enters the lyceum with a computer or tablet. Thanks to the decree, in August 2020, high school students received more than 106,000 computers and 31,000 tablets free of charge. The head of the region stated that during the spring learning period in self-isolation some students had only a mobile phone to study leading to a huge gap in equal educational opportunities, which had to be eliminated (Mohamed, 2020).

At the beginning of 2020, French schools maintained a 50/50 policy of in-class/distance learning. Generally, French teachers have access to software that allows them to develop a full-fledged digital learning environment. The software allows teachers to offer learning content, monitor the acquired knowledge, skills, and competencies, as well as organize the teaching work through LMS, feedback, systems of assessment and motivational attitudes.

School digitalization is one of the priorities of the Ministry of National Education, Youth and Sports of the French Republic (Ministère de L'éducation Nationale De La Jeunesse Et Des Sports). The development of a plan of school education digitalization has become one of the tracks of the National Education Forum (*Grenelle de l'Éducation*, October 22, 2020 – February 2021, the initiative by Minister *Jean-Michel Blanquer*).

Among the initial events of the Forum, there were the Assembly of Estates-General for Education Digitalization (Ministère de L'éducation Nationale De La Jeunesse Et Des Sports, 2020a) and the establishment of a collaborative environment to ensure national participation in the Assembly of the learning process subjects, including teachers, educational programme developers, parents, students, software developers, etc. Within the Assembly, the event welcomed 2,755 participants, 229 meetings were held, 392 articles were issued, 724 suggestions were made, 2,458 comments were shared.

The conclusions of the Forum (Ministère de L'éducation Nationale De La Jeunesse Et Des Sports, 2021a) include the following.

One of the priorities is the establishment of a research community to promote joint design, joint development, and joint evaluation, through national project contests initiated by the Directorate of Information Technology in Education (*Direction du numérique pour l'éducation*, DNE). These initiatives are undoubtedly valuable for enhancing teachers' qualifications.

The improvement of the *Edtech* public market should aim to develop tools that meet the teachers' needs. The request emphasizes the need to prioritize the integration of digital resources into learning trajectories created by teachers. Therefore, it is important that practicing teachers, researchers, and IT developers are brought together for joint design and pilot-testing to ensure the best introduction of the results of research and technical development into the learning environment. The implementation of the strategy will result in the establishment of an interactive and advanced platform that will provide access to resources and ensure their monitoring, evaluation, and updating. This idea is embodied in the collaborative learning environment *Education Netflix* that is popular among teachers and brings together

theorists and practitioners, learning content and software developers, state institutions, and private businesses.

According to the Forum's data (Ministère de L'éducation Nationale De La Jeunesse Et Des Sports, 2020b), 12% of teachers name a France-designed product as one of the three digital tools that they use most often in their professional activities. 100,000 teachers have already been trained in the use of digital technologies at the CanoTech by the National Center for Education Innovations and Methodological Support (Réseau Canopé). The Forum participants argue that the teachers' opportunities should be increased for selecting digital resources that they want to use, and teachers should be allowed to manage budgets. As a rule, free access to a resource and compliance with the General Data Protection Regulation (GDPR) are the first selection criteria (L'Express, 2020).

The Forum has also pointed out the following:

“It is crucial to expand the options for teachers by providing them with certain budgets through a simple procedure, similar to PayPal accounts, to enable them to equip their classrooms. If such market is not established, GAFAM (*Google, Amazon, Facebook, Apple, and Microsoft*) will take their place. We would like to point out a proposal that introduces a new approach to ensure consistency between study time and “out-of-classroom” time. It will be a question of creating a learning agora, including adapted tools. It will play a new role as an accelerator for homework, self-assessment, learning support for families, openness to the world, and project-based learning. It will also assist in tutoring high school students when they choose individual learning routes. In this context, teachers will be engaged in developing learning content, based on the learning topics of the discipline. Administrative staff and principals will be the coordinators to best guide the dynamics in the respective directions of the school”.

