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System design, implementation, and effectiveness of cloud computing in Chinese universities

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Abstract

The purpose of this study is to provide a comprehensive assessment of the current state of teaching management systems in Chinese universities, with a focus on identifying areas that could benefit from the integration of cloud computing technologies. In this study, the researcher administered a questionnaire to 3,000 teachers in three selected universities in China. The appropriate sample size pre-calculated using the Raosoft tool was 341 teachers. However, 425 computer science teachers were finally identified as participants after approval from their supervisors and consent from these teachers. The results of this study are intended to provide a framework for educational improvement that can be used as a reference for other schools in China. The majority of the respondents are of male gender, aged between 35-44, attained the Master's Degree, and have extended service for 10 years or more. Most respondents believe that Capability and Teaching and Learning are the most useful dimensions for Informatization Teaching Ability; and that System Integration had the greatest impact in the on system design. They identified that System Implementation of User Adoption as the most important. They also consider that on System Effectiveness, Academic Performance is the most important. There is no statistical difference in the comparison of student responses to the system design after grouping students according to their profiles. An action plan to improve cloud computing educational technology programs in Chinese universities is proposed. It is recommended that educational institutions may develop clear standards and syllabi for cloud computing educational technology courses to ensure the systematic and cutting-edge nature of course content. At the same time, they may increase the investment in cloud computing educational technology courses, including teaching equipment, experimental environments and network resources, to provide better learning conditions for students.

Keywords: system design, implementation, effectiveness, Chinese universities

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1. Introduction

The adoption of cloud computing in educational institutions has become a game-changer in instructional management. Chinese universities are no exception to the trend of modernizing their programs for the digital age. Academic institutions in the present day need instructional management systems that can adapt to their ever-changing environments. This study project aims to delve into this dynamic landscape by investigating the prevalence of cloud computing technology and its effect on Chinese universities' instructional management. It's been a familiar idea to use cloud computing for educational purposes. As a tool for providing educational institutions with solutions that are scalable, cost-effective, and user-friendly, it has gained popularity around the world. According to a scientific review by Paul et al. (2023), cloud computing can be used to make learning, administration, data storage, and content delivery more efficient. The importance of cloud computing in education is highlighted by the Educause Center for Analysis and Research's (ECAR) "2021 Horizon Report," which identifies it as one of the primary forces propelling the widespread usage of technological solutions in classrooms.

The sheer size and diversity of China's student body present unique challenges for the country's higher education institutions. To meet these challenges, a powerful learning management system is essential. Allocation of funds, creation of curricula, and student participation are all significant issues. Institutions of higher learning will need to change to accommodate the complexity and variety of today's instructional procedures. One interesting approach to meeting these requirements is to implement cloud computing systems, which could improve educational institutions' productivity, reach, and quality. This study will take a holistic approach to investigating the potential benefits of cloud computing for instructional management in Chinese universities. It will analyze these institutions' present instructional management systems to spot opportunities for improvement made possible by cloud computing. By doing this, it endeavors to create a system that is better suited to the specific requirements of Chinese academic institutions and the difficulties they confront when adopting cloud-based solutions.

The cloud computing system is designed to build an efficient, secure and reliable platform to support academic research, teaching and administration. The system adopts comprehensive security strategies, such as data encryption and authentication, to ensure security compliance. Meanwhile, open standards and inter-operability are encouraged to facilitate resource sharing and collaborative work, aiming to enhance education quality, accelerate research and innovation, improve management efficiency, and provide a convenient and flexible learning and research environment for teachers and students. Since its implementation, as the country vigorously promotes information-based education and digital campus construction, many universities have adopted cloud computing technology to improve the quality of education and scientific research capacity. Through the construction of campus cloud data centers, colleges and universities have achieved centralized management and optimal allocation of resources, greatly improving the utilization efficiency of teaching resources and scientific research data processing capacity. In addition, cloud services promote the sharing of educational resources, and cross-campus cooperation and distance teaching become possible, further broadening the boundaries of education. At the same time, Li et al. (2018) shows that the implementation of cloud computing in colleges and universities also faces challenges, including data security and privacy protection, shortage of technical and managerial talents, and integration with existing IT systems. Nevertheless, China's colleges and universities are actively promoting the in-depth application of cloud computing technology through continuous optimization of cloud computing architecture, strengthening of security measures, and cultivation of professionals, with a view to realizing the goals of education informatization and smart campus construction.

