สถาบันวิทยาการจัดการแห่งแปซิฟิค
PACIFIC INSTITUTE OF MANAGEMENT SCIENCE

A study on the Impact of Big DATA on Education Management in Chinese Universities and Countermeasures

Gao Shen
Chiang Rai Rajabhat University，Thailand
Zhengzhou Tourism Professional College, China
Email: gaos68542@gmail.com

Received August 2, 2024 Revise August 23, 2024Accepted August 31, 2024

Abstract

Big data is significantly impacting all aspects of human society, leading to a transformation in people's cognitive, operational, and lifestyle patterns. Furthermore, it alters the productivity and production relationships within society and is considered a valuable asset for the future, comparable to "new oil," "new gold mine," "new resources," and an "innovation engine." It is considered a very valuable asset for the future, comparable to "new oil," “new gold mine," "new resources," and a "new engine" for innovation. Since 2012, the United States, the United Kingdom, France, Japan, South Korea, and other developed nations have prioritized big data as a key component of their national strategies. In 2015, China explicitly stated its objective of "implementing the national big data strategy" during the Fifth Plenary Session of the 18th CPC Central Committee. To address the challenges posed by the era of big data, the government must collaborate closely with corporations, universities, and research organizations and harness society's collective strength to actively participate. In and universities will play a significant role and exert influence in this current era of big data. Despite the numerous challenges faced by China's education big data sector, university big data research possesses distinct advantages, making the future of big data research and application in education administration highly promising. Management is a form of productivity that can be more crucial than other elements in certain situations. The integration of big data into education management indicates a significant advancement in the field of education management in colleges and universities. Utilizing big data enables us to forecast trends, extract value, and encourage colleges and universities to generate new knowledge more intelligently. In contrast to big data applications in the business sector, big data in universities primarily emphasizes the exploration of correlations and the subsequent identification of causal linkages.

Keywords: business school, big data, education management, shadow, countermeasures.

Introduction

Data has been present throughout human society since ancient times, starting with the early stage of limited data, sampling, and analysis, progressing to the information age characterized by an abundance of information, and eventually reaching the era of big data,

which is supported by the Internet, cloud computing, and the Internet of Things (IoT). The first proposal of Moore's Law in 1966 led to the development of small and inexpensive transistors. This technological advancement served as the basis for the emergence of big data. Additionally, in 1989, data mining technology gained prominence, attributing significant value to big data, often likened to "gold" and "oil" (Daniel, B.K.(2019). Data mining technology, which emerged in 1989, bestowed Big Data with the significance of being akin to "gold" and "oil" (Daniel, B. K. (2017). Following 2004, the surge in popularity of social media platforms like Facebook and WeChat broadened the pool of individuals capable of generating data to encompass "social network members" worldwide. In today's information society, technology innovation is widespread. However, in the past, technological development mostly concentrated on the "technology" aspect. Siemens, G., & Long, P. (2011). Currently, the primary emphasis should be on the concept of "information" itself. We are entering a period iWe are entering a period where the notions of "empowering data," "data drives productivity," and "data is a key factor in national competitiveness" are becoming increasingly prevalent. The conceptWe widely accept the concept that "information, rather than atoms, is the fundamental origin of all things" (Pradeep, S., & Narasimhan, V. (2017)). ve influence of big data is evident, as it permeates every aspect of social existence with its relentless force. Education closely aids in the advancement of technology, and in turn, the evolution of technology drives the transformation of the education system. Colleges and universities play a crucial role as influential and foundational institutions in the knowledge-based economy period (Miller, R., & Pérez-Luño, A. (2018)). Universities play a critical role in advancing society and driving progress through their contributions to knowledge creation, talent development, technology research and development, and community service. Their impact is powerful yet often unseen. In light of the influx of vast amounts of data, universities will undergo significant transformations in their educational material, instructional techniques, management mode, and evaluation system. Despite the potential challenges, it is prudent to embrace change. This subtle transformation has now begun.

Objective of Research

In the current era of abundant information, a popular saying suggests that while technology plays a significant role (about 30%), data accounts for the remaining 70%. The one who possesses mastery over data is believed to hold the key to future dominance. The U.S. President, Barack Obama, went as far as comparing data to "the future's new oil." Currently, China possesses the most extensive education system globally, accommodating a staggering number of over 240 million pupils. Forecasts suggest that China's online education sector exhibits significant potential, with an expected annual growth rate exceeding 30%. An education system of this magnitude will unquestionably produce high-quality big data for education management. In 2014, the entire volume of big data in the basic education field was 12EB, equivalent to 12,288 petabytes (PB). To put this into perspective, if we were to connect 1PB of images end to end, it would be enough to circumnavigate the Earth in a span of two weeks. However, the key factor that will determine whether Chinese education surpasses that of Europe and the United States is the effective use of this invaluable "resource" (Gibson, P., & Ifenthaler, D. (2017)). China possesses a distinctive advantage. China has a distinct

advantage in conducting research on big data in higher education. Data released by the Bureau of Statistics in March 2016 supports this, revealing that China enrolled 25.991 million college students and 16.9 million secondary school students (Ferguson, R., 2019). An examination of big data in higher education administration is essential for advancing scientific and technological advancements, as well as fostering social and economic growth. Additionally, it serves as a significant reservoir of talent and intellectual assistance. According to system science's theory of the relationship between structure and function, which states that "structure determines function," and system theory's viewpoint that "the overall function of a system is not equal to the simple superposition of the functions of its individual components," we can deduce that optimizing structure can result in 1+1 being greater than 2 (Dev, S., Shroff, G., & Gulati, R. (2019)). Hence, enhancing the administration can also enhance the efficacy of universities and colleges. From a certain perspective, the significance of management exceeds that of the resources themselves. This paper examines the use of big data in higher education management, taking into account the philosophy of science and technology as well as social science (Dietrich, T., Albrecht, T., & Susnjak, T. (2019). The objective is to foster an understanding of big data and cultivate a mindset that is conducive to effectively leveraging big data (Dawson, S., Joksimović, S., Poquet, O., & Siemens, G. (2019). The research focuses on the field of educational management and the application of intelligent technology in higher education institutions. It aims to collect and analyze both macro- and micro-level data to create a comprehensive and precise record of educational management big data. The goal is to investigate the principles governing educational management and systematically address the question of how universities and colleges can effectively utilize intelligent technology to enhance the implementation of a "human-centered" approach. This includes supporting the professional development of faculty members, facilitating personalized learning for students, evaluating educational processes, and improving campus life.