In France, the epidemiological situation stimulated the National Center for Distance Education (CNED) to create the online portal *Ma classe à la maison*. It is not only a set of learning resources but also a “learning tool”, whose architecture and structure are aimed to assist students in mastering new learning content. The CNED service provides technical and methodological support of the portal. Besides, learning content is hosted by digital environments — internal school networks *Environnement Numérique de travail, EcoleDirecte, ProNote*, etc. Television and radio are also engaged in offering their services to education. For example, *France Télévision, Radio France, Arte*, and *National Education* provide podcasts, streaming, or broadcast on national websites and platforms.

The study examined the following digital learning resources and services: *NAVI, LUMNI, BRNE, Ma classe à la maison, ProNote, Ma SpeMaths, English for Schools, Deutsch für Schulen, Jules*. The study concludes that the learning content is structured based on a topical framework and corresponds either to an educational stage (primary, secondary, or high school), a subject (history, geography, language and literature, mathematics), or a developed competence (especially those in primary school, such as reading, writing, calculation).

The examined cases, as well as other numerous learning resources, platforms, and applications available to all users of the French education system² (which we leave out of the scope of this review due

² Among others, we indicate both institutional and personal platforms: <https://eduscol.education.fr/162/edubase> (a database of lesson scripts), <https://eco.tactileo.fr/sso/login/mescoursensolo> (a platform for independent study of school subjects), <https://www.edutheque.fr/accueil.html> (a database of learning resources), <https://www.kwyk.fr/> (a support platform for studying a course of mathematical disciplines at school), <https://www.hugolescargot.com/> (a website with interactive and creative tasks and

to its redundancy at this stage), lead us to the conclusion that French teachers have access to software that allows them to develop a full-fledged digital learning environment:

- At the level of providing learning content;
- At the level of assessing the acquired knowledge, skills, and competencies;
- At the level of organizing the academic work (LMS, feedback, systems of assessment and motivational attitudes).

However, as has been pointed out before, France has yet to overcome the “digital gap”, as the tools available to teachers are not always used to their full potential. That is why the consistent implementation of the national plan for school education digitalization is one of the priorities for the French government.

6.6. Singapore

By now, in Singapore, there have been five Masterplans (MP) for ICT in Education, including Masterplan 1 (1997—2002), Masterplan 2 (2003—2008), Masterplan 3 (2009—2014), Masterplan 4 (2015—2019), and Educational Technology (EdTech) Plan (2019—current) (Chua Chor Huat, n.d.). MP4 focuses on developing competencies and values of the 21st century through the upbringing of responsible citizens of the digital society. In particular, the objectives of MP4 include the development of digital literacy in the areas of cyber wellness and ethical use of network media (Natarajan et al., 2021; Lee et al., 2018; Ministry of Education Singapore, n.d.). All innovations for schools are introduced under the FutureSchools@Singapore initiative, supported by the Ministry of Education and the Ministry of Communications and Information. It aims to involve students through the possibilities of a virtual environment with the effect of full immersion, learning games, etc. The introduction of advanced ICT in the school infrastructure makes it possible to develop network cooperation, create student communities at school and out of it, and involve parents in the process of teaching children (Ministry of Education Singapore, n.d.). Therefore, Singapore becomes a leader in the integration of digital tools into the school.

The study examined the following digital learning resources and services: Singapore Student Learning Space, Electronic portal of the Ministry of Education Singapore, National Library Board. Access to the state learning portal of school education (Student Learning Space, SLS) is restricted for external users. The Ministry of Education Singapore states that SLS features software tools that allow educators to visualize the students' thinking process. It ensures the objectiveness of learning outcomes assessment, informed decisions regarding students, and high quality of students' knowledge. The library contains top-quality learning content, structured according to the school curriculum. Experts of the Ministry of Education verify all content before it becomes available. Educators can freely use lesson scripts of the library and customize them to the students' needs.

The Ministry of Education Singapore actively promotes the concept of digitalization of school education. Since 2018, the use of SLS is mandatory for all schools nationwide. During the pandemic, the existing practices of using digital resources facilitated the transition to the electronic environment and brought the experience of students' distance learning to in-class learning.

crafts for primary school students), <https://www.educartable.com/> (an electronic diary), <https://www.schoolmouv.fr/> (a support platform for secondary school students with additional tasks and instructional videos), <https://www.epopia.com/blog/> (an educational blog for teaching primary school students).

