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ARCHITECTURE OF UNIVERSITY EDUCATIONAL PROCESSES IN THE CONDITIONS OF THE COVID-19 PANDEMIC: FROM SMALL DATA TO BIG DATA AND DATA SCIENCE

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The paper focuses on the degree of influence of Big Data on building the educational process at the Russian Law University during the COVID-19 pandemic. We use the sociological method as the primary research method. The result shows the influence of the collected information on administrative decision-making. Additionally, we describe the educational process within the selected university. The paper demonstrates student attitude toward Big Data in various aspects, including awareness of the technology and its significance for the university's management. We conclude that Big Data has not yet been widely used in Russian higher education. Therefore, we identify the reasons preventing the use of Big Data in education. This research novelty lies in pointing to Big Data's impact on the architecture of the university educational process in different periods of the COVID-19 pandemic when higher education institutions implemented distance or mixed learning and online communications.

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1. INTRODUCTION

The current challenges require a constant reassessment of the methods, forms, and means of the educational process. The era of digital technologies and the emerging information space indicate the need to systematize existing approaches, including education. The constant increase in the amount of data requires the ability to efficiently process and extract "useful" information from the boundless and unsystematic information field.

According to the common understanding, the category Big Data refers to structured and unstructured data of considerable volume and significant diversity. Additionally, this data is effectively handled by horizontally scalable software tools that emerged in the late 2000s. The processing occurs through databases and solutions of the "Business Intelligence" class, which are alternatives to traditional management systems. A similar but more succinct interpretation of Big Data can be found in the "Concept of creating a digital analytical platform for statistical data provision".[1]

In a broad sense, Big Data is a socio-economic phenomenon associated with the emergence of technological capabilities to analyze vast amounts of data [12].

Regarding education, Big Data is a technology providing at least three critical opportunities. (1) One can create methods adapted to a large number of students. Additionally, it allows (2) the personalization of the content and (3) customization of the training mode [12].

In 2019, the vast majority of Russian institutions of higher education were working mostly with small data. This was due to the fact that there was no special electronic environment that would contain a significant amount of online content and would allow a large number of users, including academic staff and students, to interact. The federal project "Personnel for the Digital Economy" is being implemented as part of the national program "Digital Economy of the Russian Federation" [4]. The project provides training of competent, highly qualified specialists and encourages educational institutions of higher education to intensify the relevant work. The digitalization of education became possible because several general-purpose technologies were simultaneously developed and implemented. These technologies include mobile devices, the Internet, biometric technologies, cloud computing, Big Data analytics platforms, and artificial intelligence (AI) [3]. However, the period of the COVID-19 pandemic was marked

[1]Government of the Russian Federation. (2019). *The order "On the approval of the concept of creating a digital analytical platform for providing statistical data"* (December 17, 2019 No. 3074-p). Moscow, Russia. Retrieved from http://static.government.ru/media/files/4YejV8mvcCSeGWTg2kXprmthtNbWyfrU.pdf.

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by a real breakthrough – there was a clear trend for universities to make management decisions in education based on Big Data.

Indeed, the traditional notion of face-to-face educational processes has become irrelevant due to the spread of the COVID-19 infection. The transition of universities to distance learning led to the rethinking of the methods of acquiring general educational and professional competencies by students.

This publication uses the example of one of Russia's leading universities in the field of law – Kutafin Moscow State Law University [7] to consider the stages of the transition from the "analog" to the digital understanding of the educational reality in the COVID-19 pandemic. We identify the impact of Big Data on the construction of the educational process at Kutafin University and define the extent and prospects of this impact.

2. MATERIALS AND METHODS

The methodological basis of the research includes methods of scientific knowledge such as analysis, synthesis, deduction, classification, interpretation, prediction, observation, and sociological methods. In June 2020, we conducted a sociological survey, "Distance Learning during the Spread of Coronavirus Infection." The survey covered 76 first-year students of the master's programs "Legal Support of Business (Business Lawyer)" (MP "Business Lawyer") and "Lawyer in Corporate Law" of the Kutafin University. The distribution of students by the form of study is as follows:

19 full-time students,

19 part-time students

38 part-time students.

