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Using big data analytics to assess educational outcomes at Ukrainian universities

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ABSTRACT

The proposed article aims to analyze the perception of teachers and students regarding the use of Big Data analytics to assess educational outcomes at Ukrainian universities. The primary method of information collection is interviews with survey elements. A purposive method was used to find and attract participants. In total, 15 teachers and 89 students participated. The results show that all participants in the educational process are ready to work with modern technologies. Among the advantages of big data analytics are enhanced tracking of student results, data-driven decision-making, and personalization of curricula. The study also identifies certain risks: problems with security, the use of incomplete or biased data, dependence on algorithms, financial barriers, dehumanization of education, and dependence on technology. The conclusions indicate that further implementation of these technologies requires the introduction of moderate solutions to analyze information.

Keywords: Educational data management, Innovation awareness, Higher Education

1. Introduction

With the modern development of information technologies, big data analytics methods have become an integral part of the development of many areas of public life, including university education. Higher education institutions, as important centers of academic knowledge and digital innovation, play a fundamental role in training new generations of specialists in various fields who will be able to respond to the current needs of the labor market successfully and generally meet the requirements of the global economy and society [29]. In addition, an essential task of higher education institutions is to ensure the high quality and effectiveness of the educational process. This need, in turn, creates a requirement for continuous monitoring and evaluation of educational outcomes in the student environment.

Big data analytics offers the opportunity to improve the value of education meaningfully, allow for the rapid processing of large amounts of digital information and find individual opportunities and patterns that are not visible at first glance [9]. Using these functions not only helps to accelerate the assessment of students' learning outcomes but also significantly improves curricula, helps to optimize the use of available resources, and significantly increases the efficiency of managing didactic processes [4]. As a result of the use of big data analytics, universities have been able to consolidate information from various sources, including academic resources, exam results and student surveys, attendance data, conference activity of teachers and students, trends in the use of online platforms, and other digital indicators [12]. This creates new avenues for gathering more thorough and specific information about the educational process, spotting weaknesses in its structure, and figuring out how to improve things. The purpose of the proposed article is to analyze the perception of teachers and students regarding the use of big data analytics to assess educational outcomes at Ukrainian universities. To achieve this goal, we need to find answers to the following research questions:

1. How do students and teachers assess big data analytics' potential advantages and challenges?
2. What factors influence the acceptance or resistance to using big data analytics in learning assessment?
3. How can big data analytics be effectively integrated into the system of educational outcomes assessment in Ukrainian universities?

2. Literature review

The use of Big Data Analytics (BDA) is a vital part of the current scientific debate on the further development of educational systems, including higher education. Ref. [2] have demonstrated opportunities for improving the quality of educational programs, including attracting and optimizing resources to improve decision-making processes. Other scholars have analyzed individual models and methodological approaches to improve the use BDA in the educational process [7]. Importantly, researchers have tried to tailor big data analytics capabilities to different areas of education, demonstrating the specific benefits of this digital innovation. For example, ref. [3] traced the benefits of using big data in training future teachers and managers. Ref. [5] proposed some adaptive learning analytics models that successfully combine traditional approaches with digitalization processes. Ref. [28] also wrote about the positive aspects of this practice, emphasizing the importance of combining the traditional methodology of reviewing and researching information with updated digital technologies. The advantages of using big data analytics in learning management tools and analysis of students' academic success were identified by [30]. This approach, as noted, makes it possible to quickly identify individual problem areas and offer personalized solutions in time to overcome critical situations. An important aspect is also the possibility of gradually tracking students' progress, including against the background of increasing employment rates [15], [14]. The review of the proposed papers has made it possible to emphasize that the use of big data analytics is generally highly appreciated in scientific literature - researchers point to the importance of this digital tool and the ability of modern managers to use the information obtained competently. At the same time, researchers also pointed out the challenges and limitations associated with using BDA in education. First, the ethical problem of data privacy violation was noted, as the collection of information requires wide access to information about students and the educational process [23], [16]. There are also complaints about technical limitations, as the cost of equipment for information processing is exceptionally high, and the costs of the services of relevant specialists are often not provided for in university budgets (which is highly relevant to Ukraine) [19], [22]. Moreover, the availability of the necessary level of professional training among teachers allows them to use the information obtained correctly [18]. Such challenges are essential for further development of the use of BDA in education, as they affect the integration of digital innovations in general into the educational process. A significant area of research is the generalization of existing scientific experience in applying BDA in education and related fields. Considering the research of scientists, ref. [17] demonstrated specific cases of successful use of big data analytics in analyzing the learning outcomes of future specialists in various fields of study. Ref. [24] pointed out the difference in big data productivity in different educational environments. The researchers noted that data analysis can help identify trends and develop strategies to improve academic performance. The significance of the aspect of considering academic performance was also emphasized by ref. [25], who also identified the consequence of creating the necessary conditions for the potential of such digital tools to be realized. Summarizing works made it possible to determine the state of research and potential development methods. The review of scientific research has shown that BDA in the university environment has specific advantages and opportunities for improving the quality of education, educational management, etc. At the same time, there are specific gaps, particularly those relevant to the Ukrainian educational environment. Big data analytics is a relatively new phenomenon in Ukrainian reality, so its effectiveness will require additional study. As can be seen from the analysis of scientific publications, successful integration of big data analytics technologies requires a balanced approach to both their advantages and disadvantages. The prognostic aspect – the further development of digital tools - is worth mentioning separately. This aspect also did not receive adequate attention during the research and will require special attention. Future research will significantly increase knowledge about effective strategies and methods for using BDA in higher education, including Ukraine.