The effectiveness of cloud computing is demonstrated by the fact that it provides businesses and individuals with flexible, efficient and scalable computing resources. With cloud computing, users have on-demand access to storage, computing power, and a variety of software services, eliminating the need to purchase and maintain expensive hardware and software locally. The rapid deployment capability of cloud services enables organizations to quickly adapt to market changes and business needs, and the automated management of cloud platforms reduces human error and improves data security. In addition, cloud computing supports elastic scaling and can automatically adjust resources based on load, ensuring the optimal balance of performance and cost efficiency. Globally, cloud computing has facilitated the acceleration of innovation, enabling everyone from small startups to large organizations to quickly experiment with new ideas and deploy complex applications. However, the effectiveness of cloud computing also relies on proper management of cloud resources, attention to data security and privacy protection, and the stability of network connectivity. In short, cloud computing has become a key driver of digital transformation and facilitates technological innovation. There are a series of gaps and problems in the system design, implementation and effectiveness of cloud computing in Chinese universities. First, system design often lacks the foresight and flexibility to adapt to the rapidly changing technological environment and educational needs. Second, at the implementation level, there is a lack of professional staff for effective management and maintenance, resulting in the failure to fully utilize cloud computing resources, as well as insufficient security and data protection measures, increasing the risk of data leakage and security threats. Further, Liu et al. (2019) argues that regarding effectiveness assessment, your university lacks a regular and systematic performance evaluation mechanism, which fails to accurately measure the actual benefits of cloud services, leading to insufficiently scientific and reasonable resource allocation. In addition, teachers and students have low acceptance and proficiency in the use of cloud computing technology, which affects the effective application of cloud computing in education and teaching.

In summary, in order to improve the design, implementation, and effectiveness of cloud computing systems, Chinese universities need to enhance technology updates and staff training, improve security and protection measures, establish a regular evaluation mechanism, and improve the ability of faculty, staff, and students to use the technology in order to better utilize the potential of cloud computing in education. This study can provide valuable guidance for educators of cloud computing systems in China.

Objectives of the Study - The purpose of this study is to provide a comprehensive assessment of the current state of teaching management systems in Chinese universities, with a focus on identifying areas that could benefit from the integration of cloud computing technologies. This study sought to identify system design capabilities in terms of system infrastructure, system integration, and user interface; assess training and support implementation in terms of user adoption; determine the efficacy of respondents' use of the system in terms of academic achievement, student engagement, and educational efficacy; test for variation in responses when grouped according to individual circumstances; test the significant relationships among system design, implementation, and effectiveness in instructional management systems and finally, propose a Development Plan for Improving Cloud Computing Educational Technology Courses in Chinese Universities.

2. Methods

Research Design - This study used a descriptive approach to assess the effectiveness of a cloud-based instructional management system. According to Jones (2018), teachers and students provided feedback through questionnaires to assess the system's ease of use, functional completeness, performance stability, and user satisfaction on a Likert scale. In addition, teaching performance and student evaluations were compared before and after implementation to measure the impact of the system. In addition, data on personal characteristics such as age, gender, and academic background were collected to see if these factors could affect the effectiveness of the system. Analyses conducted using SPSS identified strengths and weaknesses of the system were made as basis of recommendations for improvement.

Participants of the Study - In this study, the researcher administered a questionnaire to the sample size out

of the total of 3,000 teachers in three selected universities in China. The appropriate sample size pre-calculated using the Raosoft tool was 341 teachers. However, 425 computer science teachers were finally identified as participants after approval from their supervisors and consent from these teachers. The criteria for selecting these teachers were based on the following: the schools in which they work have a good pedagogical performance in the region, and these schools are diverse enough to represent the different educational models in the region. The results of this study were intended to provide a framework for educational improvement that can be used as a reference for other schools in China.