Review of Literature

Definition of Big Data

The notions of digital, data, and big data are interconnected yet distinct components of a cohesive system. The bit is the fundamental unit of information in computing, representing a binary value of either 0 or 1. On the other hand, the byte is the fundamental unit of data storage, consisting of 8 bits. Therefore, the conversion ratio between bits and bytes is 1 to 8. The units listed below are arranged in ascending order: bit, byte, kilobyte (KB), megabyte (MB), gigabyte (GB), terabyte (TB), petabyte (PB), exabyte (EB), zettabyte (ZB), yottabyte (YB), nobyte (NB), and dobyte (DB). Each unit is incremented by a base of 1024. The units from K to D follow a geometric progression with a common ratio of 2 raised to the power of 10. The succession of K through D units follows a geometric progression with a common ratio of 2 raised to the power of 10. Data that reaches the petabyte level is generally classified as big data (Daniel, B. K. (2017)). A number is a symbol or glyph that represents a quantity. It is the fundamental form of information and serves as a numerical notation. Data, however, is a symbolic depiction of tangible entities (Benita, F., & Bignami, F. (2020)). It comprises a sequence of numerical values, facts, and details pertaining to a particular subject matter, which undergoes processing to acquire a distinct significance. Data, originally obtained through measuring operations, is a

factual representation of the physical world and consists of quantifiable information. Aside from data acquired through measurements, there exists another form of data that is derived using calculations. In the present era of abundant information, the definition of "data" has expanded significantly to include various sorts of information (Daniel, B. K. (2017).) The term "data" has become interchangeable with "information" as it encompasses not just empirical numerical evidence, but also textual content, photographs, audio, and video. Text, images, audio, and video are not directly obtained through measurement, but rather through recording. Therefore, there are three primary sources of modern data: measurement, computation, and recording. Big data often denotes datasets that exceed a size of 1 terabyte and is alternatively known as vast data or huge data. Nevertheless, there is a lack of agreement among academics regarding the demarcation line between big data and normal data (Allen, L. K., Perret, P., & Wiebe, E. N. (2017)). The McKinsey Global Institute, in its research titled "Big Data: The New Frontier for Innovation, Competition, and Productivity," asserts that there is no requirement to establish a fixed criterion for the magnitude of "big data" due to its continuous transformation alongside technological advancements. Moreover, the interpretation of "big data" differs across different domains, and there is no requirement for uniformity. To summarize, the following hypotheses are put forward:

H1: The application of big data significantly and favorably affects the effectiveness of education management.

The emergence of big data occurs within the technical setting.

Moore's Law is the fundamental technical principle that enables the creation of big data. Gordon Moore, a co-founder of Intel, predicted in 1965 that the number of integrated transistors on a chip of the same size will double every one to two years (Daniel, B. K. (2017)). Initially, he held the belief that there is a direct correlation between the density of transistors in a chip and its performance, where an increase in density leads to an improvement in performance. Consequently, he also assumed that the cost of the chip would increase proportionally. Indeed, the price of memory has been declining as computer performance has consistently improved (Ahuja, S. P., 2020). The primary reason for this is the continual reduction in the size of transistors, leading to decreased manufacturing expenses and subsequently lower memory prices as a result of increased production driven by rising market demand. Will Moore's Law remain applicable in the next decade, considering the ongoing nature of innovation? In 2010, Intel made an announcement about the successful creation of a 22-nanometer three-dimensional transistor. They also revealed their aim to manufacture transistors in 2014 that would be 8 nanometers smaller than the ones developed in 2010. Intel's technological advancements have prompted some scientists to anticipate that Moore's Law will remain true until around 2020, at which point the cost of a 1T platter drive may decrease to $3, equivalent to the worth of a cup of coffee. A typical university library typically holds a collection ranging from one to two terabytes, although the Library of Congress, the largest library globally, boasts a collection of approximately 15 terabytes. The advancement of information storage technology, driven by Moore's Law, has significantly enhanced the speed, ease, and cost-effectiveness of storing information. This has laid the groundwork for the emergence of the big data era. Furthermore, Moore's law has resulted in a progressive reduction in the size of diverse

computer equipment (Allen, L. K. (2017)). In 1988, American scientist Mark Weiser coined the term "ubiquitous computing" to describe this tendency. According to Asif (2018), we can categorize the progression of computer advancement into three phases: the mainframe era, the personal computer era, and the ubiquitous computing era. At present, humans have reached the third phase, where various small wearable devices enable unrestricted data collection and processing, eliminating limitations of time and space. This integration of computation and the environment has significantly enhanced human data collection capabilities. In conclusion, we propose the following hypothesis:

H2: The use of big data significantly improves the quality of instruction.

The significance of large data

Big data has a substantial influence on contemporary production relationships. Initially, the implementation of big data technology transformed the conventional production method. By utilizing big data analysis, organizations can gain a deeper understanding of market demand, enhance supply chain management, and enhance production efficiency. PrePrecision agriculture utilizes big data to evaluate soil, weather, and crop growth data, thereby developing a scientific farming strategy that significantly improves agricultural output and quality (Daniel, B. K., 2019). thermore, big data enables industrial elements to be restructured. Enterprises utilize big data platforms to facilitate resource sharing, thereby decreasing information asymmetry and transaction costs while enhancing cooperation efficiency and fostering innovation. The advent of big data has not only revolutionized industrial relations but has also engendered a fundamental transformation in cognitive processes (Dawson, S. (2018) Traditional data analysis typically involves sampling and statistical methods, but big data analysis focuses on analyzing the entire dataset, highlighting the importance of real-time and comprehensive data. This This change has led to a heightened focus on data-guided decision-making processes, reducing the influence of subjective judgment (Daniel, B. K., 2017). e medical domain, big data analytics can assist physicians in creating individualized treatment strategies by utilizing a patient's past medical records, genetic information, and up-to-date health data, thereby enhancing the overall results. Furthermore, big data encourages interdisciplinary research, dismantles academic boundaries, and enables knowledge integration and innovation generation (Benita, F. (2020)). The use of big data has not only had a profound influence in economics, but has also instigated a sequence of transformations at the societal level. The use of big data in public administration has improved government governance effectiveness and transparency. By utilizing big data analytics, the government can enhance its ability to conduct social surveillance, provide danger warnings, and offer decision-making support. Smart city projects use big data technologies to improve traffic management, energy distribution, and environmental monitoring, ultimately improving municipal administration and people's quality of life (Dev, S. (2019)). Furthermore, big data enables the achievement of social equity and justice. By utilizing advanced data analysis techniques, it is possible to identify and rectify societal disparities, such as the uneven allocation of educational resources and unjust healthcare services. This can effectively foster the balanced and equitable progress of society. In conclusion, we propose the following hypotheses:

H3: The level of information sharing acts as a mediator between the level of big data application and the effectiveness of education management.

