Original Article

Impact of the COVID-19 pandemic on the development of digital technologies in academic education

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ABSTRACT

The ongoing global academic education crisis resulting from the COVID-19 pandemic has provided an opportunity for greater digital adoption in the online learning process. The study aims to analyze the impact of the COVID-19 pandemic on the development of digital technologies in academic education and the creation of a digital educational environment. The article shows the impact of the COVID-19 pandemic on the functioning of the field of academic education and the spread of online learning using digital technologies analyzes the concepts of "digital technologies" and "digital educational environment", and presents the characteristics and capabilities of the digital educational environment of higher education institutions. Based on the analysis of literary sources, the criteria for selecting digital technologies for the digital educational environment have been identified, digital tools have been identified that allow creating conditions for an active educational trajectory of students, and a brief description of some of them has been given. It has been shown that the main place in the digital educational environment was given to the educational content management system. The article proves that the spread of the COVID-19 pandemic will have an impact on the accelerated introduction of digital technologies into the academic educational environment.

Keywords: Academic education, Online learning, Digital educational environment, Educational content management system, Information and communication technologies

Introduction

The problem of the research

Due to the coronavirus epidemic, most of the world's universities are switching to distance learning. For the first time in history, when the traditional teaching of universities on their campus is completely transferred to the Internet, teachers offer their lectures or teaching through online learning platforms and video conferences, as well as introduce various digital technologies to ensure better interaction with students.

Such an unusual experiment gives education researchers a great opportunity to gather information and solve important questions that were previously unanswered – whether digital technologies and online education can change the educational paradigm.

The experience and learning outcomes of students are among the most important factors in assessing the implementation of digital technologies and the quality of online education. According to several surveys [1, 2], students reported very positive learning experiences. Between 40 and 55% of students believe that online learning and traditional classroom learning are equivalent in terms of the overall quality of teaching. Between 15 and 30% of students reported that synchronous online learning using digital technologies is better than traditional learning. About 30% of

Access this article online	
Website: www.japer.in	**E-ISSN:** 2249-3379

How to cite this article: Smirnova EA, Stolyarova AN, Surnina KS, Denenberg YM, Dikova TV. Impact of the COVID-19 pandemic on the development of digital technologies in academic education. J Adv Pharm Educ Res. 2021;11(1):207-13. https://doi.org/10.51847/NOMIOs9nAQ

students believe that traditional learning is superior to online learning [3-5].

The most useful component of synchronous online learning is viewing the video or audio recordings provided by online learning platforms, along with slides, and interacting with instructors through digital online tools or virtual interaction in video conference rooms. Students note a more comfortable viewing of courses on their laptops compared to the display in the classroom [6-8].

University administrations and management structures can also clearly benefit from online education and the introduction of digital technologies in academic education. Taking advantage of the consensus on online education, the management system of the educational institution, including the usual meetings and administrative procedures, can completely move to the Internet and become more efficient and simple.

Universities may need to provide more professional support to students and ongoing support for the professional development of teachers to help them accept the new conditions for the organization and management of universities. As for education, online education does not guarantee the quality of knowledge. University leaders also need to be aware of the digital divide and equity in access to learning for disadvantaged students.

The most significant advantage of online education may be the elimination of the boundaries between elite universities and society. Better educational resources will be more accessible, improving the accessibility of academic education to the whole society. Citizens' acquisition of lifelong education will also be facilitated. However, a good online learning model is extremely expensive when it comes to establishing online systems and engaging teachers.

Summing up the above, we note that the crisis has given elite, traditional universities based on their campuses a unique opportunity to implement a system of fully digital educational environment (DEE). It is urgent to find ways to purposefully form and develop the DEE of an educational institution, designed to provide: access to education using the same digital technologies that educational applicants use for communication and activities outside the educational institution; new forms of interaction between participants in the educational process; a real opportunity to solve the problem of considering the individual characteristics of educational applicants. In general, the positive experience of stakeholders is very valuable if one strives to develop a new paradigm for academic education, but a lot of effort needs to be made to solve existing problems, both existing and potential.

Literature review

To understand the features of our research, it is necessary to describe such phenomena as "digital technologies", "digital educational environment".