Data Gathering Instrument - The questionnaires were distributed to faculty members of computer science programs in three selected universities in China, and the consultant will review the questionnaires to make sure that they are correct. The questionnaire composed of four parts: the first part is Personal Information, which contains Sex, Age, Educational attainment, and length of service. Part II is a multidimensional questionnaire adapted from Yang's (2023) computer "operating systems" course covering system architecture, system integration, and user interfaces, which was used to assess the participants' system design. Part III is adapted from Zheng et al.,(2013). Cloud-based information technology education. In International Conference on Information Computing and Applications (pp. 417-426). Berlin, Heidelberg: Springer Berlin Heidelberg Multidimensional questionnaires include training and support, user adoption to determine implementation by participants. Part IV adapted from source: Cui (2022). Development and Utilization of Chinese Curriculum Resources in Colleges and Universities Based on Cloud Computing Resource Scheduling Algorithm. Issues in Engineering Mathematics, 2022. The multidimensional questionnaire contains three dimensions of academic performance, student engagement, and educational efficiency to assess the participants' effectiveness.

Reliability Test Result

Indicators	Cronbach Alpha	Remarks
System Infrastructure	0.917	Excellent
System Integration	0.864	Good
User Interface	0.863	Good
Training and Support	0.870	Good
User Adoption	0.893	Good
Academic Performance	0.793	Acceptable
Student Engagement	0.894	Good
Educational Efficiency	0.889	Good

George and Mallery (2003) provide the following rules of thumb: "_ > .9 – Excellent, _ > .8 – Good, _ > .7 – Acceptable, _ > .6 – Questionable, _ > .5 – Poor, and _ < .5 – Unacceptable"

Reliability testing is the process of assessing the internal consistency and stability of a set of indicators or measurement tools. In this example, the indicators were assessed through Cronbach's alpha coefficients. The results showed excellent consistency in the system infrastructure, and good levels of consistency in system integration, user interface, training and support, user adoption, student engagement, and educational efficiency. However, consistency in academic performance was rated at an acceptable level. These results indicated a high level of internal consistency among most of the indicators, which strengthened the credibility of the assessment results and also revealed areas for improvement, such as academic performance, which may require further alignment and optimization.

Data Gathering Procedure - After obtaining formal permission from school leadership and notifying the teachers involved, the researchers organized a Preparatory meetings to further clarify the research details and data collection methods, ensuring that all participants signed informed consent forms. Subsequently, they provided specific training to the teachers on data collection techniques, including the use of questionnaires, observation, or interview skills, to ensure the validity and accuracy of the data. During the data collection period, the researchers regularly monitored and assessed the collection process, promptly adjusting methods to address any arising issues. Ultimately, they organized and analyzed the collected data to produce the research findings.

Data Analysis - Once the data collection was completed, the attributes of each variable and the association between the three variables were interpreted and investigated using frequency distributions, percentage

distributions, weighted averages, multivariate regression and covariance. Weighted averages and ranking were used to determine the values of the three variables. ANOVA was used to test the relationship between the three variables. Regression analysis was also used in the statistical treatment. All the data collected were processed through the Statistical Package for the Social Sciences (SPSS)17 statistical analysis tool.

Ethical Considerations - Before initiating the study on the system design, implementation, and effectiveness of cloud computing in Chinese universities, the research proposal was thoroughly reviewed and approved by the Ethics Review Board, ensuring adherence to all ethical guidelines. As part of the process, consent was obtained from the relevant departments at the universities, highlighting the study's significance and relevance to the field. Throughout the study, ethical standards were meticulously upheld. The researchers fully informed the participants about the study's objectives and the potential benefits of the research for both the academic community and the participants. Informed consent was secured from all participants, and confidentiality was strictly maintained. The voluntary nature of participation was emphasized, with assurances that participants could withdraw at any time without repercussions. Additionally, it was guaranteed that participation would pose no harm to the participants and that all data gathered would be used solely for scholarly purposes to enhance the understanding of cloud computing's impact in educational settings. These measures ensured the protection of participants' rights and welfare while maintaining the integrity and credibility of the research process.