6.7. Australia

In December 2015, the Australian Government issued the National Innovation and Science Agenda, where “Talent and Skills” was one of the key areas, and developed the plan “Inspiring all Australians in digital literacy and STEM”. The Australian Curriculum (Version 4.0) was approved and introduced in 2015 and includes “digital technologies” as one of the 8 learning elements from the basic to 10th grade.

In December 2018, the Department of Industry Innovation and Science issued a policy document “Australia's Tech Future. Delivering a strong, safe and inclusive digital economy”, where allocated a special \$1.4 million Ph.D. scholarship to support emerging Australian researchers in artificial intelligence.

The “Australia's Tech Future. Delivering a strong, safe and inclusive digital economy” features an strong ethics agenda. Experts develop digital science and technology ethics and legal regulations, strengthen the science and technology ethics in education, and reinforce the self-discipline of consciousness. Besides, they become engaged in the developing students' digital literacies (Wang et al., 2019).

The study examined the following digital learning resources and services: National Digital Learning Resources Network, Learning at home, Scootle, Digital Technologies Hub, Learning potential.

In Australia, the topical framework of electronic libraries is based on the structure of the National School Curriculum. The digital objects are classified first according to a level of education (grade), then to a subject area, and a unit. In high school, a unit includes tasks, which consist of activity packs as PDF documents, presentations, MS Word worksheets. There are state services that provide support to digital learning, and teachers use automated verification as empirical data for learning outcomes assessment.

The Australian Government gives priority to offline schooling and strives to create a healthy and safe learning environment for students. Nonetheless, large-scale state financial resources are allocated to introduce a digital interactive component into the school curriculum. The lesson scripts in electronic libraries necessarily include a component of teaching and learning of digital competencies. For example, as part of the lesson subject topics, children learn to systematize information, transform it into the digital form, edit, discuss and save it for future use.

Resources for learning outcomes assessment are usually divided into two groups: software tools that automate part of the intermediate assessment of school students' knowledge and competencies and provide teachers with empirical data for more reasonable decisions; methodological content as manuals, guidelines, presentations to ensure informed learning outcomes assessment.

6.8. Canada. Province of Alberta

Canadian provinces and territories are independent in matters of education. The education system of the English-speaking provinces and territories adopts the Anglo-American education system. The education system of Francophone territories and provinces tends more towards the French education system.

The study examined the following digital learning resources and services of the province of Alberta: *the Center for Alternative and Virtual Education, Black Gold Virtual School, Revelation On-Line, Argyll Center, St. Isidore Learning Center, Peace Academy of Virtual Education, Vista Virtual School, etc.*

In Canada, online schooling is most widespread. Online learning is considered one of the numerous programmes that facilitate individual learning and provide students with flexible opportunities to complete their studies. In Alberta, online learning includes a structured learning environment, where students take one or more online courses with their teachers.

The digital transformation of school education in Canada results in flexible learning. Digital learning solves the problems of individual learning of school students and adults. Students of online schools can learn subjects both online and in class, and take part in public events. Online learning is based on accredited programmes, and credits received at online schools are counted at in-class schools. Besides, online education in Canada helps parents who want to be teachers for their children. Schools provide services to facilitate family education.

Access to the information systems is restricted for public users, which are based on distance, electronic, and home learning. However, *Moodle* is mentioned on most of the examined resources. Probably, there is no unified platform for schools in Canada due to the general education policy. Learning content is structured based on the content of academic disciplines and programmes that specify the developed skills. Learning outcomes assessment is based on the completed tasks and passed exams.