3. Methodology

3.1. Research design

This study is based on qualitative research based on semi-structured interviews and surveys. This approach was chosen not only because of the impact on the implementation of the main research object (understanding the attitude towards the use of BDA) but also because it allows the identification of specific hidden gaps or risks

that cannot be considered in a quantitative study. In addition, such a study can influence the study of certain institutional or cultural factors that affect the implementation of innovative solutions. Thus, the chosen approach made it possible to study the perceptions, experiences, and attitudes of educational process participants toward using BDA in assessing educational outcomes.

3.2. Sample and Participants

A purposive method was used to find and attract participants. This method allowed us to attract respondents with direct experience in higher education. For this purpose, information about the survey was disseminated on official university websites and websites of research and teaching institutions. To ensure the representativeness of the data collected, the study defined preliminary inclusion criteria. In particular, the following criteria were considered for teachers:

1. Representatives of higher education institutions of Ukraine, research and teaching staff
2. Have at least 3 years of teaching or research experience
3. Directly involved in the process of assessing educational outcomes
4. Provided informative consent to participate in the study
5. At the time of the study - the requirement of residence and work in Ukraine

For students, other criteria were formed that related to the requirements of their studies, representation of different specialties, voluntary consent to participate in the study, and the processing of their data. In particular, the criteria were as follows:

1. Studying at Ukrainian higher education institutions in bachelor's or master's programs.
2. Represent different specialties
3. Students are studying at least in the second year (to have experience in the evaluation procedures).
4. Voluntarily agreed to participate in the study.
5. Are actively involved in the educational process.

In this way, 15 teachers from different universities of Ukraine were involved, as well as representatives of the Department of Research Activities of Universities of the Institute of Higher Education of the National Academy of Pedagogical Sciences of Ukraine and 89 students of different educational levels and specialties studying in higher education institutions of Ukraine, in particular at Sumy National Agrarian University.

Figures 1-2 show some demographic data of the study participants, particularly their distribution by gender. In Figure 1, the first indicators relate to teachers, and the following two columns relate to student data. Figure 2 presents the distribution of students by specialties.