3. Results and discussion

Table 1

Summary Table on System Design

Indicators	Weighted Mean	Verbal Interpretation	Rank
System Infrastructure	3.07	Agree	3
System Integration	3.09	Agree	1
User Interface	3.08	Agree	2
Composite Mean	3.08	Agree	

Legend: 3.50 – 4.00 = Strongly Agree; 2.50 – 3.49 = Agree; 1.50 – 2.49 = Disagree; 1.00 - 1.49 = Strongly Disagree

Table 1 presents the respondents assessment on Summary Table on System Design . The composite mean of 3.08 indicates that the respondents agreed in general. Among the items cited, “System integration” the highest mean score of 3.09 , System integration is the key to ensuring smooth collaboration and data exchange between different systems, which is important for improving overall work efficiency and reducing resource wastage. Liu et al. (2019) stated that the reason why the system received such a high rating is most likely due to its strong integration capability, which enables it to easily and seamlessly interface with other systems, thus providing users with a more efficient and convenient work experience.

Followed by “User interface”, This indicates that users not only recognized the system's ability to integrate different systems, but also gave positive comments on its user interface. Liu et al.,(2019) concluded that the design of the user interface, as the window of interaction between the system and the user, has a direct impact on the user's experience and satisfaction. An intuitive and easy-to-use user interface can reduce users' learning costs and improve their work efficiency. Therefore, the excellent performance of the system in terms of user interface undoubtedly brings users a more convenient and comfortable using experience.

Meanwhile,”System infrastructure”(3.07) rated the least. This rating suggests that while users are satisfied with the overall performance of the system infrastructure, the system infrastructure may not be the most important aspect that users are concerned about compared to other characteristics that more directly affect user experience and efficiency, such as the system's integration capabilities and user interface design. Therefore, despite the relatively low ratings, this result also indicates that the system infrastructure is recognized by users in terms of stability and reliability.

Table 2

Summary Table on System Implementation

Indicators	Weighted Mean	Verbal Interpretation	Rank
Training and Support	3.07	Agree	2
User Adoption	3.09	Agree	1
Composite Mean	3.08	Agree	

Legend: 3.50 – 4.00 = Strongly Agree; 2.50 – 3.49 = Agree; 1.50 – 2.49 = Disagree; 1.00 - 1.49 = Strongly Disagree

Table 2 presents the respondents assessment on Summary Table on System Implementation. The composite mean of 3.08 indicates that the respondents agreed in general. Among the items cited, “User adoption” the highest mean score of 3.09, This score indicates that user acceptance of the new system or service is very high and many users have successfully adopted and started to use the system or service. Liu et al. (2019) stated that high user adoption is one of the important signs of success of a system or service because it means that the system or service meets the needs of the users and provides enough value to attract them to use it. This positive result can be attributed to the ease of use, functionality, and customizability of the system or service, as well as to effective communication and user support during implementation. Meanwhile,”Training and support”(3.07) rated the least. This rating suggests that although users are satisfied with the training and support services provided, there may be some room for improvement in this area of performance compared to other items (e.g., user adoption.) Nonetheless, this rating indicates that the training and support services as a whole have met users' expectations and played a positive role in their adoption and use of the new system or service.

Table 3

Summary Table on System Effectiveness

Indicators	Weighted Mean	Verbal Interpretation	Rank
Academic Performance	3.10	Agree	3
Student Engagement	3.13	Agree	1.5
Educational Efficiency	3.13	Agree	1.5
Composite Mean	3.12	Agree	

Legend: 3.50 – 4.00 = Strongly Agree; 2.50 – 3.49 = Agree; 1.50 – 2.49 = Disagree; 1.00 - 1.49 = Strongly Disagree

Table 3 presents the respondents assessment on Summary Table on System Effectiveness . The composite mean of 3.12 indicates that the respondents agreed in general. Among the items cited,”Educational efficiency and Student engagement” the highest mean score of 3.13, This result fully demonstrates the system's remarkable effectiveness in improving educational efficiency and student engagement. At the same time, the system has greatly enhanced student engagement and motivation by providing rich interactive features and personalized learning paths. This positive feedback indicates that the system has a positive impact on optimizing the education process and improving the quality of education. Meanwhile,”Academic performance” (3.10) rated the least. Overall, academic performance is affected by a number of factors, including students' individual efforts, teachers' teaching methods and course content. In contrast, the system's main concern is to provide a more efficient, interactive and personalized learning environment that promotes holistic development and active student participation.

