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AI Empowering Teaching Management : Scenarios and Pathways for Local Undergraduate Universities

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Abstract

With the rapid development of artificial intelligence technology, teaching management in local undergraduate universities is undergoing profound transformation. Based on practical explorations from multiple domestic institutions, this paper systematically analyzes the core scenarios of AI empowerment, key technological pathways, practical challenges, and response strategies. Research indicates that AI demonstrates significant value in educational administration process reengineering, personalized learning management, and practical teaching effectiveness enhancement, which depends on technical pathways comprising data-driven decision-making, human-machine collaborative tools, and flexible institutional design. To address challenges such as data silos, faculty competency, and ethical risks, strategies including regional collaboration, capacity training, technical safeguards, and lightweight deployment must be implemented. AI will drive the teaching management paradigm toward technology-empowered transformation, injecting new momentum into the high-quality development of local undergraduate universities.

Keywords

Artificial Intelligence, Teaching Management, Local Undergraduate Universities.

1. Introduction

Under the dual wave of higher education popularization and digital transformation, local undergraduate institutions serve as important forces for regional economic and social development, with their teaching management efficiency directly related to talent cultivation quality and core competitiveness. However, traditional teaching management models generally suffer from complex processes, uneven resource allocation, insufficient personalized support, and delayed supervision and evaluation, making it difficult to meet the demand for high-quality applied talent cultivation in the new era. The rise of artificial intelligence (AI) technology, with its powerful data processing, pattern recognition, and intelligent decision-making capabilities, provides revolutionary tools to solve these problems. This paper focuses on local undergraduate institutions and, combined with the pioneering practices of Jilin University, University of Electronic Science and Technology of China, University of Science and Technology Beijing, and others, systematically reviews the core scenarios, key technological pathways, practical challenges, and response strategies of AI-empowered teaching management, aiming to provide theoretical references and practical guidelines for similar institutions in their intelligent upgrading.

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2. Core Teaching Management Scenarios Empowered by AI

In the process of AI empowerment in teaching management at local undergraduate institutions, the transformation of core teaching management scenarios is particularly noteworthy. AI technology is deeply penetrating the entire teaching management process, restructuring traditional models, and catalyzing three core application scenarios that fundamentally improve management efficiency, precision, and warmth.

2.1. Intelligent Educational Administration Process Reengineering

Traditional educational administration processes are complex, time-consuming, and easily affected by human factors. The introduction of AI is driving their evolution toward automation, intelligence, and transparency.

2.1.1. Automated Course Scheduling and Resource Allocation

Course scheduling is one of the most complex and core aspects of educational administration, involving multiple constraints and matching of resources such as courses, teachers, students, classrooms, and laboratories. Traditional manual scheduling not only involves enormous workload but also struggles to achieve global optimization. AI algorithms (such as constraint satisfaction problem solving, genetic algorithms, optimization algorithms) can comprehensively consider dozens of constraint conditions including course nature, teacher availability, student course selection preferences, classroom capacity and equipment, laboratory availability, etc., and generate optimal or near-optimal scheduling solutions in a short time. For example, Jilin University optimized its 32-week project-based courses through AI technology, successfully achieving intelligent matching and dynamic adjustment of online and offline teaching resources, resolving resource conflicts while improving the scientific nature of course arrangements and satisfaction among teachers and students [1].

2.1.2. Digital Teaching Supervision

Traditional teaching supervision relies on supervisors "dropping in on classes," which has problems such as small sample size, strong subjectivity, and delayed feedback. The "Online Class Listening System" developed by the University of Electronic Science and Technology of China provides a revolutionary solution [2]. The system collects classroom audio and video data through intelligent devices deployed in classrooms and uses computer vision and natural language processing technologies to analyze key indicators in real-time, such as classroom interaction frequency, student concentration (e.g., head-up rate, facial expression recognition), teacher question quality, and student response participation. The system automatically generates data-driven classroom analysis reports, transforming teaching evaluation from subjective impression to objective quantification, achieving comprehensive, routine, and immediate feedback in supervision work, effectively promoting continuous improvement in classroom teaching quality.

2.2. Personalized Learning Management

Students at local undergraduate institutions have significant differences in their foundations, making unified teaching and management models inadequate for meeting individual development needs. AI provides possibilities for large-scale personalized learning management.