In September 2020, the authors conducted a questionnaire survey, "Managing the educational process of a university during the COVID-19 pandemic: The impact of Big Data". The purposive sampling of our survey involved 72 first-year students getting a master's degree in "Business Law".

Our sociological research should be described as applied research. This is due to the fact that the research aims to study certain problems related to distance learning, university management, and the use of Big Data. These were express studies, lasting from a week to a month. We can divide the studies as one-time, point-by-point, and exploratory according to the depth of analysis. They were carried out once

to obtain information about the state of the studied object at a particular point in time in the shortest time possible.

During the sociological research, we implemented a survey method, followed by analysis and interpretation of the information received. Surveys are the most common type of sociological research. It is the most used method of collecting primary information, given limited research time. There was a written interaction between researchers and respondents. Namely, we conducted an anonymous face-to-face and distance questionnaire using purposive sampling. Based on the design of the questions asked, we created semi-closed questionnaires. For some questions, along with choosing one of the proposed options for an answer, the respondents had the opportunity to express themselves freely. For other questions, all answer options were provided in advance. According to the criterion of the source (carrier) of primary sociological information, a mass survey was carried out. The main information source was the students of Kutafin University.

We manually processed the results obtained due to the small (less than 100 people) number of respondents. The research task was identified through the application of the above methods. The research aims to study approaches to the application of Big Data and Data Science in the structure of the modern educational process in the context of the spread of the new coronavirus infection, in particular, in terms of the following problems:

Understanding of the categories of Big Data and Data Science by university students;

Determination of the forms of educational processes based on Big Data analysis;

Identification of useful and negative aspects of the application of Big Data (in space, time, and a circle of learners);

Modeling the architecture of the modern educational process using Big Data.

3. RESULTS

The primary value of Big Data is not in the information in electronic form but in the result of its analysis. The sources of Big Data are any information of analytical interest for processing and study. This information is obtained by the relevant services (e.g., Google Analytics or Yandex.Metrika). Using Big Data, a well-trained AI can replace traditional face-to-face forms of education involving a human teacher in terms of analytical data processing and the formation of final decisions. Such work can only be

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performed by AI. Nevertheless, the cognitive system of the human teacher is not displaced but unloaded from unnecessary work – the processing of unstructured information accumulated by humankind. The educational process at universities needs to accumulate and process content using Big Data. In this matter, the use of AI is inevitable. Its work is set by university faculty based on the current and professional needs, as well as the traditions of academic schools and universities.

3.1. Regulatory Certainty

The beginning of the formation of a special electronic environment as the basis for the emergence of Big Data at the Kutafin University was set by Order No. 148 (May 17, 2019), which approved the Regulation on the electronic information and educational environment [7,8].

In this local act, the electronic information and educational environment of the Kutafin University (EIEE) are understood as a system-organized set of information, technical, educational, and methodological support in electronic form. The main objectives of the EIEE include the following:

Creating a unified educational and communicative space based on modern information technologies;

Providing students, regardless of their location, with access to curricula, working programs of disciplines (modules), practices, publications of electronic library systems, and electronic educational resources through the Internet;

Recording the progress of the educational process, the results of interim certification, and the results of developing basic educational programs;

Conducting classes and assessment of learning outcomes, the implementation of which is envisaged with the use of e-learning;

Forming electronic portfolios of students.

EIEE operates on the principles of accessibility and openness, complexity of construction, user orientation, consistency, integrability, and multifunctionality.

One of the critical elements of EIEE is the digital scientific, educational, and social network of the Kutafin University (DSESN). It is designed to create a personality-oriented information and

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communication environment that provides informational interaction of all participants in the educational process of Kutafin University. DSESN should provide publicly available and personalized reference, scientific, educational, and social information. This should be done through services operating based on the applied information systems of Kutafin University. The DSESN system provides for the operation of electronic personal accounts. Personal accounts allow for the personalization of profiles and portfolios and social interaction between participants in the learning process.

The reviewed local act assigned the responsibility for forming the EIEE to the technical unit of the Kutafin University. However, the Regulation on Electronic Educational Resources (approved by Order No. 17, January 17, 2020) [10] requires teachers to develop EIEE. In this case, the electronic educational resource is positioned as an element of the University EIEE structure. An electronic educational resource (EER) is understood as a system of educational and teaching materials presented in electronic digital form and providing the implementation of e-learning. The Regulation stipulates that the structure, subject content, and metadata of EERs must correspond to their purpose in the educational process and the requirements for the educational activities of the Kutafin University. Metadata includes information about the educational content, describing its structure and content, including the level of education, its form, number of hours in the curriculum, number of hours in the EERs, and forms of control.