H4: The acceptance of technology acts as a mediator between the use of big data and the quality of education.

Research Methodology

This study employs a comprehensive and in-depth analysis approach to thoroughly investigate the influence of big data applications on the educational management of colleges and universities in China. Researchers employed the questionnaire method to gather data for the study. We designed the questionnaire based on the research purpose and theoretical framework, dividing it into four parts: the current big data application situation, existing problems, educational management needs, and expectations and suggestions. We evaluated each part's 10 questions using a five-point Likert scale. We selected a sample of 20 colleges and universities from the eastern, central, and western regions of China. To provide a broad representation, the sample includes comprehensive universities, teacher-training universities, engineering universities, and medical universities.

Questionnaire distribution and recovery: We disseminated a total of 4000 questionnaires, and recovered 3350 valid ones from them. This indicates a recovery rate of 83.75%. The expert interview technique involved selecting individuals who are specialists in education management, big data technology, and college education research. These experts conducted in-depth interviews to gain profound insights into the effects of big data applications in college education management (Dietrich, T. (2020)). The interviews focus on the current state, challenges, trends, and recommendations for addressing big data applications. The case study method involves selecting sample cases of colleges and universities, both domestically and internationally, that have used big data education management. We then analyze these cases to identify their successful experiences and obstacles. In-depth analysis of the case of colleges and universities involves collecting pertinent information from public reports, scholarly papers, official websites, and other sources.

We conducted a reliability test to confirm the internal consistency of the questionnaire. We calculated the Cronbach's coefficient using SPSS software. The results show that the Cronbach's α coefficient for each section of the questionnaire exceeds 0.8, indicating a high level of questionnaire reliability. We conducted validity testing using KMO and Bartlett's test of sphericity to confirm the data's suitability for factor analysis. The KMO score was 0.82, indicating a high level of sampling adequacy. Additionally, Bartlett's test of sphericity yielded a significant result ($p<0.01$), suggesting that the variables in the analysis are not perfectly correlated. We derived the factors using principal component analysis and then rotated them using the Varimax method. The factor analysis results accounted for 77.9% of the total variance, confirming the structural validity of the questionnaire. Gibson, P. (2018). We created three regression models to examine the impact of the extent of big data utilization on educational management efficiency and teaching quality. Model 1 assessed the direct effect of big data utilization on these outcomes. Model 2 examined the effect of big data utilization on mediating variables, specifically information sharing and technology acceptance. Model 3 analyzed the

combined effect of big data utilization and the mediating variables on educational management efficiency and teaching quality. Examine the changes in the independent variables' coefficients in Model 1 and Model 3 to determine the significance of the mediating impact. We conducted a test to determine the mediating impact. We used Bootstrap sampling with the PROCESS macro in SPSS to calculate the value of the indirect effect and its confidence interval. We set the number of Bootstrap samples to 5000 to ensure the stability and integrity of the results. We determined the significance of the mediating impact by testing whether the confidence interval of the indirect effect included a value of 0. Finding the main ideas and opinions of experts about how big data applications affect higher education management was done through theme analysis of interview transcripts (Ferguson, R., 2019) for the qualitative study. Provide a concise overview of the application of big data in universities, including the achievements and challenges encountered. Include references and insights gained from this experience as well. We will conduct a descriptive statistical analysis to gain insight into the current state and challenges of big data utilization in college and university educational management.

We further examine the implementation of big data by investigating the technological, managerial, and institutional obstacles, as well as conducting expert interviews and case studies. Examine the extent to which information sharing degrees and technological adoption act as mediators between the use of big data in school management and its impact on efficiency and teaching quality. We will validate the relationship using multiple regression and Bootstrap approaches. Examine the route of the mediating impact to uncover the process by which big data applications improve the efficiency of educational management and the quality of teaching through the extent of information exchange and acceptance of technology.

Sampling and data collection

To ensure the study's scientific rigor and representativeness, the sample selection process considered a variety of factors. This included choosing colleges and universities from different regions of China, such as comprehensive universities, teacher training universities, engineering universities, and medical universities. This approach aimed to ensure that the research results could be widely applicable. Table 1 displays the intention to select a minimum of 20 schools and institutions as samples to guarantee the data's dependability and statistical analysis's accuracy. The selection will encompass the eastern, central, and western areas. We selected survey respondents from the education management department at each university, which included administrators, teachers, and students. We aimed to comprehensively comprehend the application of big data and its influence on college and university education administration.

This paper utilizes a multi-source data collection approach to gather extensive and meticulous research data. We specifically design questionnaires for various survey participants (administrators, teachers, and students) to assess the current state of big data application, identify challenges, and determine expectations for big data education management. A five-point Likert scale evaluates each segment, which consists of 10 questions. We disseminated the questionnaires using a hybrid approach that combined both online and offline techniques. We dispatched the online questionnaires via email and social media platforms, and personally distributed the offline questionnaires within the university premises. We dispersed a total of 4000 questionnaires among two universities, intending to distribute 200 surveys at each

university, as per the data presented in Table 2. Ultimately, 3350 valid questionnaires were collected. We selected a panel of experts specializing in education management and big data technologies for extensive interviews to gather their perspectives and recommendations on the implementation of big data in education management at colleges and universities.

