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Framework of it Management for Big Data Technology to Improve Teaching Strategy in College, China

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Abstract

This study is a research-based analysis of how China integrated big data technology into education along with the major challenges involved, machine learning algorithm usage, and training I.T. management frameworks. It was determined that the main obstacles to Big Data implementation were the reliability of information, privacy issues, and institutional infrastructure. These challenges were addressed by implementing machine learning algorithms such as the LightGBM, XGBoost, SVM, and RF to develop a universal IT management framework. Through this approach, teachers attempted to determine teaching strategies based on the analyzed educational data patterns and future adherence and effectiveness of students to school education. Using usability analyses the platform was performing effectively and easy for educators as well as students to apply in their practice. The research results showed that these strategies provided a change to an approach not only to the methods of teaching but also to improve the quality of educational outcomes and the development of a modern system of education. The solutions proposed include promoting communication and collaboration between the IT leaders, instructors, and scientists by ensuring that they work together to overcome the challenges, taking also longitudinal studies to measure the long-term achievements and impact of the IT management design on teaching and student accomplishment. To this end, research works on this topic will aid the development of educational practices by using big data technology and machine learning algorithms to develop strategies for the betterment of educational outcomes in China.

Keywords: Big Data Technology, Machine Learning Algorithms, Teaching Strategies, Educational Data Analytics, IT Management Framework

Introduction

Digital strategy is gaining a growing and essential place in the educational context in China, where digitalization with the incorporation of big data resources aims at bettering learning productivity. Even as researchers recognize the potential of big data to facilitate the flow of

insights on student behaviours and needs, the reality is there are shortcomings in areas such as data storage and analysis due to the absence of expertise in handling and analyzing big data. Traditional machine learning algorithms exhibit weaknesses in the possession of adeptness to deal with educational data complexity. As a result, such a situation arises that needs immediate introduction of improved techniques like LightGBM and XGBoost. The fact that there are different classes of educational data is a key issue that poses a vast challenge when putting forward a general management framework. Moreover, advancing shapes and frameworks of accuracy teaching as well as precision teaching to cater for each learner is imperative. Therefore, by taking a closer look at these shortcomings, this study will contribute to the development and improvement of the field of education. This study will attempt to apply advanced machine learning methods in the hope of using these new techniques to enhance the analysis and application of educational data that is currently potential rather than practical. Creation of a framework for IT management across all the schools, improvements on one-to-one teaching approaches, and consequently, overall student learning and efficiency of teaching methods. That is why this study aims at giving specific recommendations that would help to enhance the educational outcomes, thereby becoming the further development of the digital learning process in China.

Research Objectives (RO)

- To identify the limitations, and challenges faced by administration, and teachers while implementing IT management for big data technology in improving teaching strategies.
- To analyze attributes, and train models using machine learning algorithms for the development of a universal IT management framework for big data technology to improve teaching strategy.
- To evaluate the usability of the platform and the effectiveness of the IT management framework.

This research seeks to look into the big data technology implementation into education, which incorporates the top practices, difficulties, and viability of education-personalised methods in Chinese Colleges. The purpose of this analysis will be to identify through case administrators' and educators' experiences factors of success and barriers. Building baseline knowledge of big data-driven teaching methods will undoubtedly be the foundation of personalized teaching frameworks that align with modern technologies' needs. The impact of these frameworks on teachers' professional development and student academic outcomes will be assessed through such measurement; these findings will serve as a solid basis for their subsequent use throughout Chinese higher education.

Studies centre on the use of big data technologies for educational purposes in the southern provinces of China, spanning from highly developed to more resource-restricted areas, to balance demographic differences (Shniekat et al., 2021). This is the focus area of the study where the researcher is to identify the best practices and the challenges that IT administrators and teachers are facing in information technology education. The research relies upon the usage of machine learning techniques including LightGBM and XGBoost for the prediction of student learning outcomes (SLOs) as well as the devising of effective teaching techniques (Wang & Liu, 2021). Despite this, some obstacles such as resource constraints limit the research scope and confine it to the local level because of diverse learning environments and technology infrastructure around the globe (Sun & Scanlon, 2019). Delimitations, on the other hand, require the study to ignore irrelevant issues like funding and infrastructure

considerations that may not fit in the study topic and only address the students in mainland China, excluding colleges in other parts of the world. Apart from this, the study might not account for permanent opportunities for the technology of big data in education because of its specific timeframe.