6.9. Kazakhstan

The directions of education digitalization in **Kazakhstan** are indicated in the State programme “Digital Kazakhstan”. In 2018-2022, five key areas of the State programme have been implemented, including “Economic Sectors Digitalization”, “Transition to a Digital State”, “Implementation of the Digital Silk Road”, “Human Capital Development”, and “Innovation Ecosystem Creation”. The programme defines the role of education in the country's development (Programme “Digital Kazakhstan”, n.d.) as follows:

The new education will meet the needs of the digital economy and emphasize, first of all, on information analysis skills and creative thinking development, rather than on memorizing facts and formulas. The subject “Fundamentals of Programming” will be introduced to secondary education, from the 2nd grade, to develop creative skills and critical thinking among the younger generation. The curriculum from 5th through 11th grade will also be updated. Primarily, programming languages will be revised, the STEM elements will be introduced, including robotics, virtual reality, 3D printing, etc. Regular hackathons, Olympiads, and contests, as well as robotics and programming clubs, will be held to develop and support young talents. Besides, teachers will be offered advanced training on new digital technology to enhance and acquire new skills. Within technical and professional education, the same events as within secondary education will be carried out to increase students' access to resources and knowledge. These events include hackathons, Olympiads, contests, and infrastructure to train for them. In addition, standard curricula and programmes will be updated based on the professional standards and labor market requirements. The new standard curricula and programmes will be aimed at training

specialists with knowledge in the field of development, administration, and testing, considering coding skills development. Furthermore, the subject "Information Science" will be introduced to teach digital skills for specialists with technical and professional education. Teachers will be offered advanced training courses on educational programs that provide competencies in the use of ICT.

The Ministry of Education website features the section "Digitalization", which includes distance learning platforms and "Kundelik", the most widespread electronic learning environment in Kazakhstan. 6,000 schools in Kazakhstan have been using "Kundelik" since 2018. The environment comprises an electronic diary and an electronic document management system. It is a platform for communication of educational stakeholders and storage of video lessons.

Kazakhstan is at the beginning of the path to digitalization. Before the pandemic, there were no other electronic resources but *Kundelik*. School education was in-class. Students had access to *Kundelik* to strengthen the knowledge acquired and prepare for exams. Currently, the systems in Kazakhstan are non-centralized and unclearly structured. For example, there is no access to all services through the Ministry's website, and the links on the Ministry's website are inactive. It is impossible to explore the functionality of the programmes without a login and password. The content of the platforms is presumably arranged by subjects and grades. The study examined the most widespread digital learning resources and services: *TV lessons*, *lessons on the "Qazaq radiosy" radio*, *Kundelik*, *Daryn.online*, *Online mektep*, *Opiq*, *Onlinemektep*.

The year 2020 saw a "crisis" transition to distance learning in Kazakhstan due to the pandemic. The Ministry has issued methodological guidelines for the learning process during the period of restrictive measures. Promptly, video and radio classes were recorded for students. In 2020, the development of online platforms was initiated in Kazakhstan to enable students to strengthen their subject knowledge and prepare for exams. The programme for school education development predicts that by 2022, education will have become paperless and all the schools will have been provided with computers, multimedia equipment, and broadband Internet access.

6.10. Latvia

Latvia is a country where digital platforms have been widely used for a long time. Almost all school education services are supported by the Ministry of Education and Science, connected and integrated.

The study examined the following digital learning resources and practices: *E-klase*, *Mykoob*, *Tavaklase*, *Skola 2030*, *SOMA*, *Maconis Zvaigzne ABC*, *Uzdevumi*, *FIZMIX*, *LVA*, *Letonika*, *Start (IT)*. Distance learning was carried out through *TV lessons*, which were posted on *Tavaklase*.

In Latvia, there are several electronic school management systems. *E-klase* is the most widespread among them. The system has been operating since 2005 and is used by the vast majority of schools (90%). The system cooperates with the Ministry of Education and Science of Latvia and coordinates electronic journals with the Ministry, among other things. *Mykoob* is the second most popular system in Latvia, which has been operating for more than 10 years. *Uzdevumi* is one of the major systems, which has been operating for more than 5 years. It contains a large number of tasks in basic school subjects, which allows students to prepare for exams and test their knowledge. Since 2016, the project

“Competency-based approach in the curriculum” (*School2030*) has been implemented in Latvia, which pays particular attention to the development of students' digital competencies. Within the project, the portal has been created to host learning resources, which are focused on the development of students' subject and meta-subject competencies, including digital literacy. Integration of the platforms allows teachers to post assignments from *Uzdevumi* and *School2030* in *E-klase*.