E-learning refers to the organization of educational activities using the University's e-Learning resources, which allows interaction with students through ICT. Intensified implementation of e-learning was facilitated by the University Order "On the organization of educational activities in conditions of prevention of the spread of new coronavirus infection in the Russian Federation" (March 17, 2020, No. 10p) [9]. The Kutafin University established a mode of academic (lecture and practical) classes and weekly consultations exclusively in its electronic information and educational environment. Additionally, classes can use all available external resources allowing online and remote communication with the ability to identify learners (e-mail, Zoom, Google Hangouts Meet, Skype, Mircosoft Teams, Discord, messengers, streaming platforms, etc.).

Two months later, the university approved the "Regulation on the use of e-learning and distance learning technologies in the implementation of educational programs" (Regulation) (May 6, 2020, No. 149) [11]. It took into account the short, but very extensive in terms of content, the experience of applying the previous Order.

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The Regulation and Order No. 317 (August 21, 2020) "On the start of the academic year 2020–2021 and the specifics of the organization of educational process" (Order) [8] are adopted based on the analysis of Big Data. This is connected to the fact that the Kutafin University has created and operates EIEE.

Thus, the vice-rector for educational and methodological work of the Kutafin University initiated and conducted an anonymous survey "Transition to Distance Education: Anti-Coeducation and My Impressions." More than 1,200 undergraduate and graduate students participated in the survey. Of them, 42% are satisfied with the way distance learning was organized at the university during the pandemic. Speaking about the format of distance learning, a third of respondents (35%) indicated that most classes are held online using the University's distance learning system (DLS), as well as on the platforms of Zoom, Skype, etc. Only 15% of respondents indicated that teachers preferred the asynchronous form of conducting classes (issuing and assessing assignments).

The survey results allowed to provide various forms of e-learning in the Regulations (according to the criterion of the form of interaction, it is divided into synchronous and asynchronous). Moreover, the results allowed us to classify distance learning technologies (video lecture, lecture-webinar, lecture-forum, practical training in a webinar format, and practical forum-lesson).

In developing the Order, the rector decided to implement blended learning actively. It is based on a combination of various proportions of full-time education with e-learning and the use of distance learning technologies, depending on the level of education, form of training, year of study, period of time, etc. The students' opinions directly influenced this decision. The majority of respondents (41%) voted for the traditional training format, assessing it as more effective and convenient. At the same time, 52% of respondents indicated that distance learning is more time-consuming. Only about one-fifth of those surveyed (19%) support a full transition to distance learning in the future. The numbers speak for themselves.

3.2. Sociological Perspective

The high relevance of the issues studied made it necessary to determine the students' position.

In June 2020, the authors conducted a sociological study with the participation of students getting their master's degree at the Kutafin University. The study was conducted right after spring distance

learning and the use of the new Regulation in the classroom. Table 1 shows the results of the survey on the positions of interest.

Table 1. Distance learning during the spread of COVID-19 infection.

Question	Level: Master's degree / Form of study			
	Full-time	Part-time	Extramural	Total
1. What form of interaction with the teacher turned out to be the most convenient and effective?				
A) remote asynchronous interaction by directing and executing tasks;	A – 5	A – 10	A – 25	A – 40
B) synchronous online interaction.	B – 14	B – 9	B – 13	B – 36
2. What form of lecture seems more promising and effective?				
A) synchronous webinar lecture;	A – 12	A – 8	A – 18	A – 38
B) synchronous lecture-forum;	B – 4	B – 7	B – 9	B – 20
C) asynchronous video lecture.	C – 3	C – 4	C – 11	C – 18
3. What format of the practical session out of those provided by the Regulation seems more promising and effective?				
A) Practical training in webinar format;	A – 14	A – 15	A – 20	A – 49