The concern for this research stems from the desire to introduce the concept of big data into colleges within China with an emphasis on improving the qualities of both teaching and learning. This research aims to uncover the key success factors and obstacles in the process and, therefore, significantly contribute to the development of efficient data-oriented teaching paradigms. If effectively implemented, these frameworks may increase students' learning achievements and enhance the professional growth of teachers, and consequently, promote the enhancement of the quality of higher education in China.

This research has practical importance in the sense that it proposes solutions for the removal of barriers that make the use of big data hard in education, and it offers pragmatic solutions that can improve methods of teaching and eventually raise the level of education in the nation (Nguyen et al., 2020). It contributes to the theory and practice of learning environments by leveraging standard machine learning algorithms including LightGBM, XGBoost, SVM and RF to assess different teaching styles which shows advantages over single ones and opens the way for research in educational contexts (Fischer et al., 2020). An international IT control framework the creation of which is quite a practical guidance for the administrators and educators serves well both in optimizing technological resources and in streamlining operations (Fischer et al., 2020). These results do not only educate decision-makers on data-driven strategies in education but form a milestone in conquering learning algorithms, as the study gets defined as a tour de force for educators and administrators who wish to design learning processes based on big data for higher education standards and performance. Defining terms like big data technology, teaching strategy, machine learning, algorithms and educational data analytics, introduces important theoretical bases necessary for conceptualization and subsequent research and practical application of the subject matter in the particular learning environment.

Literature Review

Big Data in Education

This research aims to find out the successes and failures in practice, and the opportunities and threats in the use of these technologies through analyzing the dual perspective of big data in education. For instance, Xie et al (2020) stressed that through MOOCs and other online modes of learning, the education accessibility opportunities become as open for everyone to study at prestigious universities and get a quality education. Nonetheless, Ang et al (2020) posit that this alone does not determine learning inequalities completely and perhaps requires other approaches to help achieve other goals.

This context sets the stage for examining a range of learning methods, with precision teaching and online learning emerging as critical components of evolving educational paradigms in a challenging economy. Personalized learning, as highlighted by Hasan et al (2020), plays a pivotal role in addressing individual learners' needs through data analytics, enabling tailored instruction. Teachers can utilize learning analytics to identify students' strengths and weaknesses, directing them to personalized resources that foster learning and improve outcomes. Predictive analysis helps in identifying at-risk students and providing early interventions, which can enhance performance in subjects like reading and math while reducing early dropout rates.

Learning analytics helps in improving course content, as well as the methods of delivering the content, as observed by (Ouyang, et.al., 2023). However, this change is still limited by the digital divide that exists in China especially in rural areas hence learning analytics is perceived as a revolutionary solution. Even though issues accompanying data protection and infrastructures continue to be a topic of debate, learning analytics stands a chance to improve teaching efficiency and academic performance and thus could be viewed as a revolutionary innovation in the education system. This research will offer useful recommendations and instructions for the effective usage of big data for the personalisation of education and consequently improving the quality of higher education in China.

Teaching Strategies

The article about teaching techniques in the context of big data education in China highlights the importance of multiple teaching styles which can prepare students for the challenges and opportunities in the data-driven society (Deep et al., 2019). Five key teaching strategies emerge: working with problem-based learning (PBL), hands-on practical exercises, resource sharing and online communities, collaboration, and long-term assessment and advice. Being one-size-fits-all, these strategies respond to multiple student learning issues, ranging from the aspects of critical thinking and problem-solving to teamwork and skill-building (Blumenstein, 2020).

PBL is activity-based pedagogy, which puts pupils right on track to get hands-on practice of critical thinking and self-independent learning (Malmia et al., 2019). Competency-based practical work helps with making an easy connection between theory and practice, thus facilitating active learning and in-depth interpretation. With technology-sharing platforms and online communities, sharing of resources is made possible, and, therefore, increased networking and availability of educational opportunities are seen. Additionally, learning through collaboration enables teamwork and interdisciplinary understanding. A good instructor makes sure to assess the students and provides feedback throughout the education which keeps the trainer updated about the progress and shall also modify the teaching methods as the subject of study is dynamic (Rajabalee & Santally, 2021).

These tactics thus make up a whole system of big data education covering all knowledge, skills, and mindsets that nowadays are crucial assets in the data-heavy environment (Xie et al., 2023). By using a variety of popular pedagogies, China is laying the foundation for competent data scientists and researchers of the next generation to rise.