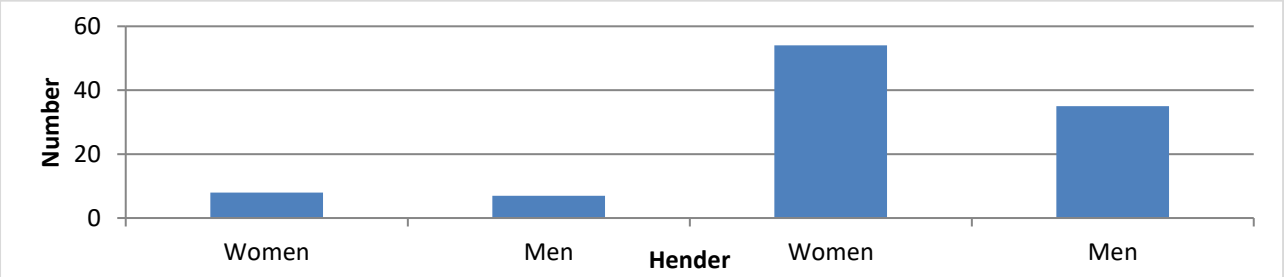

Figure 1. Distribution of participants by gender

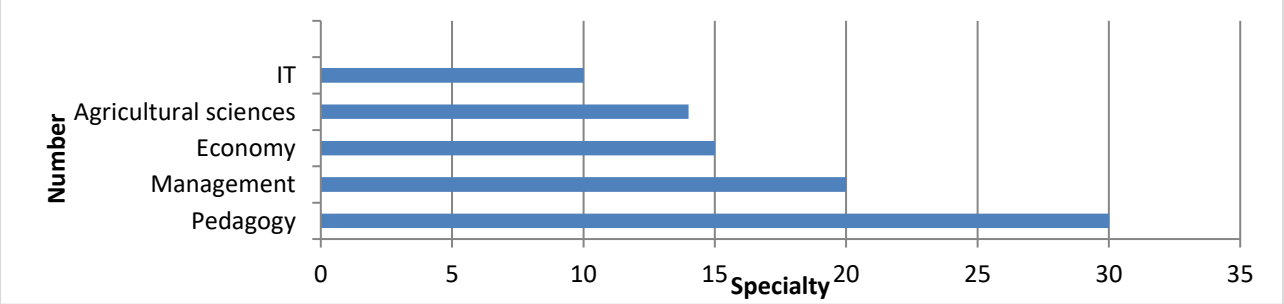

Figure 2. Distribution of students by major

Table 1 presents the general demographic data of all study participants, including average age, position, and experience in higher education. As for students, the following indicators are provided: age, educational level, major, course of study, and form of study.

Table 1. Demographic data

Category	Variable	Indicator
Teachers (n = 15)	Gender	8 women, 7 men
	Age	31–65 years old
	Position	5 professors, 7 associate professors, 3 senior lecturers
	Experience in higher education	3–35 years old
	Industry	Management, pedagogy, education, history
Students (n = 89)	Gender	54 women, 35 men
	Age	18–25 years old
	Educational level	65 bachelors, 24 masters
	Specialty	Economics (30), Management (20), Pedagogy (15), Agrarian Sciences (14), IT (10)
	Course of study	2nd year – 20 people, 3rd – 25, 4th – 20, master's degree – 24
	Form of study	Daytime – 89

Source: Author's development

3.3. Tools and procedure

The primary method of information collection is interviews with survey elements. They were conducted in both face-to-face and online formats via Zoom platforms. The following questions were used in the interviews:

1. What is your opinion on using Big Data analytics in education?
2. Do you consider it helpful in assessing learning outcomes?
3. Do you know examples of implementing such systems at your university?
4. What risks do you think are associated with the use of BDA in higher education?
5. Do you know examples of implementing such systems at your university?

At the same time, special surveys were also conducted, consisting of both open and closed questions. These questions were designed to more broadly describe the role of using analytical tools for assessing educational outcomes. These questions are presented in Table 2.

Table 2. General information about respondents

Block	Description
General Information	1. Please indicate your gender 2. Please indicate your role in higher education institution: - Lecturer - Student 3. Speciality/department: 4. Educational level (for students): - Bachelor's degree - Master's degree 5. Teaching experience (for teachers): - Up to 3 years - From 3 to 10 years - Over 10 years
Experience and Attitude towards Big Data Analytics	6. Have you used data analytics in your teaching? 7. Rate the statement from 1 to 5, where 1 - where 1 - does not help at all, 5 - very effectively To what extent, in your opinion, does big data analytics help/can help in: - Assessing academic performance - Identifying student difficulties - Improving curricula - Individualizing learning 7. What are the benefits of using big data analytics in education? 8. Do you know of examples of implementing similar systems at your university? 9. What are the risks or limitations in using big data analytics? 10. What would personally motivate you to use such tools more in teaching/learning?