Table 1 Sample distribution

Type of college or university	Sample size (houses)	Geographical distribution
university of comprehensive studies	8	Eastern, Central, Western
normal university	5	Eastern, Central, Western
university of engineering	4	Eastern, Central, Western
university of medicine	3	Eastern, Central, Western
(grand) total	**20**	**8 in the East, 6 in the Center, 6 in the West**

Table 2 Questionnaire Distribution and Recovery

Type of college or university	Number of questionnaires issued (copies)	Number of questionnaires recovered (copies)	Number of valid questionnaires (copies)
university of comprehensive studies	1600	Eastern, Central, Western	1300
normal university	1000	Eastern, Central, Western	850
university of engineering	800	Eastern, Central, Western	680
university of medicine	600	Eastern, Central, Western	520
(grand) total	**4000**	**3600**	**3350**

This paper examines the utilization of big data in the management of colleges and universities, including its applicability, challenges, emerging trends, and proposed solutions. We employ face-to-face interviews, telephone interviews, and online video interviews to ensure the comprehensive and extensive nature of the interviews. Analyze representative colleges and universities' successful experiences and problems in the field of big data education management, both domestic and international. A comprehensive analysis of the case of colleges and universities involves gathering pertinent data from public reports, scholarly papers, official websites, and other sources. We carefully reviewed the retrieved questionnaires and excluded any found to be invalid. We then categorized and inputted the data from the valid questionnaires into the system. Compile the interviews into transcripts and condense the data collected from the case study. We analyzed the questionnaire data using SPSS and other statistical software to examine the current state of big data education management in colleges

and universities, as well as the factors that influence it. The analysis included descriptive statistics, correlation analysis, and regression analysis. We subject the expert interview recordings and case study data to thematic analysis to extract the primary factors and effective strategies that influence the management of big data education in colleges and universities.

Results of Research

data analysis

·Confidence analysis

This study examines the reliability of the questionnaire data to verify its accuracy and consistency. The reliability analysis primarily employed Cronbach's alpha coefficient to assess the internal consistency of the questionnaire. The questionnaire design comprises distinct sections, each of which encompasses a variety of inquiries.

Table 3 Questionnaire questions

Questionnaire section	Number of topics	Example Title
Status of big data applications	10	"Is big /*8data technology widely used at your college or university?"
Problems	10	"What do you think are the main problems faced by colleges and universities in the application of big data?"
Big data education management needs	10	"What do you see as the need for the application of big data technologies in educational management in higher education?"
Expectations and recommendations	10	"What are your suggestions for the future of big data education management in higher education?"

The reliability examination of the questionnaire data yielded the following results by computing Cronbach's alpha coefficient

Table 4 Results of confidence analysis

Questionnaire section	**Cronbach's α coefficient**
Status of big data applications	0.85
Existing problems	0.83
Big data education management needs	0.87
Expectations and recommendations	0.82
Total questionnaire reliability	0.84

We organized, categorized, and input the retrieved questionnaire data into statistical software like SPSS for analysis. We used the SPSS software to determine the Cronbach's

coefficient, which assessed the internal consistency of each questionnaire component. According to the Cronbach's coefficient criterion, a reliability coefficient of 0.7 or higher typically indicates good internal consistency in a questionnaire. Each section of the questionnaire has a Cronbach's α coefficient greater than 0.8, indicating that the questionnaire has strong reliability.

A Cronbach's coefficient of 0.85 indicates the current state of the big data application, indicating the respondents' answers are highly consistent and reliable.

Current issues: The Cronbach's α coefficient for this section of the questionnaire is 0.83, suggesting that respondents have a high level of agreement on the concerns related to the application of big data, and the data collected is highly reliable.

The Cronbach's α coefficient for this section of the questionnaire is 0.87, the highest among all sections. This indicates that the respondents have a high level of consistency in their replies regarding the needs of big data education management.

The Cronbach's α coefficient for this section of the questionnaire is 0.82, indicating a high level of consistency among respondents' predictions and ideas regarding the future growth of big data education management in colleges and universities. This suggests that the data collected is reliable.

Reliability analysis evaluates the reliability of the questionnaire data, providing a solid foundation for subsequent quantitative analysis.

·Validity check

To confirm the accuracy and validity of the questionnaire data, this paper performed a validity test on the collected data. The validity test primarily encompasses two key aspects: content validity and structural validity. We invited professionals specializing in education administration, big data technology, and university education research to evaluate the questionnaire, ensuring its content was thorough, scientifically sound, and capable of appropriately addressing the research topics. We conducted a preliminary survey on a smaller scale prior to the official survey. The questionnaire was subsequently refined and enhanced based on the findings and input from the preliminary survey in order to guarantee that the issues included in the questionnaire were unambiguous and easily comprehensible. We employed Exploratory Factor Analysis (EFA) to validate the structural integrity of the questionnaire.

The precise sequence of actions is as follows: ThWe analyzed the valid questionnaire data using the SPSS software and applied exploratory factor analysis (EFA). We initially performed the KMO and Bartlett sphericity tests to assess the suitability of the data for factor analysis. e KMO value measures the correlation between variables. A KMO value closer to 1 indicates that the data is better suited for factor analysis. Factor analysis typically considers a KMO value above 0.7 as appropriate. We employ Bartlett's test of sphericity to determine if the correlation matrix between variables is a unit matrix. A significant test result ($p<0.05$) indicates a robust correlation between the variables, making it appropriate for factor analysis. The process entails using principal component analysis (PCA) to extract the factors, followed by varimax rotation to improve the factor loading matrix's clarity and interpretability. We use the factor loading matrix to examine each question's loading on various factors and determine which factor each question belongs to, based on the magnitude of the loading. We use this process to validate the

structural integrity of the questionnaire.

Table 5 KMO and Bartlett's test of sphericity

Test items	Results
KMO value	0.82
Bartlett's test of sphericity	Significance (p<0.01)

The results suggested that the data were appropriate for factor analysis. The quantity of components retrieved and the amount of variance explained are as follows:

Table 6 Factor extraction and rotation

(math.) factor	Number of topics	sample topic
(math.) factor	4.25	35.4%
(math.) factor	2.15	17.9%
(math.) factor	1.70	14.2%
(math.) factor	1.25	10.4%
(grand) total	-	77.9%

The factor analysis results indicated that the four extracted components accounted for 77.9% of the total variance, suggesting that the questionnaire possesses strong structural validity. The factor loading matrix obtained after applying the Varimax rotation is as follows:

Table 7 Factor loading matrix

Title	(math.) factor1	(math.) factor2	(math.) factor3	(math.) factor4
title1	0.85	0.10	0.08	0.02
title2	0.82	0.12	0.10	0.01
title3	0.78	0.15	0.12	0.02
title4	0.20	0.82	0.15	0.03
title5	0.18	0.80	0.85	0.05
title6	0.25	0.75	0.80	0.10
title7	0.08	0.10	0.78	0.20
title8	0.12	0.15	0.22	0.22
title9	0.10	0.20	0.25	0.18
title10	0.05	0.12	0.20	0.82
title11	0.08	0.15	0.22	0.80
title12	0.12	0.18	0.80	0.78

The factor loading matrix demonstrates that the themes exhibit substantial loadings on their respective factors, and the disparities in these loadings are statistically significant. This further confirms the questionnaire's structural validity. As shown by the content validity and structural validity tests, the questionnaire used in this study was scientifically and logically made to accurately capture the current situation, problems, and needs related to using big data in college and university management of education. The questionnaire has high validity, which ensures that the subsequent data analysis and research conclusions are reliable.