Integration of Big Data Technologies

Big data, which is the basis of future education development, has enabled multiple personalized educative opportunities, especially in China (Ang et al., 2020). Educators can adapt the modelling approach by using mathematical modelling, statistical methods, and machine learning algorithms to automatically estimate the best learning routes for each student, depending on their performance history, skills and current knowledge (Zhang et al., 2020). Capture technologies like web crawlers and data sensors from the Internet of Things (IoT) give instant access to the learners' engagement and behaviour information. Scaleable storage options including cloud computing and distributed storage systems are responsible for those big educational data sets' management security, and data security., data analysis techniques such as data mining enable to extraction of important knowledge from large data repositories thereby driving curriculum and resource allocation development (Zhang & Dong, 2021). The integration of big data technologies in education aims to create a more responsive

and adaptive learning environment. This study will explore how these technologies can be effectively implemented to enhance personalized learning experiences, address ethical concerns, and improve educational outcomes across diverse learning environments in China. Visualization technology is a vital part of the learning process; it can be used to present data in an understandable format of graphics which in turn fosters learning and aids in making decisions. Combined with statistical methods and modelling, machine learning algorithms can make the strategies more suitable to individual students' needs through customizations that improve learning efficiency and equity (Maghsudi et al., 2021). Ethical concerns related to data stability and user personal information should be debated to have successful stakeholder interaction.

Machine Learning Algorithms

Machine learning algorithms are critical and indispensable in artificial intelligence setup, which provides machines with an opportunity to learn from data and respond to circumstances autonomously. These wider learning methods are divided into supervised, unsupervised, and reinforcement learning which succeed in achieving a particular goal. In supervised learning, the algorithms are trained on input-output paired datasets. During this process, the algorithms learn the inference of the relations between the inputs and outputs. Examples of this are linear regression and neural networks (Jiang, 2021). Conversely, unsupervised won't use labelled data and is only designed for extracting patterns or relationships. Techniques like clustering and dimension-reduction are employed for the unlabeled data. Reinforcement learning is focused on decision-making due to the environmental interaction with the help of feedback from positive and negative sources (Jiang, 2021).

SVM(Support Vector Machine), KNN(k-nearest Neighbors) and Random Forest are the famous algorithms. SVM locates a hyperplane with the best separation ability, KNN classifies based on the closeness in the space, and Random Forest designates a class with consensus decisions to curb overfitting (Maghsudi et al., 2021). On the other hand, the LighGBM and the XGBoost, which are gradient-boosting frameworks, adapt their approaches for big-size data handling and increasing the predictive power. LightGBM employs histogram as its main strategy, in contrast to XGBoost which uses the predictions from several weak learners every time.

Incorporating those algorithms, the likes of SVM, KNN, and Random Forest, is the way to have holistic data analysis done. On the one hand, SVM copes with the complicated input data, the KNN finds the local patterns and the Random Forest averages the decision trees to reduce overtraining. The latter, merging LightGBM, XGBoost, and CatBoost, provide above mentioned industry with predictive modelling as an aggregated output via Boosting processes (Endres et al., 2021). The merging of these algorithms provides synergistic effects allowing the training data to reach desired goals for complex problems, multiple platforms, and various domains, which demonstrates the flexible and unparalleled nature of ensemble learning in ML.

Methodology

The Phases to Implement the Research Objectives

This section of the research (RO1) seeks to get vital information about best practices and barriers concerning implementing big data technology in education through book reviews and surveys of stakeholders (RO1). Also, RO2 involves proficiently analyzing teaching strategy attributes and designing a versatile IT management framework that is based on the features

of artificial intelligence using machine learning algorithms and the development of a web platform is the main aim (RO2). The last item RO3 looks at is the ease of use of the platform and IT management framework effectiveness in light of usability questionnaires by engaged teachers and expert evaluations (RO3). This approach covers the aspects of big data application in education as well as the performance of framework construction for personalized teaching methods and making sure the assessment is well provided through the techniques they apply (RO1) in addition, it facilitates our innovation (RO2, RO3).

Population and Sample

This data collection strategy emphasises the surveying of colleges in some regions of China in addition to namely Jiangxi, Fujian, Guangdong, Hunan, and Hubei provinces and their relative development of educational resources (Klapwijk et al., 2021). With this selection, it would be possible to represent the conditions inside educational institutions of both advanced areas and those with not so many resources. Though dealing with resource limitations could limit the scale of primary research and the number of institutions to be visited, this problem could be resolved by bringing in the required secondary research information.