A.D. Olofsson *et al*. [9] defines the concept of "digital technologies" as technologies that use digital signals to transmit information. It was found out that there is no single approach to the definition of "digital technologies" in scientific circles. In the classical sense, we interpret it as an electronic method of processing and transmitting information using coding signs that are used in computer engineering and computer technologies.

Herewith, the scientific works of researchers [10, 11] emphasize that professional associations, publishing, and technology companies should support and strengthen the efforts of teachers of higher education institutions in the introduction of digital technologies to continuously improve the learning process. This ensures the success of the educational trajectory of the individual, the demand in the labor market, and society as a whole.

The result of the widespread introduction of digital technologies in academic education is the creation of a DEE of the university [12].

An analytical study of scientific sources has revealed that the phenomenon of the "educational environment" is complex. At the present stage of the development of science, many approaches and interpretations describe it in different aspects, in particular: as a natural or artificial creation of favorable conditions for the human environment, opportunities for changing the pedagogical interaction between the subjects of the educational process, the conditions for learning and personal development, and so on [13]. However, for the education system, one of the main challenges of digital transformation is the speed of changes taking place in technologies and computer tools. Consequently, an important place among the current trends in the development of education is occupied by the renewal of the educational environment with their use, which expands the opportunities of the applicant for education in the "zone of his/her immediate development" [14].

The characteristics of the digital environment of modern society are rapid changes in socio-economic needs, new ways of perception and interpretation of information, cultural and social diversity, technologization based on universal and national values.

The transformation of modern social relations determines the renewal of systems, processes, and terminological concepts. One of them is the concept of "digital environment", which is defined as a set of information and communication technologies (ICT), including the Internet, mobile technologies, and tools, as well as digital networks, databases, content, and services [15].

Different approaches to the concept of "digital educational environment" are presented in **Table 1**.

Table 1. Analysis of approaches to the concept of DEE

No.	Source	DEE
1	[16]	is an environment that combines components that ensure the digitalization of the main types of activities: educational (educational and nurturing process), management of the educational process, the contingent of students, material and technical, information, human resources), communication (full-fledged information exchange), automation of managerial and pedagogical processes, coordinated processing and use of information; assumes the presence of a regulatory and organizational framework, technical and methodological support

2	[17]	is an open system that combines intellectual, cultural, software and methodological, organizational, and technical resources
3	[18]	combines a wide range of educational software and networking technologies, including email, forms, collaborative software, chats, video conferencing, audio and video recordings, and a wide range of web-based learning tools
4	[19]	is a system consisting of a set of subsystems (educational resources) that are in the conditions of information exchange between participants of the educational process based on modern digital technologies

Researchers [20] have proved that the creation of the DEE in academic education provides for updating educational information in the context of the development of science, technology, and culture; qualitative changes in the methods and forms of educational work; obtaining operational information about the level of cognitive abilities and knowledge of each student and timely adjustments to the methodology of knowledge acquisition; strengthening interdisciplinary links in training, ensuring the complexity of the study of reality phenomena; increasing the volume of independent work through the optimal sequence for each student, the speed of perception of the material and the ability to self-control the quality of knowledge obtained.

After analyzing the above definitions of the concept of DEE, we can summarize the approaches to its understanding and interpretation. DEE is a single digital space of a higher education institution that provides a holistic training of future specialists in the university, an integrated approach to the use of ICT in the educational process through professional and project activities, interactive communication systems, verification, and monitoring of acquired knowledge and skills.

Researchers [21] note that the use of digital tools and technologies that have acquired signs of mobility affects the environment where education applicants are trained and is a mechanism for implementing personal flexibility and adapting the modern personality to changing ways of educational interaction. Such an environment is characterized by dynamism, mobility, and adaptability, and the implementation of educational activities in it takes place without territorial restrictions (at home, on the road, at work), geographical (from any location), temporary (at a convenient time and a convenient pace). We consider it promising to use the capabilities of modern digital technologies in its development.

The purpose of the article is to analyze the impact of the COVID-19 pandemic on the development of digital technologies in academic education and the creation of a DEE.

Research problem:

- to consider the impact of the spread of the COVID-19 pandemic on the activities of higher education institutions;
- to predict the impact of the COVID-19 pandemic on the development of digital technologies in academic education;
- to analyze the possibilities of using digital technologies in higher education during the spread of the COVID-19 pandemic.