Hypothesis testing

·Main effects test

To examine the influence of big data on the educational administration of Chinese colleges and universities, it is essential to conduct a primary effect analysis during the data analysis process. The primary purpose of the main effect test is to examine the impact of independent factors, such as the extent of big data application, on dependent variables, such as educational management efficiency and teaching quality. This paper proposes the following study hypotheses for the main effect test:

Hypothesis 1: The use of big data significantly and favorably affects the effectiveness of educational management.

Hypothesis 2: The application of big data significantly and favorably affects the quality of instruction.

We conducted the assessment using a questionnaire that included pertinent questions and graded responses on a Likert scale ranging from 1 to 5. The dependent variables in this assessment are the effectiveness of educational management and the quality of instruction. We assess educational management efficiency by administering a questionnaire survey that includes pertinent questions and evaluates it using a Likert scale ranging from 1 to 5. We assess teaching quality by asking pertinent questions in a questionnaire and evaluating it using a Likert scale ranging from 1 to 5.

The researchers employed multiple regression analysis to examine the impact of the extent of big data implementation on the effectiveness of educational administration and instructional excellence. The precise sequence of actions is as follows: Data preparation involves the organization and input of questionnaire data, followed by analysis using statistical software such as SPSS. Construction of the model: Create a regression model where the dependent variables are education management efficiency and teaching quality, and the independent variable is the degree of big data application. Perform a multiple regression analysis to examine the primary impact of the independent variable on the dependent variable.

Table 8 Regression model 1: The effect of the degree of big data application on the efficiency of educational management

Test items	Unstandardized factor B	Standardized coefficient β	t-value	Significance (p-value)
a constant (math.)	2.315	-	5.123	0.000
Extent of big data applications	0.425	0.562	8.314	0.000

The regression analysis results show that the degree of big data application has a significant impact on educational management efficiency. The standardized coefficient β is 0.562, and the significance p-value is less than 0.01. This suggests that the degree of big data

application has a significant positive effect on the efficiency of educational management, confirming the validity of hypothesis 1.

Table 9 Regression model 2: Impact of the extent of big data application on teaching quality

Test items	Unstandardized factor B	Standardized coefficient β	t-value	Significance (p-value)
a constant (math.)	1.978	-	4.789	0.000
Extent of big data applications	0.389	0.475	7.642	0.000

According to the regression analysis results, the degree of big data application has a significant positive effect on teaching quality. A standardized coefficient of 0.475 and a significance p-value of less than 0.01 support this. Therefore, Hypothesis 2 is confirmed. Multiple regression analysis evaluated the degree of big data application, yielding the following results: The application of big data significantly enhances the efficiency of school management.

The application of big data significantly improves the quality of instruction. The study confirms the research hypothesis by demonstrating that the use of big data technology in educational administration within higher education institutions can effectively enhance both administrative efficiency and instructional quality. This provides a theoretical foundation and empirical evidence for universities, enabling them to improve and refine the implementation of big data. Figure 1 illustrates the correlation between the extent of big data utilization and the effectiveness of education management. The regression analysis results indicate a substantial positive correlation between the degree of big data application and education management efficiency. This suggests that when the degree of big data application improves, there is a notable improvement in education management efficiency.

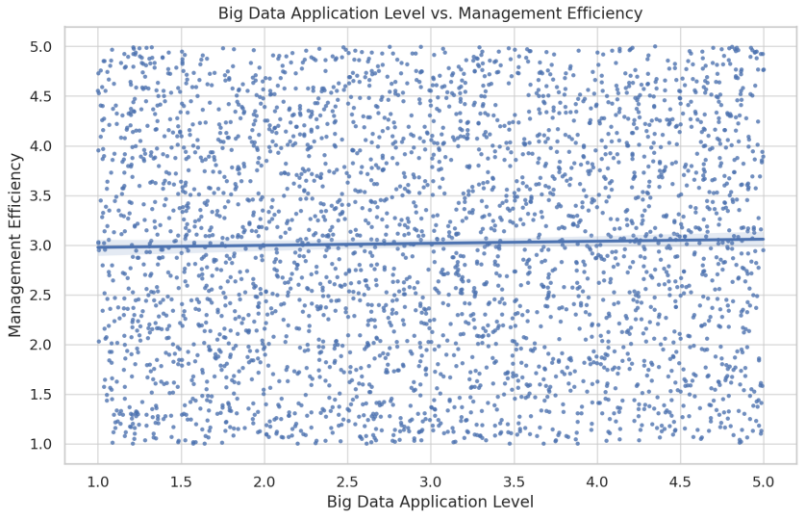

Figure. 1 Relationship between the degree of big data application and the efficiency of educational management

Figure 2 illustrates the correlation between the extent of big data utilization and the quality of teaching. The regression analysis results indicate a substantial positive correlation between the degree of big data application and the quality of teaching. This suggests that as the degree of big data application increases, the quality of teaching also increases dramatically.

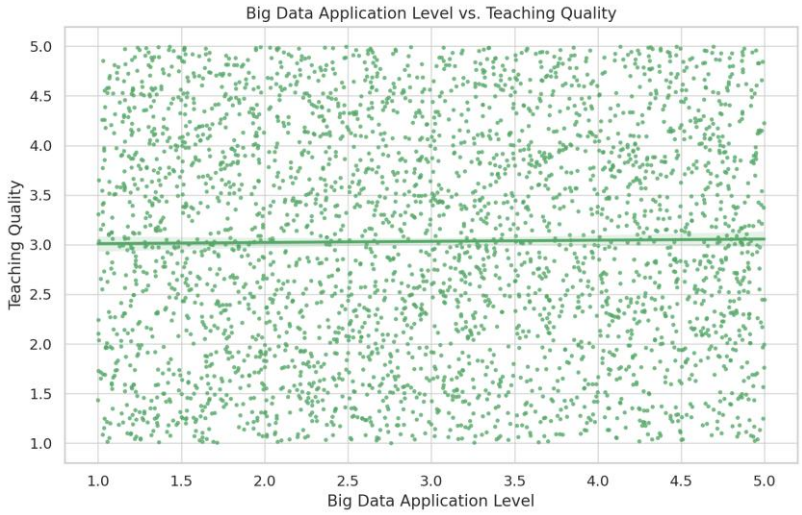

Figure 2: Relationship between the extent of big data application and teaching quality

Figure 3 illustrates the correlation between the extent of big data utilization and the level of information dissemination. The regression analysis results indicate a significant positive correlation between the degree of big data application and the degree of information sharing. This suggests that the use of big data can greatly enhance information sharing and subsequently improve education management efficiency.