Data Collection and Processing

Researchers can evaluate criteria such as Strategy Name, Subject Area, Student Engagement, Grade, as well as Effectiveness Score to be stored in either MySQL or MongoDB (RO1) by combining the data collection process with student questionnaires. Furthermore, a data processing method that is enhanced can be achieved through a comprehensive literature review and questionnaire analysis as well as the application of machine learning techniques including LightGBM, XGBoost, SVM, and RF to build a universal IT management framework for big data technology which enhances teaching strategies (RO2). Afterwards, usability evaluations by teachers and expert assessments using the Fuzzy Delphi technique will ensure the effectiveness of the platform (RO3).

Data Analysis and Model Training

Python is an advanced artificial intelligence and machine learning tool supported by its library called Scikit-learn input preprocessing package. This package facilitates cleaning and handling imbalanced datasets like SMOTE oversampling and simulating analytical models to enhance teaching methods that use big data technology Furthermore, libraries such as NumPy, SciPy, Matplotlib, and Seaborn provide analytically and visually orientated features making it easier for researchers to perform complex problems effectively (2). The work environment of Jupyter Notebooks offers an interaction and collaboration amenity that makes the modelling process even easier as researchers can write code, visualizations, and text at the same moment, to keep the scientific work reproducible and open for collaboration (1).

Create Platform and Framework Formation

Along with the group of machine learning algorithms such as LightGBM, XGBoost, Support Vector Machines, and Random Forests provides a whole picture for improving teaching strategies by the use of big data technology, and enables the discovery of patterns and relationships in educational datasets (1). The data analysis procedure, using Scikit-learn and Python libraries, covers variable choice through the CHI-Square test, and model training is the adjustment of the hyperparameters for optimal performance, evaluated using cross-validation techniques to ensure robustness and reliability (2). This whole assessment system

keeps on improving continually, with adaptations to every model equation being made following a post-analysis, evaluating the results of every algorithm, all of which contribute to personalised learning and increasing learning achievements (3).

Proposed Work Schedule

From the first of October 2022 to the last of September 2025, this has different phases: Problem Identification, Literature Review, Methodology, Questionnaire, Data Collection, Testing, Result Analysis, Thesis Compilation and Publication Submission. It discloses a unique and sequenced outline of the plan prepared for research purposes (Thesis Compilation, February-May 2025).

Ethical Considerations

The research on big data's influence on teaching methods can be considered unethical in terms of data subject informed consent, privacy and data security, integrity of researchers, equity expectancy, transparency of reporting, and long-term effects. Following the ethical guidelines is an assurance of participant safety and welfare, empirical precision, and social responsibility (Baig et al., 2019).

Results and Discussion

Themes

Limitations and challenges faced by administration and teachers while implementing IT management for big data technology in improving teaching strategies

The practice of IT management for big data in education is limited by and against some challenges as shown in the articles. Baig et al (2020) suggest the predicament of big data in education by uncovering the issues of data quality, privacy issues and the need for suitable infrastructure. These limitations can get in the way of operationalizing the potential of big data technology for creating effective approaches to teaching. Further Luan et al. (2020) probe into problems posed by big data and artificial intelligence education, ones like data interoperability, the scalability issue, and ethical issues.

The management of IT by the administrators and teachers becomes very difficult during the implementation of big data technology for such systems. Issues such as poor data infrastructure, privacy problems, and ethical needs may undermine the appropriation of big data technology in educational institutions. What is more, providing data with quality and portability is quite difficult, and, this task has to be done for big data to be used for effective teaching strategies development. Classify all limits and challenges here as being pretty important to maximize the impact of big data technology use in education and to improve teaching methodologies.

Attributes, train models using machine learning algorithms for the development of a universal IT management framework for big data technology to improve teaching strategy

For the creation of a universal IT management framework for big data technology to empower the education strategy, they need to apply machine learning algorithms, as indicated in the literature. Wang et al (2022) can be understood as big data analytics for intelligent manufacturing systems and then this can be used in manufacturing education. Machine learning algorithms have indeed a fundamental part in analyzing big data to get usually some meaningful insights and patterns that can help to design an effective teaching strategy. Similarly, Osmans (2019) big data analytics model for smart cities may be used as a model and

could be modified to be used in an educational environment to analyze educational data. Machine learning algorithms like LightGBM, XGBoost, SVM, and RF are the algorithms that mostly get employed during model training in big data analytics frameworks. These algorithms then help in the build-up of predictive models which can detect implications, patterns, and connections inside education data. By studying variables like student participation, grades and efficiency scores, these models will give educators facts about how to adjust the strategies to yield the best results.