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B) Practical forum-training.	B – 5	B – 4	B – 18	B – 27
4. What elements of distance learning would you suggest to retain and use at the end of the lockdown regime?				
A) Weekly online consultations from faculty members;	A – 6	A – 13	A – 18	A – 27
B) Online consultations before exams;	B – 10	B – 13	B – 18	B – 41
C) Initial passing of credits and examinations	C – 3	C – 5	C – 8	C – 16
D) Retaking tests and exams;	D – 0	D – 2	D – 4	D – 6
E) Video lectures posted in the DLS along with lectures delivered by teachers in the classroom;	E – 7	E – 8	E – 19	E – 34
F) Video lectures posted in the DLS instead of lectures delivered by teachers in the classroom;	F – 4	F – 10	F – 8	F – 22
G) Partial conducting of practical lessons in the form of webinars;	G – 0	G – 12	G – 21	G – 33
H) Remote laboratory workshops.	H – 1	H – 7	H – 8	H – 16
5. What are the main problems that you faced during distance learning?				
A) Imperfections of my computer equipment and connection quality;	A – 4	A – 6	A – 14	A – 24
B) Imperfections in the technical support of the university;	B – 8	B – 2	B – 11	B – 21
C) My (personal) lack of qualifications	C – 0	C – 0	C – 0	C – 0

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D) Insufficient qualifications of teachers	D – 3	D – 1	D – 4	D – 8
E) Increased labor and time costs	E – 4	E – 4	E – 3	E – 11

Source: Compiled by the authors.

The students perceived both formats of interactions proposed by Order No. 10p (March 17, 2020) as quite convenient and effective. Remote asynchronous interaction was favored by 52.6% and synchronous online communication by 47.4%.

As for the format of the lectures, the top three are as follows:

Synchronous webinar lecture (50%);

Synchronous lecture-forum (26,3%);

Asynchronous video lecture (23,7%).

Practical lessons in a webinar format are seen as the most promising and effective by 64.5% of respondents. Another, 35.5% of respondents preferred a practical forum-lesson.

The responses of students regarding the elements of distance learning are of certain interest for the construction of a blended learning regime. It is advisable to use their opinion after the end of the coronavirus pandemic. Thus, 54.7% of respondents were in favor of remote consultations before the exams. The idea of posting video lectures in the DLS, along with lectures given by professors in the classroom, was positively evaluated by 45.3% of respondents. Moreover, 44% of students supported maintaining partial hands-on classes via webinars. Weekly online consultations were optimal for 36% of respondents. Online workshops and primary tests and exams were approved by 21.3% of respondents. The students' opinion was taken into account when developing Order No. 317 [8].

The transition to distance learning has inevitably revealed several problems. The main one was the technical problems faced by 70.3% of respondents. The problem arose equally among individual students and the entire university. According to 12.5% of students, the insufficient qualifications of teachers is a factor hindering communication in distance learning. It is noteworthy that students getting a master's

degree consider the level of their digital literacy to be appropriate, judging by their answers. Growth in labor and time costs was considered a problem by 17.2% of respondents.

In September 2020, the authors undertook another sociological study presented in Table 2.

Table 2. Management of the university's educational process during the COVID-19 pandemic: the impact of Big Data.

1. Do you know what Big Data is?	
A) Yes;	A 40
B) No;	B 16
C) The concept is familiar, but the content is unknown.	C 16
2. Does the analysis of Big Data affect management decision-making at the university?	
A) Yes;	A 39
B) No;	B 4
C) Partially.	C 29
3. Big data is	
A) Self-sufficient, its knowledge allows one to state a certain conclusion;	A 12
B) Subject to subjective evaluation, like any data.	B 60
4. What data influences the construction of the educational process in the university?	
A) Regulatory legal and non-regulatory acts of federal executive authorities;	A 47

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B) Data on the sanitary and epidemiological situation;	B 9
C) Data from sociological studies involving teachers and students;	C 16
D) Other (specify).	D 0
5. What factors have the most significant impact on the formation of the educational process at the university?	
A) External (e.g., epidemiological situation and its evaluation in the act of the Federal Service for Surveillance on Consumer Rights Protection and Human Wellbeing);	A 30
B) Internal (e.g., needs of students, opinion of teachers).	B 42
6. When university management makes management decisions, Big Data	
A) Is currently used	A 26
B) Will be used in 1–3 years	B 37
C) Will be used in 3–5 years	C 9

Source: Compiled by the authors.