Source: Author's development

3.4. Data analysis

Thematic analysis was used to process the responses received, which highlighted the main themes and categories in teachers' and students' systems of ideas.

This analysis was systematic and step-by-step. It included several stages. At first, a thorough familiarization with the data was carried out, which involved carefully rereading the received responses and recorded texts from the interviews. After that, significant fragments of the text were coded. These fragments reflected the main themes, in particular, "efficiency", "frequency", "familiarity with innovations", "understanding the importance of big data analytics", "Identification of students' difficulties", "speed of decision processing", "analysis of results", "individualization", "technical competence", "improvement of learning. At the next stage, the formation of themes was carried out. At this stage, the codes were grouped into broad categories, including: "understanding the importance of using technology," "advantages," "Big Data analytics opportunities," "impact

on learning," "limitations or risks," and "practical implementation." After that, the data obtained was compared with the results of other scientists using comparative analysis**.**

4. Results

Modern technologies significantly impact all spheres of social life, gradually changing existing approaches to education and education management (Foster; Francis, 2019). In such circumstances, BDA has become a powerful tool contributing to making important informed decisions (Salas-Martínez; Ramírez-Martinell, 2024). This made it possible to identify existing educational trends, assess academic performance indicators, and make adequate predictions about student outcomes in the future, which could be used to improve educational strategies in the future.

Considering the peculiarities of Ukrainian realities, it is essential to determine the levels of awareness, attitudes, and practices regarding the use of BDA in Ukrainian universities. It is proposed to start by determining the attitudes of teachers and students (see Figure 3).

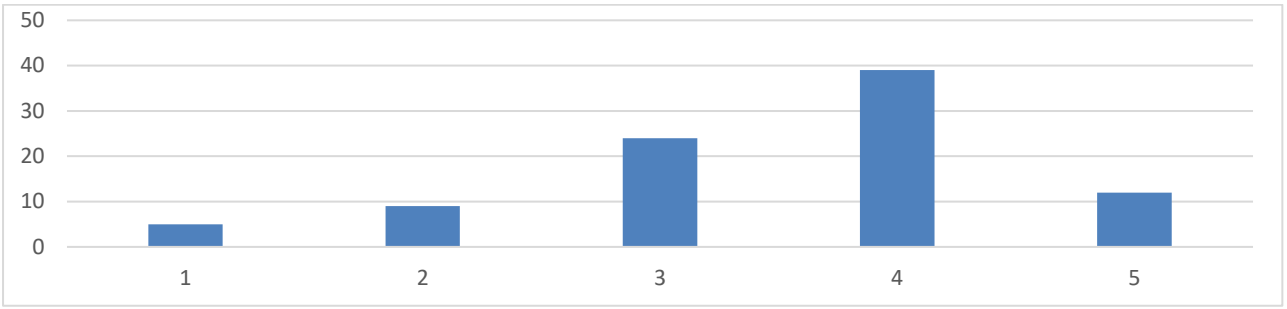

Figure 3. Level of attitude towards the use of big data analytics in education (students)

Thus, students' attitudes toward the possibilities of using big data analytics were rated by the Likert scale at a relatively high 3.45 points (out of 5 possible). This indicates that students are ready to use the latest technologies and want high technologies to be applied to them. The results can be compared with the indicators of teachers (see Figure 4).