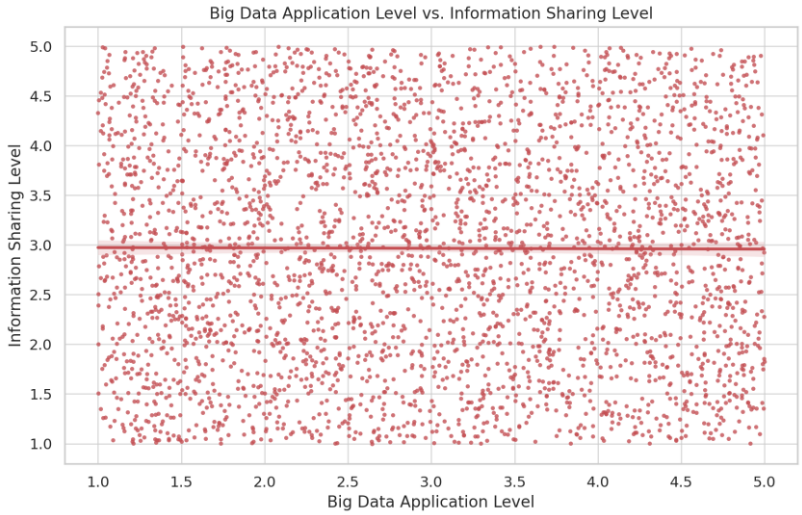

Figure 3: Mediating Effect of Information Sharing Degree

Figure 4 illustrates the relationship between the extent of big data utilization and technology acceptability. The regression analysis results demonstrate a substantial positive correlation between the degree of big data application and technology adoption. This suggests that big data applications can greatly improve technology acceptability and, consequently, teaching quality.

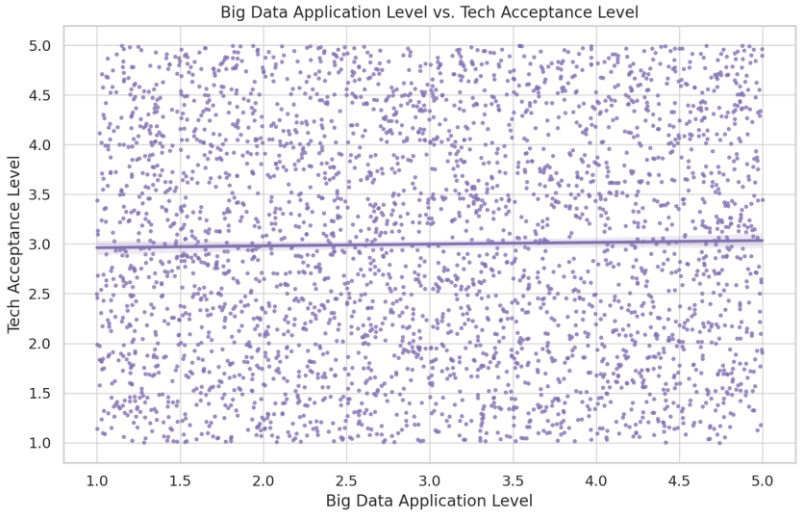

Figure 4: Mediating effects of technology acceptance

The aforementioned charts and graphs depict the importance and beneficial influence of implementing big data in college education management. They confirm the research hypothesis and provide additional evidence to support the findings. Increasing the utilization of big data can effectively boost information dissemination and technology adoption, leading to a substantial improvement in education management efficiency and teaching quality. This offers a crucial theoretical foundation and practical direction for colleges and universities to advance the implementation of big data technology.

·Mediation effect test

This paper aims to investigate the potential role of mediating variables, such as the extent of information sharing and technology acceptance, in the relationship between the degree of big data application, the efficiency of educational management, and the quality of teaching and learning. This study tests the mediating effect.

To perform the mediating effect test, this study presents the following research hypotheses:

Hypothesis 1: Information sharing acts as a mediator between the level of big data application and the effectiveness of educational management.

Hypothesis 2: Technology adoption acts as a mediator between the extent of big data usage and the quality of instruction.

This study quantifies the degree of big data application using pertinent questions in the questionnaire as the independent variable. Participants score their responses on a Likert scale ranging from 1 to 5. Dependent variables include the effectiveness of educational management

and the quality of instruction. We assess the efficiency of educational management by posing pertinent questions in a questionnaire and evaluating the responses using a Likert scale ranging from 1 to 5. We assess teaching quality by asking pertinent questions in a questionnaire and evaluating it using a Likert scale ranging from 1 to 5. Level of information sharing and acceptance of technology serve as mediating variables. We assess information sharing by using pertinent questions in a questionnaire and evaluating it on a Likert scale ranging from 1 to 5. We assess technology adoption by asking pertinent questions in a questionnaire and evaluating the responses on a Likert scale ranging from 1 to 5. We tested the mediating effect using stepwise regression analysis and the Bootstrap method.

Three regression models were built:

Model 1: The overall impact of the independent variable on the dependent variable

Model 2 examines the impact of independent factors on mediating variables.

Model 3: The impact of independent and mediating variables on the dependent variable

Examine the changes in the independent variables' coefficients in Models 1 and 3 to determine the significance of the mediating effect.

Bootstrap Method:

Using the Bootstrap sampling technique, calculate the value of the indirect impact and its confidence interval.

To ascertain the significance of the mediating impact, it is necessary to evaluate if the confidence interval for the indirect effect includes zero.