Research hypothesis: the spread of the COVID-19 pandemic will have an impact on the accelerated introduction of digital technologies into the academic educational environment.

The article consists of an introduction, methods, results, discussion, and conclusion.

Materials and Methods

To determine the impact of the COVID-19 pandemic on the development of digital technologies in academic education and the creation of a DEE, an analysis of scientific literature, analytical reports of international organizations in the field of higher education, opinions of experts and analysts in the field of higher (academic) education was carried out.

At the first stage of the study, the available analytical data and scientific works in the field of research were studied. At the second stage of the study, based on the data analysis, the main characteristics of the DEE, the criteria for selecting digital technologies, and the corresponding tools of the DEE were determined. The results of the study were summarized at the third stage of the study.

Results and Discussion

Based on the analysis of the scientific literature [22, 23], we distinguish the following characteristics of the DEE **(Table 2)**.

Table 2. DEE Characteristics

No.	Characteristics	Content
1	openness	support of modern standards, network technologies
2	ability to expand	building up functions following the specific requirements of the educational institution
3	scalability	an increase in the number of services provided in the environment; the amount of information that can be processed, the expansion of databases and knowledge that does not lead to the need to reconfigure the system
4	integration	the ability to organize a unified educational environment for expanding the tasks associated with the development and design of educational and methodological support for the educational process
5	adaptability	dynamic customization for the needs of both a specific educational institution and an individual user

From the point of view of ensuring the implementation of the planned learning outcomes and the implementation of formative assessment in the DEE of higher education institutions, we distinguish three criteria for the selection of digital technologies **(Table 3)**.

Table 3. Digital technology selection criteria

No.	Criteria
1	providing interactive information interaction in the learning process
2	adapting to the individual characteristics of students

3	the possibility of synchronous or asynchronous interaction of subjects of educational activity. The use of digital tools for evaluation is multivariate. The teacher chooses a specific technology based on the educational needs of the students

Following the specified criteria and based on the results of the monitoring of online resources, digital tools were identified that allow the teacher to create conditions for an active educational trajectory of students in the DEE. We classify them according to the directions **(Table 4)**.

Table 4. DEE Tools

No.	Assignment	Digital tools
1	for setting the educational problem, summarizing the studied material, summing up the results	Google Drive, Google Forms
2	for testing and consolidating knowledge, forming critical thinking	Learning apps, Educaplay, Flippity
3	for organizing group work, reflection	MindMeister, Cacoo, Bubblus, Mindomo
4	for organizing independent work	Glogster, ThingLink, Google Drive

The use of digital technologies, based on which the DEE is created in an educational institution, where students can access educational materials at any time and in any place. It makes the educational process more attractive, comfortable and encourages students to self-education [24]. The use of digital technologies in the DEE creates opportunities for managing the learning process, methodological support, optimal organization of joint interaction between the teacher and students, and updating the forms of interpersonal communication [25]. Scholars also refer the following to the advantages of using digital technologies in academic education: savings on the purchase of software; accessibility to resources regardless of location, operating system, types of computer equipment; increasing opportunities for organizing collaboration and diverse communication; reduction of data storage and backup problems [26].

Therewith, the main place in the DEE is assigned to the LCMS (learning content management system) as a point of access to the knowledge of educational applicants. The system's educational content is created by teachers or by their developments, or by using a copy of another developer's course.

It is not possible to determine the exact number of LCMS at the moment, but the review and analysis of the systems attract the attention of many scholars. The article [27] presents LCMS considering the basic functionality and describes the characteristics of various control systems. The researcher [28] also reviewed and compared the main functional modules of content management systems, such as administration, access to educational materials, and means for ensuring communication between participants in the learning process. In the conclusions of the study [29], it was noted that most of the LCMS considered, have sufficient capabilities for organizing effective training, but it was revealed that some of them lack interface localization.

Thus, according to the analysis of sources, it can be noted that in all the LCMS considered, access to educational materials is organized, the interaction between the teacher and the student is provided, testing and reporting is possible. The CMS market is rapidly developing. The use of LCMS is promising because it is a fast tool for creating content and tracking learning outcomes.

As for the choice of LCMS, in our opinion, MOODLE, Claroline, or Blackboard Learn are the best choice for organizing the training of an educational institution in the context of a pandemic.

LCMS MOODLE is successfully used in more than 200 countries and more than 40,000 organizations. This modern learning management system is aimed at creating interaction between the teacher and students.