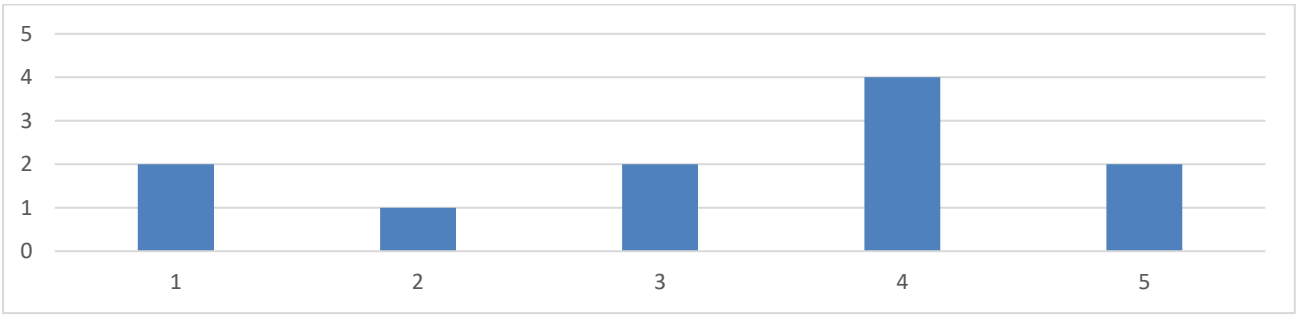

Figure 4. Level of attitude towards the use of big data analytics in education (teachers)

Thus, the average score among teachers is 3.25. These figures are lower than those in the student survey but still relatively high. This indicates that in Ukrainian realities, the teaching staff is willing to work with the processed information and improve the educational process following the results obtained. The respondents were also asked to determine the extent to which the use of Big Data analytics helps assess learning outcomes. Students defined their attitude to this important issue (see Figure 5).

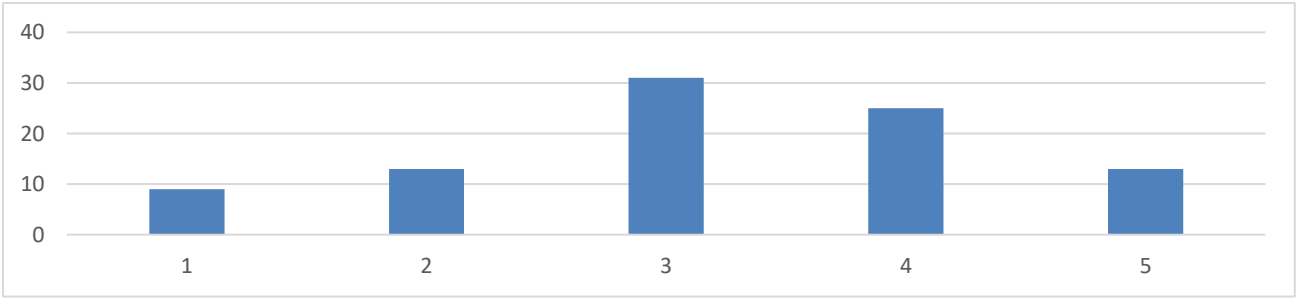

Figure 5. The level of usefulness of big data analytics for the evaluation of learning outcomes (students)

Therefore, the average assessment of the usefulness of big data analytics in the student environment is 3.22, which indicates an above-average result. Such a balanced approach indicates a rather moderate perception of this innovation among students from this perspective. At the same time, it is also worthwhile determining the teachers' assessment (see Figure 6).

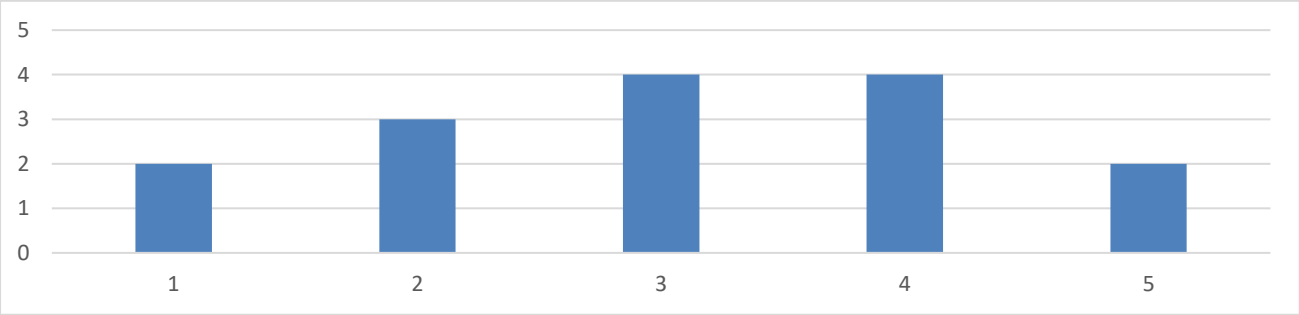

Figure 6. The level of usefulness of big data analytics for the evaluation of learning outcomes (teachers)