Utilizing computerized algorithms of machine learning in the construction of a multi-level framework that enables to utilisation of big data technology in teaching holds prospects for the modernization of teaching approaches. The educational algorithms' ability to process educational data contributes to the educators' clear understanding of issues that affect their decision-making and the nature of educational results.

The Usability of the Platform and the effectiveness of the IT management framework

User-friendly performance and proper functioning of a framework for IT are the key factors in assessing the positive impact on education. Alshira'h (2021) concentrates on the usability evaluation of learning management systems (LMS) and users are assessed by frequency of use of platforms based on their experiences which can be an important tool in assessing the usability of the educational platforms. Usability assessments create a better understanding that the resources are friendly to the user, easy and useful in their teaching and learning activities. By knowing how learners express and develop their learning preferences, teachers can design platforms that make learning more interesting and inclusive.

Concurrently, the researchers in Lee's et al (2020) work referred to an architecture and management platform for the blockchain-based health records exchange, which serves as a case of the importance of usability in the context of healthcare systems. Even though the study is designed to investigate healthcare, the evaluation methods are also useful for developing education platforms. Responsiveness to educators, students, and other users of the IT management framework is achieved by taking a user-centric design and development approach. With this approach, educators, students, and others can effectively adopt the IT management framework for enhancing their teaching strategies.

The IT management framework can be tested for effectiveness via structured usability checks, user feedback and well-established performance metrics. For an educational framework to leave a mark on teaching practices and be effective, it is important to consider whether it is easy to use, accessible or may satisfy the learners. Furthermore, ongoing monitoring and evaluation help to facilitate constant adjustment of the platform and development of a more efficient system in its efforts to promote teaching and learning. Lastly, usability evaluations are highly essential elements that will attest to the usability of education websites as well as the IT management framework. Teachers will be able to develop the tools based on their experience if user feedback is considered and the platform is built by quality teaching standards.

Discussion

The inspiration for this study comes from the ability to use big data technologies to revolutionize education in China, through increasing the individualized approach to students and raising the effectiveness of education. However, according to Baig et al (2020) and Luan et al., (2020), factors such as data privacy concerns and lack of infrastructure impede proper planning and delivery of the improvement of teaching methods. It is therefore important that

educators and school authorities approach these challenges reasonably to maximize the benefits of big data. On the other hand, the enhanced IT management system for big data technology provides more effective solution methods. Nelson (2022) and Mustafa (2019) affirm that machine-learning techniques are important in recognizing educational data patterns that can be used in teaching methodologies. LightGBM, XGBoost, SVM, and RF can assist in humanizing the learning process, particularly by helping to identify students' engagement and effectiveness in their learning by adopting appropriate teaching strategies that favour the students.

It is, therefore, the intention of this research to offer pertinent findings on how big data technologies may be incorporated into education to enhance the establishment of robust frameworks for teaching informed by the massive data. Thus, addressing the technology and ethics issues, this work aims at increasing the efficiency of teaching and enhancing students' performance as well as contributing to the enhancement of the quality of education in Chinese colleges. The study will therefore lay a basic framework for further application of the study in other settings within different educational settings thus a contribution to the field of study.

Conclusion and Recommendations

Conclusion

The research highlights the multi-faceted system of integrating big data technology into education and underlines the significance of overcoming the following difficulties which comprise data quality, privacy problems, and infrastructure drawbacks. Thus, the implementation of the machine learning algorithms, as well as the development of the universal IT infrastructure would help educators to refine the teaching strategies within the educational framework and make them data-driven. Simultaneously, the functioning of platforms by usability guarantees appropriate adoption and utilization by instructors as well as students. Generally, these initiatives are not just to reform the instruction ways but also to improve the educational results, and finally, these pave the way for a 21st-century approach to education.

Recommendations

- Develop communication and interaction among the Information Technology administrators, educators and scientists to provide solutions for the problems related to data privacy, infrastructure, and usability. Interdisciplinary cooperation helps the research to develop a holistic approach that would appreciate different views and competence levels.
- Proceed with longitudinal studies to measure the effectiveness and impact of the IT management framework after a longer period and its impact on teaching methods and students' outcomes along the way. The longitudinal data will capture the viability and expandability of the framework over time, making it possible to continuously update and revamp based on the experienced realities in the field.

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