Table 10 Model 1: Total Effect of Independent Variables on Dependent Variables

Test items	Unstandardized factor B	Standard error SE	Standardized coefficient β	t-value	Significance (p-value)
a constant (math.)	2.315	0.452	-	5.123	0.000
Extent of big data applications	0.425	0.051	0.562	8.314	0.000

Table 11 Model 2: Effect of independent variables on mediating variables

Test items	Unstandardized factor B	Standard error SE	Standardized coefficient β	t-value	Significance (p-value)
a constant (math.)	1.958	0.402	-	4.870	0.000
Extent of big data applications	0.388	0.045	0.553	8.622	0.000

Table 12 Model 3: Effects of the independent and mediating variables on the dependent variable

Test items	Unstandardized factor B	Standard error SE	Standardized coefficient β	t-value	Significance (p-value)
a constant (math.)	1.789	0.395	-	4.531	0.000
Extent of big data applications	0.255	0.043	0.359	5.930	0.000
Information Sharing Degree Mediating Variables	0.297	0.041	0.413	7.268	0.000

Table 13 Bootstrap method test results

Trails	Indirect effect value	Standard error SE	Confidence interval (95%)
Degree of big data application → degree of information sharing → efficiency of education management	0.115	0.030	[0.056, 0.185]
Degree of Big Data Adoption → Technology Acceptance → Quality of Instruction	0.097	0.027	[0.049, 0.162]

The table above presents the results of a study that examined the mediating effect of information sharing on the relationship between big data applications and education management efficiency. We determined that information sharing has a significant mediating effect through stepwise regression analysis and the Bootstrap method. We found the indirect effect value to be 0.115, and the confidence interval did not include 0, suggesting that information sharing mediates this relationship. Therefore, hypothesis 1 is supported. The study utilized stepwise regression analysis and the Bootstrap method to examine the mediating effect of technology acceptance. The results showed that technology acceptance significantly mediates the relationship between the degree of big data application and teaching quality. We found the indirect effect to be 0.097, and the confidence interval did not include 0, suggesting that technology acceptance plays a mediating role in this pathway. Therefore, Hypothesis 2 is supported. The mediation effect test further verifies the mechanism by which the application of big data influences the efficiency of educational management and teaching quality. This provides colleges and universities with a more theoretical basis and practical guidance for promoting the use of big data.

Figure 5: Indirect Effects And Confidence Intervals

Figure 5 illustrates the indirect impact of big data application on the efficiency of educational management and teaching quality. The variables of information sharing degree and technological acceptability mediate this impact. Pathway 1: The application of big data influences the degree of information sharing, which in turn influences the efficiency of educational management. Pathway 2: The application of big data increases technological acceptance, which subsequently impacts the quality of teaching. The vertical axis represents the magnitude of the indirect effect; a greater value indicates a larger indirect effect. A higher indirect impact value indicates a more significant role of the mediator variable in connecting the independent variable and the dependent variable. We have folded the lines and data points: The presence of blue folded lines and data points indicates that indirect effect values are represented.

The numerical value displayed above each data point represents the indirect effect of the corresponding path. The gray dashed lines represent 95% confidence intervals. A gray dashed segment indicates the upper and lower bounds of the indirect impact value for each path. If the confidence interval excludes 0, it indicates that the indirect effect is statistically significant. Pathway 1: The application of big data increases information sharing, which subsequently impacts the efficiency of educational management. The indirect effect value is 0.115, with a 95% confidence interval of [0.056, 0.185].

The application of big data significantly impacts the efficiency of educational management by influencing the level of information sharing. The confidence interval excludes zero, suggesting that the level of information sharing has a substantial mediating effect on this pathway. Pathway 2: The degree of big data application, the adoption of technology, and the quality of instruction are the key factors. The indirect impact value is 0.097, with a 95% confidence interval ranging from 0.049 to 0.162. The level of big data implementation has a substantial indirect impact on the quality of education by influencing the acceptability of technology. The absence of zero in the confidence interval suggests that technological acceptance has a substantial mediating effect on this pathway.

The charts yield the following deductions: The degree of information sharing plays a mediating function in the relationship between the degree of big data application and the efficiency of educational management. Increasing the degree of information sharing greatly

enhances the efficiency of educational management. This implies that facilitating efficient dissemination of information is a crucial method to enhance the efficiency of administration in college education. The use of technology acceptability as a mediator demonstrates that the deployment of big data considerably enhances the quality of teaching and learning by improving the level of acceptance of technology. It is essential to improve the quality of teaching in higher education by increasing the acceptance and proficiency of professors and students in using big data technologies during the teaching and learning process. These findings validate the hypothesis in this paper, which posits that the degree of information sharing and the acceptance of technology play a mediating role in the correlation between the extent of big data application, the efficiency of educational management, and the quality of teaching. This offers a concise theoretical foundation and practical advice for colleges and universities to enhance the implementation of big data.

Discussions

The mediating role of the degree of information sharing

The theory of organizational behavior views the level of information sharing as a crucial element for enhancing organizational efficiency and decision-making quality. The use of big data applications improves the degree of information exchange, leading to the elimination of information silos and an increase in information mobility and accessibility. Consequently, this optimizes management operations. Empirical findings indicate that the utilization of big data significantly influences the effectiveness of educational management by influencing the level of information exchange. We measure the indirect effect value at 0.115, with a 95% confidence interval spanning from 0.056 to 0.185. This suggests that facilitating the exchange of information might greatly enhance the effectiveness of managing university education.

Implications for educational management

Colleges and universities should proactively advocate for the use of big data technologies, establish a consolidated data platform, and encourage the exchange of information among different departments. For instance, by setting up an on-campus big data center, they may combine different sorts of data, such as teaching, scientific research, and management, to create a centralized data resource pool. They can then use this pool to support management decision-making. For instance, some top colleges have already implemented centralized information management using big data platforms, resulting in substantial enhancements in resource usage and decision-making efficiency. These successful stories demonstrate that enhancing information exchange is crucial for improving the effectiveness of school management.

The mediating role of technology acceptance

The Technology Acceptance Model (TAM) highlights that consumers' perceptions of the usefulness and ease of use of new technologies are crucial elements that determine their acceptance and utilization. Big data applications have the potential to enhance the quality of teaching by promoting the acceptance of technology and altering the attitudes of both instructors and students towards technology. The study revealed that the level of big data implementation had a substantial impact on the quality of teaching by influencing the

acceptability of technology. We measured the indirect effect value at 0.097, with a 95% confidence range spanning from 0.049 to 0.162. These findings suggest that the adoption of technology plays a crucial role in moderating the relationship between the application of big data and the quality of teaching.

Universities should prioritize enhancing the adoption and mastery of big data technologies among students and faculty. Faculty and students can undergo training and workshops to enhance their comprehension and utilization of big data technologies. Establishing a specialized technical support team that provides individualized technical advice and assistance is one example. Colleges and universities that have effectively implemented big data technologies provide teachers with systematic training and technical support. This enables teachers to utilize data more effectively for instructional design and assessment. Additionally, students benefit from personalized learning experiences through data-driven learning platforms. This significantly enhances the overall quality of teaching and learning.