The average score of teachers on the role of data analytics in assessing learning outcomes is 3.16. On the one hand, these results are comparable to those of students. At the same time, they also indicate the importance of Big Data analytics. Teachers take this tool seriously and are ready to use it in the educational process, considering all the positive and negative aspects. Moreover, 73% of teachers (11 out of 15) reported already using data analytics in their practice. These responses indicated the gradual introduction of digital tools for analyzing academic performance and monitoring the learning process. Besides, 36% of students (32 out of 89) indicated that they had encountered the use of data analytics in their studies. These responses show that introducing such technologies is either not transparent enough for students or not widespread at the level of student experience.

At the same time, academics and teachers generally praised the potential of analytics to improve the assessment process (average score of 4.3). At the same time, students were reserved in their assessment of the potential of using BDA (average score of 3.9). In general, this may indicate that students have less experience using such technologies and do not have a broad awareness of specific application cases of these tools. Moreover, both groups highly appreciated the potential of BDA to identify learning difficulties (4.1 for teachers, 4.0 for students). At the same time, the surveyed teachers noticed significant potential for analytics in adapting the content of curricula, as evidenced by the average score of 4.5. Besides, students also consider these opportunities important (4.2 points). The groups rated the ability to customize the educational process to the needs of a particular student as average and relatively high (4.1 by teachers, 3.4 by students) (Table 3).

Table 3. Assessment of Big Data Analytics Capabilities

Category	Teachers (avg)	Students (avg)
Assessment of academic performance	4.3	3.9
Identifying students' difficulties	4.1	4.0
Improving educational programs	4.5	4.2
Individualized learning	4.1.	3.4.

Among the advantages, the most frequently mentioned was the possibility of improving tracking of student results. This area was mentioned most often by teachers (13 out of 15) and students (60 out of 89). At the same time, data-driven decision-making was also frequently mentioned by teachers (13 out of 15) and students (61 out of 89). This indicates a recognition of the potential of data analytics in monitoring learning progress. The advantage of personalizing curricula was also mentioned quite frequently (67 among teachers). At the same time, the early identification of at-risk students was also mentioned, and 11 teachers and 58 students emphasized this aspect. Most teachers (12) and students (55) agree that data analytics can help to adapt curricula to modern challenges and student needs. Most faculty (12) and students (55) recognized that data analytics can help adapt curricula to modern challenges and current student needs. Improvements in student engagement were not as frequent (8 faculty members and 50 students recognized this). Expanded resource allocation was mentioned by 9 teachers and 40 students. In general, this demonstrated the interest of all participants in the educational process in the system of effective distribution of educational resources—time, content, and support. Table 4 shows the main benefits of using BDA in education.

Table 4. Benefits of using BDA in education

Advantage	Teachers (n=15)	Students (n=89)
Better tracking of student performance	13	60
Early detection of students at risk	11	58
Improved curriculum design	12	55
Personalized learning paths	10	67
Data-driven decision making	14	62
Enhanced resource allocation	9	40
Increased student engagement	8	50
Support for remote and hybrid learning	6	45

Source: Author's development

The analysis of respondents' opinions on examples of the implementation of big data analytics at universities demonstrated separate experiences of students and teachers with such digital systems (see Table 5). Respondents determined that big data analysis systems are not fully used in the university environment. Only 33% of teachers and 20% of students answered affirmatively. Instead, using individual tools was emphasized by 33% of teachers but more than 40% of students. This indicates that students do not have complete information about using BDA tools. On the other hand, teachers have access to such information, so their ratings are higher. Indications of complete ignorance about the policy of using modern analysis technologies also demonstrate a serious problem in internal university administrative work.