More than half of the respondents (55.6%) are substantively aware of digital technology being studied. The absolute majority of respondents believe that the analysis of Big Data completely (54.2%) or partially (40.3%) affects the adoption of management decisions by the university's management. Simultaneously, the majority of respondents (83.3%), like the authors of the study, do not consider the results obtained using the analyzed technology to be final. We believe that analysis, interpretation, and systematic interpretation of the data are necessary for completeness and objectivity.

More than half (65.3%) of the respondents were positivists. They gave preference to the regulatory and non-regulatory acts of federal executive bodies in terms of the degree of influence on the construction

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of the educational process at the university. The data of the sociological survey and the data on the sanitary-epidemiological situation ranked second (22.2%) and third (12.5%).

At the same time, among the factors having a more significant impact on the formation of the educational process in the university, respondents preferred internal factors (58.3%) to external ones (41.7%).

Only a small percentage (36.1%) of students believe that the university's management uses Big Data in making management decisions. However, the absolute majority of the participants of the sociological survey see the prospect of this technology in the near (51.4%) or distant future (12.5%). These results are encouraging.

4. DISCUSSION

The potential of Big Data is a topic of discussion of Russian and foreign researchers. Ray Saptarshi [13] emphasized the ability of Big Data to identify the interest of an educational course and the visualization benefits of interactive educational processes. Christos Vaitsis, Vasilis Hervatis, and Nabil Zary [16] explore data manipulation with the appropriate use of visual Big Data analytics. Vidal Alonso and Olga Arranz [1] highlight the potential of Big Data as a source of information in student distance learning and automation of education. Giti Javidi, Lila Rajabion, and Ehsan Sheybani [6] revealed the benefits of Big Data analysis for making educational decisions, determining learner behavior, and applying effective learning models.

At the same time, the full use of Big Data in education seems to be difficult due to several reasons.

First, the special electronic environment that generates Big Data is in its infancy at many universities. In this regard, the Big Data of higher educational institutions are not yet considerable volumes of information of significant diversity in the sense of the classical Big Data. In essence, it is Big Data in miniature. Increasing the rate of forming and improving electronic information and educational environment will accelerate the full application of Big Data.

Second, as developers of electronic educational resources, teachers are often aware of the lack of technical knowledge and skills necessary to implement effective online interaction with learners. Ways to

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improve digital literacy vary from self-education to various professional development courses (Ershova, Tarasenko, Enkova & Trofimova, 2020). For example, in June 2020, the Kutafin University organized a massive mandatory professional development for its teaching staff under the program "The Use of Information and Communication Technologies in the Educational Activities of a Modern University."

Third, Russian universities often do not possess horizontally scalable software tools allowing them to process enormous information amounts efficiently. The technical means and software of higher education organizations can process Big Data in test mode, but not permanently. As a consequence, only isolated management decisions will be made using this advanced technology. The access of the university to the Big Data analytics platform is seen as possible due to a partnership agreement with a relevant company.

Fourth, Big Data is usually unstructured data of great volume. The collection and primary processing of such data are not enough to make management decisions based on them. A serious analysis of such data is required. In this regard, the profession of a Big Data analyst is in high demand. Therefore, it is advisable to find a place in the university staff for the position of Big Data analyst. For example, the Center for Academic Development and Educational Innovation at the Kutafin University has a full-time position of the analyst of innovative forms of education.

5. CONCLUSIONS

In large educational organizations of higher education, the transition from Small Data to Big Data in the aspect of management decision-making based on the analysis of such data has been made. An example of this is the Kutafin University. This was made possible by forming the electronic information and educational environment of the university with the help of scientific and pedagogical staff and specialists of technical departments. A powerful catalyst for this process was the COVID-19 pandemic.

However, there are only the first experiences with the use of Big Data in the field of education.

The defining characteristics of Big Data are "three V's": (1) volume (in the sense of the size of the physical volume), (2) velocity (in the sense of the growth rate and the need for high-speed processing and

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obtaining results), and (3) variety (in the sense of the ability to simultaneously process different types of structured and unstructured data).