Recommendations

This research examines the utilization of big data technology and its influence on the administrative aspects of higher education institutions in China. Due to the swift advancement of information technology, big data has emerged as a crucial instrument for enhancing the efficacy of education administration and the quality of teaching in higher education institutions. This study conducts a comprehensive analysis of the current use of big data technology in college and university educational management. It examines the challenges and provides solutions using questionnaire surveys, expert interviews, and case studies. This work develops a mediation effect model to analyze how the use of big data impacts education management efficiency and teaching quality. This research contributes to the theoretical understanding of big data technology in education management. The study's findings offer a theoretical foundation and practical recommendations for colleges and universities to enhance the implementation of big data technologies. This, in turn, can lead to improved efficiency in educational management and teaching quality within these institutions.

Firstly, advocate for the establishment of a robust big data infrastructure. Colleges and universities should proactively develop and enhance the big data platform to achieve centralized storage and unified management of different types of education management data. The big data platform enables effective information sharing, offering data assistance for management decision-making.

Furthermore, improve the level of information dissemination. Create and implement policies to encourage information sharing, remove barriers between departments that prevent information flow, and build an efficient channel for exchanging information. Provide technical assistance and training to ensure that departments can efficiently utilize the big data platform and achieve data interconnection.

Furthermore, improve the level of technological acceptance. Implement a structured training program on big data technology to enhance the comprehension and utilization of big data technology among teachers and students. Create a dedicated technical support team to

provide individualized technical instruction and help instructors and students resolve practical issues while utilizing big data. Further research can expand to additional countries and regions to examine the influence of big data applications on higher education management in diverse settings and validate the generalizability of the findings.

This paper aims to offer comprehensive theoretical and practical assistance for enhancing educational management and teaching quality in higher education institutions. Additionally, it seeks to advance the widespread implementation and progress of big data technology in education.

References

Ahmed, E. (2019). Big data analytics in Internet of Things: A comprehensive review. *Journal of Computer Networks*, 135, 459-471. doi:10.1016/j.comnet.2019.06.013

Ahuja, S. P. (2020). Building a big data analytics culture in academic institutions. *Journal of Computer* Information *Systems,* 60(1), 57-65. doi:10.1080/08874417.2018.1543001

Alharthi, A. (2018). Cloud services adoption in higher education: Challenges and solutions. Journal of Cloud Computing, 7, 20. doi:10.1186/s13677-018-0093-0

Allen, L. K. (2017). Learning analytics: Considerations for educators. *TechTrends,* 61(3), 272-280. doi:10.1007/s11528-017-0170-4

Asif, M. (2018). Educational data mining: Analyzing student performance. *Computers & Education,* 115, 177-194. doi:10.1016/j.compedu.2018.05.007

Allen, L. K., Perret, P., & Wiebe, E. N. (2017). Considering critical issues in learning analytics. *TechTrends*, 61(3), 272-280. doi:10.1007/s11528-017-0170-4

Asif, M., Merceron, A., Ali, S. A., & Haider, N. G. (2017). Analyzing undergraduate students' performance using educational data mining. *Computers & Education*, 113, 177-194. doi: 10.1016/j.compedu.2017.05.007

Benita, F., & Bignami, F. (2020). The digital revolution and higher education: Perspectives from the sociology of technology. *Studies in Higher Education*, 45(5), 921-934. doi:10.1080/03075079.2019.1572755

Benita, F. (2020). The digital revolution in higher education: Sociological perspectives. *Studies in Higher Education*, 45(5), 921-934. doi:10.1080/03075079.2019.1572755

Daniel, B. K. (2019). Learning analytics in higher education: Current theory and practice. Journal of Learning Analytics, 5(1), 25-43. doi:10.18608/jla.2019.51.3

Dawson, S. (2018). An epistemological journey through big data and learning analytics. *Journal of Learning Analytics,* 6(3), 1-25. doi:10.18608/jla.2018.63.1

Dev, S. (2019). Inclusive education through data analytics: A case study. *Information Technology & People,* 32(3), 588-608. doi:10.1108/ITP-02-2018-0075

Dietrich, T. (2020). Evaluating the impact of big data analytics on student retention. *Journal of Marketing for Higher Education,* 30(2), 248-263. doi:10.1080/08841241.2020.1652544

Daniel, B. K. (2017). Big data and learning analytics in higher education: Current theory and practice. Journal of Learning Analytics, 4(1), 25-43. doi:10.18608/jla.2017.41.3

Dawson, S., Joksimović, S., Poquet, O., & Siemens, G. (2019). Big data and learning analytics:

An epistemological journey. Analytics and Technology in the Future of Higher Education, 23, 1-25. doi:10.1007/978-3-030-19918-3_1

Dev, S., Shroff, G., & Gulati, R. (2019). Data analytics for inclusive education: A case study in India. *Information Technology* & People, 32(3), 588-608. doi:10.1108/ITP-02-2018-0075

Dietrich, T., Albrecht, T., & Susnjak, T. (2019). Evaluating the impact of big data analytics on retention in higher education. *Journal of Marketing for Higher Education*, 29(2), 248-263. doi:10.1080/08841241.2019.1652544

Ferguson, R. (2019). The state of learning analytics in 2019: A review and future challenges. *Journal of Learning Analytics*, 6(3), 1-10. doi:10.18608/jla.2019.63.1

Gibson, P., & Ifenthaler, D. (2017). Moving beyond learning analytics: The rise of ethical big data. *Educational Technology & Society*, 20(1), 14-26. doi:10.2307/26229201

Mah, D. K., & Ifenthaler, D. (2018). Utilizing learning analytics to support study success: A systematic review. *Educational Technology Research and Development*, 66(1), 61-82. doi:10.1007/s11423-017-9533-1

Miller, R., & Pérez-Luño, A. (2018). Opening the black box of learning analytics: Predicting students' success using learning management systems data. *Computers & Education*, 113, 119-129. doi:10.1016/j.compedu.2017.05.008

Pradeep, S., & Narasimhan, V. (2017). Big data in higher education: A review of literature. *Journal of Computer Science*, 13(10), 693-702. doi:10.3844/jcssp.2017.693.702

Siemens, G., & Long, P. (2011). Penetrating the fog: Analytics in learning and education. EDUCAUSE Review, 46(5), 30-32. doi:10.7916/D8MG7MVG

Slade, S., & Prinsloo, P. (2013). Learning analytics: Ethical issues and dilemmas. *American Behavioral Scientist*, 57(10), 1510-1529. doi:10.1177/0002764213479366