A backup copy of the course (activity module, course section) created in any MOODLE e-course can be restored in another e-course of this or another site on the MOODLE platform, which ensures the mobility and prevalence of this system. If teachers do not use the full potential of the LCMS, they can still use it to direct applicants to external sources of education on the Internet, or at least to post homework [30].

Among other things, MOODLE provides for issuing tasks to applicants for education and evaluating them; uploading files in the form of written answers; online testing with a bank of various types of test tasks; posting and accessing various types of resources aimed at improving the assimilation of educational material; the possibility of communication between students and teachers in the form of forums and messages; various ways of enrolling in the course/course discipline.

Also, within the framework of this article, we will briefly describe the digital tools that can be used to create distance online education courses in a pandemic.

Google Drive is an online environment that includes tools for creating text documents, spreadsheets, presentations, and data visualization, where files (pictures, recordings, videos, documents, tables, etc.) are organized, stored, modified, deleted, and added. Files are accessible from any device that has an Internet connection, and changes are saved automatically. In general, the set of functionality of Google services allows creating a local network of an educational institution through the administration module and settings of user rights policies, network folders, documents to provide students and teachers with personal access to corporate network resources. The administrator, teacher, and student have a corporate email account, access to certain electronic information of the educational institution, which can be edited by them without access to other pages. This, on the one hand, provides the opportunity for the teacher to systematically update the educational material and control the information received from students and colleagues, and on the other – develops the independence and responsibility of students. To enter a corporate network account, any computer communication tool convenient for the subject of educational interaction is used (laptop, netbook, smartphone, tablet, stationary computer). Note that this tool can be used in the educational process by a teacher of any discipline in lectures, laboratories, and practical

classes. The ability to work through comments allows synchronously or asynchronously processing tasks for students with a teacher, accepting or rejecting a proposed solution, and so on. This makes students more consciously study the learning material.

Google Forms is a tool for reflection, creating simple surveys on any topic. It is possible to analyze the results of the survey using the spreadsheet tools from Google.

Learning apps is a tool that allows creating interactive exercises. It is a constructor for the development of various tasks (quizzes, crosswords, puzzles) of various levels of difficulty and various subject areas.

Cacoo is a tool that allows collectively creating charts and diagrams online, simultaneously making changes and discussing the work in a special chat.

Answer garden is a tool for organizing instant evaluation of responses, simplifying the process of obtaining statistical data.

At the same time, their use by the teacher in the educational process provides feedback, in particular, for the final and formative assessments, which provide various data on the level of students' understanding of key concepts of the educational material and the formation of certain skills. Formative assessment is constructive feedback from the teacher to the student. Also, it is an opportunity to track the student's development process, error analysis, development of critical thinking, and so on. In other words, the reflection of educational achievements with a clear idea of what needs to be done next.

Conclusion

The epidemic of the COVID-19 virus has become the engine of the use of the latest digital technologies in education, which, in turn, leads to changes in the construction of the DEE of the university [31, 32]. The selection of digital technologies depends on the educational goals. The process of educational interaction with the use of digital technologies is becoming more flexible, accessible, and personalized, which meets the challenges of modern society – the difficulties of offline learning in the context of a pandemic. The active introduction of digital technologies in academic education is an important factor in the modernization of the education system.

The use of DEE in the educational process of the university opens up significant opportunities for creating innovative approaches in vocational education; ensures the preservation of human resources, continuous improvement of professional skills; equalizes conditions for all, ensuring equal access to educational materials through the systematic use of ICT for vocational training in universities.

Summing up the possibilities of introducing digital technologies in academic education during the pandemic, it is revealed that they enrich traditional teaching methods with new forms of presentation of educational information and ways of interaction, which are characterized by dynamism and mobility. Their use by the teacher in the educational process for educational tasks and formative assessment ensures the inclusion of the student in the processes of information exchange, maintaining an individual approach to everyone, considering the needs of the applicant for education, creating conditions for self-realization, cooperation, reflection, and so on.

Thus, the results of the study confirmed the hypothesis that the spread of the COVID-19 pandemic will have an impact on the accelerated introduction of digital technologies into the academic educational environment.

Acknowledgments: None

Conflict of interest: None

Financial support: None

Ethics statement: None

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