Table 4

Relationship Between System Design and Implementation

System Infrastructure	r-value	p-value	Interpretation
Training and Support	.594**	0.000	Highly Significant
User Adoption	.615**	0.000	Highly Significant
System Integration			
Training and Support	.628**	0.000	Highly Significant
User Adoption	.678**	0.000	Highly Significant
User Interface			
Training and Support	.626**	0.000	Highly Significant
User Adoption	.638**	0.000	Highly Significant

Legend: Significant at p-value < 0.01

Table 4 shows the association between System Design and Implementation. The computed r-values indicate a strong direct correlation and the resulted p-values were less than the alpha level. Results show that there is significant relationship that exists; therefore and implies that the better is the system design, the better is the implementation. This result not only highlights the strong link between system design and implementation, but also further reveals the causal relationship between the two. Excellent system design is the prerequisite and foundation for successful system implementation, which provides clear guidance and a reliable framework for the subsequent implementation process. Only with proper design can the system give full play to its advantages in the implementation process, ensure the smooth operation of various functions, and ultimately enhance the overall performance of the system and user satisfaction. Therefore, in the process of system development, the importance and investment in system design is the key to ensure the successful implementation of the system.

Table 5

Relationship Between System Design and Effectiveness

System Infrastructure	r-value	p-value	Interpretation
Academic Performance	.658**	0.000	Highly Significant
Student Engagement	.723**	0.000	Highly Significant
Educational Efficiency	.711**	0.000	Highly Significant
System Integration			
Academic Performance	.725**	0.000	Highly Significant
Student Engagement	.803**	0.000	Highly Significant
Educational Efficiency	.823**	0.000	Highly Significant
User Interface			
Academic Performance	.733**	0.000	Highly Significant
Student Engagement	.827**	0.000	Highly Significant
Educational Efficiency	.754**	0.000	Highly Significant

Legend: Significant at p-value < 0.01

Table 5 shows the association between System Design and effectiveness. The computed r-values indicate a strong direct correlation and the resulted p-values were less than the alpha level. Results shows that there was significant relationship exists and implies that the better is the system design, the more that the school are effective. This results profoundly reveal the close connection between system design and school effectiveness. When a system is designed with full consideration of the actual needs of the school and with a high degree of ease of use, stability and innovation, it can not only effectively meet the various teaching and management needs of the school, but also significantly improve the efficiency and quality of work. A well-designed system can provide schools with more accurate and efficient information support, thus optimizing the decision-making process, enhancing teamwork, and further improving the overall performance and competitiveness of schools. Therefore, paying attention to the optimization of system design is of inestimable value in promoting the sustainable development of schools.

Table 6

Relationship Between System Implementation and Effectiveness

Training and Support	r-value	p-value	Interpretation
Academic Performance	.656**	0.000	Highly Significant
Student Engagement	.739**	0.000	Highly Significant
Educational Efficiency	.708**	0.000	Highly Significant
User Adoption			
Academic Performance	.737**	0.000	Highly Significant
Student Engagement	.758**	0.000	Highly Significant
Educational Efficiency	.761**	0.000	Highly Significant

Legend: Significant at p-value < 0.01

Table 6 presents the association between System Implementation and Effectiveness. The computed r-values indicate a strong direct correlation and the resulted p-values were less than the alpha level. This means that a significant relationship exists and implies that the better is the system implementation, the more that the

system are effective. This means that there is a significant correlation between system implementation and effectiveness, specifically, the higher the quality of system implementation, the higher the effectiveness of the system. In short, a smooth and efficient system implementation process ensures that the system achieves the desired results in actual operation, thus enhancing the effectiveness of the entire system. This finding emphasizes the importance of system implementation in safeguarding system effectiveness.