The goal of the further development of Big Data in relation to the educational process is both the early achievement by universities of these essential features and the development of "two more V's" (veracity and value of the information accumulated). Big Data is important for higher educational organizations. This technology has a use-value – the ability to bring informative benefits and include the final socio-economic effect. Additionally, this technology has an applied nature.

In particular, the authors of the study predict an increasing use of such useful content of Big Data as:

Location of the audience (coverage of the audience depending on the disciplines taught);

Tracking the activity of accounts in addressing interactive forms of learning (analysis of popular educational technologies: Interactive presentations, business games, testing, video lectures, etc.);

Tracking student visits to websites and their sections (determining the relevance of educational disciplines and programs, individual qualities of faculty depending on the composition of published video lectures, articles, monographs, theses of reports, and other electronic works);

Discussion by students of various issues in the educational process (e.g., questions about the disciplines taught, doubts about understanding the topic, unclear material);

Keyword analysis of search queries (assessing student needs and the content of existing web search pages).

We are convinced of the need for a clear separation between Big Data categories as a form of processing and storage of large unstructured data and Data Science as the intelligent processing of Big Data with the construction of models of understanding of certain problems. The modern educational process will integrate human memory, the cognitive (individual) capabilities of the individual with the corresponding cognitive (collective) systems of social groups and society as a whole, as well as with machine intelligence.

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The authors see the task of "university AI" in the analysis of Big Data in education (Date University Science) as follows:

Determination of the geosocial audience and the time of its educational activity (attendance);

Identification of effective educational technologies and teaching methods;

Establishment of the faculty rating and criteria for additional remuneration for the work function;

Formulation of in-demand professional competencies;

Structuring controversial issues and identifying trends in the future interest of students in specific disciplines;

Work of the university on mistakes.

We believe that the inevitable need of modern society to train social groups in the core competencies of the digital economy in the future can be achieved by using Big Data and Data Science technologies.

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ARQUITECTURA DE LOS PROCESOS EDUCATIVOS UNIVERSITARIOS EN LAS CONDICIONES DE LA PANDEMIA DE LA COVID-19: DEL SMALL DATA AL BIG DATA Y LA CIENCIA DE DATOS

RESUMEN

El documento se centra en el grado de influencia de Big Data en la construcción del proceso educativo en la Universidad de Derecho de Rusia durante la pandemia de COVID-19. Utilizamos el método sociológico como el principal método de investigación. El resultado muestra la influencia de la información recopilada en la toma de decisiones administrativas. Además, describimos el proceso educativo dentro de la universidad seleccionada. El documento demuestra la actitud de los estudiantes hacia Big Data en varios aspectos, incluido el conocimiento de la tecnología y su importancia para la gestión de la universidad. Concluimos que Big Data aún no se ha utilizado ampliamente en la educación superior rusa. Por lo tanto, identificamos las razones que impiden el uso de Big Data en educación. Esta novedad de la investigación radica en señalar el impacto de Big Data en la arquitectura del proceso educativo universitario en diferentes períodos de la pandemia de COVID-19 cuando las instituciones de educación superior implementaron aprendizaje a distancia o mixto y comunicaciones en línea.

Palabras clave: Big Data, ciencia de datos, gestión universitaria, proceso educativo, maestría, estudiantes de posgrado, aprendizaje en línea, educación a distancia, abogados, economía digital, pandemia COVID-19.

新冠疫情条件下的大学教育流程架构：从小数据到大数据和数据科学

摘要

本文重点研究了大数据在COVID-19大流行期间对俄罗斯法学院教育流程构建的影响程度。我们以社会学方法作为主要研究方法。结果显示了收集到的信息对行政决策的影响。此外，我们还描述了所选大学内的教育过程。本文从各个方面展示了学生对大数据的态度，包括对该技术的认识及其对大学管理的意义。我们得出的结论是，大数据尚未在俄罗斯高等教育中得到广泛应用。因此，我们找出了阻碍大数据在教育中使用的原因。这项研究的新颖之处在于指出了大数据在COVID-19大流行的不同时期对大学教育过程架构的影响，当时高等教育机构实施了远程或混合学习和在线通信。

关键词：大数据、数据科学、大学管理、教育过程、硕士学位、研究生、在线学习、远程学习、律师、数字经济、COVID-19 疫情。

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