Table 5. Knowledge of examples of implementation of big data analytics systems at the university

Answer	Teachers (max 15)	Students (max 89)
Yes, the university is actively using big data analytics	5	20
Only some functions are used at the university (for example, digital systems for collecting grades or student attendance)	5	41
No, I am not aware of any use of such systems at the university	3	18
Difficult to answer	2	10

Source: Author's development

Despite respondents' average level of awareness, their knowledge of individual university initiatives is still noticeable. At the same time, some problems with the use of BDA should be considered. Problems with data privacy and security were the most recognized among the survey participants. Accordingly, respondents expressed concerns about the safety of personal data or possible information leaks (13 teachers and 70 students, respectively). At the same time, the fact that analytics can be based on incomplete or biased data was recognized by 10 teachers and 60 students. Both groups acknowledged that some users may not have the proper level of training to interpret the results of big data analytics. This was emphasized by 9 professors and 55 students. Dependence on algorithms and financial barriers were notable risks. Some participants identified that over-reliance on analytics can lead to the "dehumanization" of education. This, in turn, can reduce the creative approach to learning (8 teachers and 40 students). Another critical risk was the consideration of legal and ethical aspects. A significant challenge is the lack of clear guidelines for collecting, storing, and analyzing such information. Twelve professors and 62 students mentioned this problem. Accordingly, Table 6 demonstrates the principal risks of using BDA in education.

Table 6. Perceived risks of using Big Data analytics in education

Risk / Limitation	Teachers (n=15)	Students (n=89)
Data privacy and security concerns	13	70
Bias or misinterpretation of data	10	60
Lack of digital literacy	9	55
Over-reliance on algorithms	8	40
Financial and technical limitations	11	58
Legal and ethical uncertainties	12	62

Source: Author's development

Such problems open new directions for improving the involvement of big data technologies in the educational process. Participants in the study specifically mentioned that having prior training, attracting more support, and improving the effectiveness of the educational process would be significant drivers for the future use of big data analytics. Teachers' positive examples were also vital. The primary drivers of continued usage of the examined technologies are displayed in Table 7.

Table 7. Key drivers that influence the further use of Big Data analytics

Motivator	Teachers (n=15)	Students (n=89)
Improving teaching and learning quality	12	71
Training and technical support	11	65
Integration with current LMS platforms	9	59
Personalized learning suggestions	10	63
Positive example from peers/admin	7	51

Source: Author's development

Thus, most participants (12 teachers and 71 students, respectively) indicated that the primary motivation for further use of BDA would be to improve the efficiency of the educational process. That is, it is necessary to accurately identify opportunities for progress, weaknesses, and needs of students using modern technologies. Besides, 11 teachers and 65 students expressed interest in using such tools if they received preliminary training. An imperative area for further use of these technologies is the integration of analytics into existing learning platforms, such as Moodle or Google Classroom. This was recognized by 9 teachers and 59 students. The positive example of colleagues was also important. Seven teachers and 51 students noted that real cases of effective implementation of analytics at the university or among colleagues could be decisive for further use of these technologies.

5. Discussion

Thus, the chief research problem is to establish the level of awareness of teachers and students of the peculiarities of using big data analytics to assess educational outcomes at Ukrainian universities. For this purpose, several research questions were formulated regarding the attitudes of all participants in the educational process towards these technologies. Accordingly, it has been found that respondents generally highly appreciate the potential of BDA in the field of higher education in Ukraine and recognize both the advantages and some disadvantages of these tools.

It has been found that the attitude of students towards the use of big data analytics technologies is above average (on average, 3.45 points out of 5 possible). At the same time, the indicator among teachers was 3.25. This indicates that all participants are ready to work with modern technologies. This aspect was also emphasized by other scientists who pointed out that, first of all, it is important that the learning process is interactive and focused on the practical application of new technologies [20], [26]. In such conditions, not only students but also teachers are willing to use modern tools. Accordingly, such an approach will ensure that all participants in the training will be able not only to gain theoretical knowledge but also to develop the necessary skills to solve real problems