The systems ensure the communication "teacher — student — parent", as well as provides an opportunity to give marks, attach assignments, monitor attendance, and automatically generate final marks. The Ministry's website contains links to other electronic learning systems that students, teachers, and parents can use during the learning process. The information on the platforms is clearly structured. Students can choose content, differentiated by a subject, a grade, a complexity level, a format of tasks, etc., to master basic and additional educational programs. The use of the platforms is mostly free for students.

6.11. Tunisia

The education system in Tunisia largely reproduces the French model, due to its colonial background. Since 1999, Tunisia has been named the leading Arab country in the *Trends in International Mathematics and Science Study* (TIMSS). However, in 2020, a collapse of the education system was observed in the areas of teaching mathematics, natural sciences, and foreign languages. Programme for International Student Assessment (PISA) and TIMSS listed Tunisia among the countries with the poorest indicators [Tunisienumerique.com, 2020].

Tunisia declared the ambition to digitize school education, quite a long time ago. In 2011, Tunisia, among the first Arab countries, announced establishment of the website for Tunisian Digital School (Tunisienumerique, 2011). In 2016, it was reported that 52 basic education schools had become digital (MKJ, 2016). Now, the French-speaking version of the website of Tunisia's Ministry of Education shows a significant number of results, indicating the government's initiatives in this area, in response to the search request “*école numérique*” (*school digitalization*). However, the information about the initiatives is hardly available. There are sporadic initiatives announced by the Minister of Education on school digitalization, the introduction of a new digital service in the Arabic language, the Forum of Digital Twinning, the digitalization of documents within basic educational programmes.

Therefore, the information about school digitalization in Tunisia is insufficient in the French-speaking sector. We have considered a single case of *École numérique Tunisienne*, which is a digital platform of methodological developments in the basic school disciplines. At this stage of the analysis, it is impossible to draw adequate conclusions with regard to the research questions. Further study of the Arabic-speaking sector of the information field in Tunisia is required.

7. Conclusion

The study allows making a conclusion that the countries selected for analysis are currently at different levels of education digitalization. In some countries, such as the U.S. and Latvia, digital platforms have been integrated into the learning process for more than 10—15 years. In others, as

Kazakhstan, there has been the "shock transition" to digitalization. The countries introduce into school education various resources, including video lessons, electronic textbooks, learning games, educational forums, etc.

Speaking of integrating digital resources into the learning process, different tracks can be defined based on the period of using digital platforms by educational institutions before the outbreak of the pandemic. In the countries where digital resources were integrated earlier, the transition was more systemized. Links and tasks have been attached to the existing platforms. In other countries, where digitalization was rapid, the transition was carried out unsystematically. For example, teachers sent assignments and gave feedback via messengers, rather than unified digital platforms.

The practice of school education has adopted best teachers' lessons through mass broadcasts (video, TV, and audio), jointly developed and used repositories of learning content, adults' online learning of school curriculum, public services for collaboration, classes of students from different regions, customized learning of students with varying needs, tools for automate verification of test assignments, Big Data mining of learning activities, etc.

Digital learning systems of schools serve as tools for fostering values, languages, cultures (e.g. the expansion of French language-based learning environment in the African countries), and maintaining the unified learning environment, including through the instruction language (e.g. in Russia, Latvia, France).

Across the globe, school education systems of different countries interconnect through the development of supranational digital learning resources and services and the translation of learning content in different languages.

On the one hand, the new school education evolves in the context of shifting from the paradigm *learning by doing* to the paradigm *learning by faults* (when students have to do practical tasks with no understanding, even theoretic, of the methods how to do them; when students complete their tasks, special coaches discuss with them their faults, what could have been done better), and to the paradigm *learning by coworking* when students are encouraged to learn through interaction and experience exchange. The hierarchy "teacher — student as a listener" breaks down, geographical and time barriers are no longer relevant, the learning process becomes open, and incorporates customized training programmes, and mass network educational formats.

On the other hand, the digital gap of access to education between different countries, as well and individuals, increases. The "humanitarian profit" becomes evident: to overcome the digital gap, the measures are taken at different levels, from the state level to individuals who start their own educational blogs as a voluntary contribution to education (for example, <https://www.epopia.com/blog/>). Repositories of learning content are created in collaboration of users: teachers are ready to share their developments to contribute to the common good.

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