Table 7

A Continuous Improvement Plan for cloud computing educational technology programs in Chinese universities

Key Result Area	Objectives	Strategies	Success Indicator	Persons Involved
System Infrastructure	Optimize the user interface design to enhance the user experience and ensure that users can easily and intuitively use the Cloud Computing EdTech project.	Introduce user research and testing to gain a deeper understanding of user needs and behaviors. Hire professional UI/UX designers for interface design and interaction optimization. Regularly carry out user feedback collection, timely adjustment and iteration of interface design.	User satisfaction survey results reached over 90%. User interface operation response time reduced by 30%. More than 85% of the positive ratings of ease of use and interface aesthetics mentioned in user feedback.	Professor Student
Training and Support	Build a stable, scalable and efficient system infrastructure to support the long-term development and large-scale adoption of cloud computing educational technology programs.	Upgrade hardware equipment, including servers, storage devices and network equipment, to ensure high performance and reliability of the system. Optimize network architecture to improve data transmission efficiency and system response speed. Introduce automated management tools to simplify system maintenance processes and reduce operating costs.	System availability reached over 99.9%. System response time reduced to less than 80% of the original. Infrastructure costs reduced by more than 10% while maintaining or improving system performance.	
Academic Performance	Increase user adoption of the Cloud Computing EdTech program in Chinese universities and ensure widespread acceptance and use of the program.	Conduct user education and training activities, providing detailed operating guides and online support to help users quickly get started and fully utilize the project's features. Actively publicize project advantages and success stories to increase user awareness and trust in the project. Establish a user community to promote communication and cooperation among users, and share usage experience and skills.	User adoption rate (i.e., the ratio of the number of users actually using the project to the total number of target users) reaches over 80%. User satisfaction survey results show that more than 90% of users believe that the project has positively helped them in their work and study. User community activity continues to increase, with steady growth in the number of new posts and user interactions each month.	

4. Conclusions and recommendations

The majority of respondents agreed that SYSTEM INTEGRATION had the greatest impact on System Design. The majority of respondents identified and agreed USER ADOPTION as the most important factor in System Implementation. The majority of respondents in System Effectiveness agreed that ACADEMIC PERFORMANCE as the most important. There is a significant relationship between system design, implementation and effectiveness. A Continuous improvement plan to enhance cloud computing educational technology programs in Chinese universities is proposed.

Educational institutions may develop clear standards and syllabi for cloud computing educational technology courses to ensure the systematic and cutting-edge nature of course content. At the same time, they should increase the investment in cloud computing educational technology courses, including teaching equipment, experimental environments and network resources, to provide better learning conditions for students. Teachers may continuously update their knowledge and skills of cloud computing and participate in relevant trainings and seminars in order to introduce the latest technologies and concepts into the classroom. Teachers may also focus on practical teaching and design challenging and practical course projects so that students can deepen their understanding of cloud computing knowledge in practice. Students may actively participate in the learning of cloud computing educational technology courses and take the initiative to explore and practice. In addition to classroom learning, they may utilize their extracurricular time for independent study and expansion,

and participate in relevant academic competitions or internship projects to enhance their practical ability and innovative thinking.

The education sector may build a cloud computing education technology learning community to promote exchanges and cooperation between teachers and students, and between students and students. The community may provide online discussion, resource sharing, experience sharing and other functions to help students solve problems encountered in learning, stimulate learning enthusiasm and form a good learning atmosphere. Future researchers, may conduct in-depth research on the development trends and challenges of cloud computing education technology and explore new teaching methods and assessment mechanisms. At the same time, they may pay attention to the industry dynamics and technology updates so as to adjust the research direction and teaching content in time and contribute to the cultivation of cloud computing talents in the new era. The proposed continuous enhancement plan may be implemented, monitored thorughn regular evaluation and feedback mechanisms to ensure that cloud computing education technology remains at the leading edge.

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