faced by modern researchers and practitioners. However, other researchers have also drawn attention to other vital aspects [10]. In particular, curricula and courses must be constantly updated following current technological trends. However, the works of other scholars mention other aspects that are not considered in this paper. Some authors have pointed out that attention should be paid to creating a favorable environment for interdisciplinary cooperation [8]. This should be considered, as big data analysis often involves specialists from different fields, from mathematicians and statisticians to humanities specialists, who can offer essential approaches to data interpretation. The following research question was to identify the main benefits and risks of actively using the capabilities of big data analytics. Accordingly, it was found that among the advantages, the most noted were the possibilities of improving the tracking of student results. The advantage of personalizing curricula and early identification of at-risk students was also mentioned quite often. In addition, most faculty and students recognize that data analytics can help adapt curricula to modern challenges and the current needs of students. Other scholars have also emphasized the potential of big data analytics in education. Some studies indicate that BDA in the university environment affects the introduction of personalized learning by analyzing students' behavioral and educational data (academic performance, activity in the LMS, learning style) [1]. In this way, it influences the formation of individual learning trajectories. According to other works, big data analytics affects the identification of risks [27]. This makes it possible to identify students who may lag even before critical problems arise. In addition, other researchers have drawn attention to more effective decision-making using big data [6]. Analyzing a large amount of administrative information (enrollment, attendance, costs, resources) allows management to make informed decisions. At the same time, the study found that despite this potential, there are certain risks in using big data. In particular, it was determined that problems with data confidentiality and security, the use of incomplete or biased data, dependence on algorithms, financial barriers, the "dehumanization" of education, dependence on technology, and the lack of clear instructions for collecting, storing, and analyzing such information can negatively affect higher education. Other scholars have also pointed out similar challenges, including insufficient control, ethical dilemmas, data overload, etc. [7].

According to recent research, data overload is becoming a moderate risk. Collecting data is only half the battle. Without the right analytics and structure, it is easy to "drown" in an array of information. At the same time, other authors have drawn attention to ethical dilemmas. Researchers wonder whether it is ethical to identify "risky" students and influence their trajectory automatically. Insufficient control over consent is also highlighted; students may not realize how and for what purpose their data is used. At the same time, it is also worth paying attention to the high cost of implementation. Collection, storage, analytics, and support require significant financial investments.

However, despite these problems, big data analytics remains essential for data processing and analysis. For the further implementation of these technologies, a prerequisite is the introduction of moderate solutions that would allow the simultaneous implementation of the requirements of modern work with large amounts of information while adhering to established procedures and not abusing access opportunities. Other researchers have come to similar conclusions [5], [28], which suggest that the results align with trends in the evaluation of big data analytics in education. The methodology in this study also has certain limitations that should be considered when further analyzing the results. It is worth noting that the Likert scale is a somewhat subjective tool for conducting empirical research, as it is based primarily on respondents' personal experiences. However, this does not affect the high assessment of the organization of education in the Ukrainian reality, when the military threat from the Kremlin regime is dangerous not only for the organization of education but also from a purely physical point of view.

6. Conclusions

In Ukrainian realities, as established, the potential of the perception of big data analytics is assessed at a high level. It was determined that education students have a better attitude towards using BDA technologies in education than representatives of the teaching environment. However, high scores indicate the readiness of all participants to work with modern technologies.

The study also identified the main advantages and risks of actively using Big Data analytics capabilities. Among the advantages, the possibility of improving the tracking of student results and data-driven decision-making was noted. The personalization of curricula and the possibility of early identification of at-risk students were also noted. In addition, most teachers and students recognize that data analytics can contribute to adapting curricula to modern challenges and the current needs of students. The study also identified some risks: data privacy and security issues, the use of incomplete or biased data, dependence on algorithms, financial barriers, the

"dehumanization" of education, dependence on technology, and the lack of clear guidelines for collecting, storing, and analyzing such information can negatively impact higher education.

Even with these challenges, Big Data analytics remains an essential tool for data processing and analysis. To further implement these technologies, a prerequisite is the introduction of moderate solutions that would simultaneously meet the requirements of modern work with large volumes of information while also adhering to established procedures and not abusing access capabilities.

Declaration of competing interest

The authors declare that they have no known financial or non-financial competing interests in any material discussed in this paper.

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Author contribution

The contribution to the paper is as follows: I. Sokhan, Z. Tsybulnyk: study conception and design; Z. Tsybulnyk: data collection; I. Sokhan, Z. Tsybulnyk, O. Kyrychenko, N. Guts, N. Prykhodkina: analysis and interpretation of results; I. Sokhan: draft preparation. All authors approved the final version of the manuscript.

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