2.2.1. Dynamic Learning Profiles

AI technology can integrate student data scattered across different systems to construct a comprehensive, dynamic, and three-dimensional student capability map. Data sources include but are not limited to: entrance scores, level test results, online learning platform behaviors (video viewing duration, forum posts, material downloads), assignment completion status, classroom interaction performance, etc. Through machine learning algorithms (such as cluster analysis, association rule mining), the system can precisely locate each student's knowledge blind spots, learning styles, and potential strengths. Based on dynamic learning profiles, teachers can receive personalized teaching suggestions, such as pushing supplementary learning resources for students who have difficulty understanding or designing extension tasks for those with surplus learning capacity. The system can also automatically generate periodic learning reports, presenting students' ability development trajectories through visualization charts, helping teachers and students adjust teaching strategies in a timely manner, effectively promoting the implementation of the "teaching based on learning" concept.

2.2.2. Academic Risk Early Warning

Timely identification and intervention for academically struggling students is a key defense line for ensuring talent cultivation quality. AI academic risk early warning systems build prediction models (such as logistic regression, random forests) by analyzing students' multimodal data (such as attendance rates, assignment quality, declining test score trends, library borrowing frequency, online platform activity, etc.) [3]. When the model predicts that a student has a high academic risk, the system automatically sends warning messages to counselors, class advisors, or academic advisors, and triggers targeted guidance mechanisms such as interviews, peer support, and academic planning guidance, transforming post-remediation into pre-prevention, effectively reducing the incidence of academic crises.

2.3. Enhancement of Practical Teaching Effectiveness

Practical teaching is a key link for local undergraduate institutions to cultivate applied talents but generally faces bottlenecks such as expensive equipment, high consumable costs, high safety risks, and difficulties in industry connection.

2.3.1. Virtual Simulation Laboratories

AI-empowered virtual simulation laboratories use VR/AR, computer vision, physics engines, and other technologies to build highly immersive and interactive virtual training environments. The AI-empowered virtual training platform developed by the Open University is a typical representative [4]. When students perform operations such as equipment disassembly or chemical experiments in the virtual environment, the system can capture their operation trajectories in real-time, generate operation heat maps, and use intelligent algorithms to judge whether their actions are standardized and steps are correct. Once an error occurs, the system immediately pauses and provides targeted feedback and guidance, allowing students to practice repeatedly in a "zero-risk, low-cost" environment until they master the skills, greatly improving the efficiency and safety of training teaching.

2.3.2. Inter-institutional Resource Collaboration

The practical teaching resources of a single local institution are often limited. Through AI technology, a regional resource-sharing ecosystem can be constructed. Local higher education institutions accessing the provincial "credit bank" system is an important institutional innovation [3]. AI-assisted review systems can intelligently assess students' diverse learning outcomes from MOOCs, industry qualifications, enterprise internships, innovation and entrepreneurship projects, etc., and conduct credit recognition and transfer according to standardized rules. This not only broadens students' learning paths and promotes deep integration of industry and education but also achieves optimized allocation and collaborative sharing of quality educational resources within the region.

3. Key Technological Implementation Pathways

The successful implementation of AI-empowered teaching management depends on a systematic and operational technological pathway. This pathway is based on data as its foundation, tools as its carriers, and institutions as its guarantee, constructing an intelligent

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closed loop from data collection, processing, and analysis to decision support and process optimization.

3.1. Building a Full-domain Integrated Data-driven Decision-making System

Teaching management in local undergraduate institutions involves multiple departments and links, with data scattered across heterogeneous platforms such as educational administration systems, student work systems, library systems, one-card systems, etc., creating "data silos." Therefore, building a unified, high-quality, full-domain teaching data center is a prerequisite for achieving intelligent management.

3.1.1. Construction and Governance of Institutional Teaching Data Centers

The core task of this system is to establish an institutional teaching data lake or data warehouse. Through ETL (Extract, Transform, Load) tools and data interface technologies, multi-source heterogeneous data scattered across educational administration systems, learning management platforms (LMS), campus one-card systems, network behavior logs, and even classroom IoT devices are collected and cleaned. After integration, strict standardized governance must be performed, including unified coding standards and defined data dictionaries to ensure data consistency and accuracy. In the process of data cleaning and standardization, data quality monitoring tools need to be used to detect and correct errors, missing values, and duplications in the data in real-time, ensuring high data quality. Simultaneously, to ensure data security and privacy, a multi-layered security protection system must be constructed, covering data encryption, access control, audit tracking, and other measures to prevent data leakage and illegal access. Additionally, a data governance committee needs to be established to clarify the responsibilities and authorities of various departments in data management, formulate data management specifications and processes, and ensure effective control over the entire lifecycle of data from collection and storage to use. Through the construction and governance of institutional teaching data centers, local undergraduate institutions can break down data barriers, achieve centralized data management and sharing, and provide a solid data foundation for subsequent intelligent analysis and decision-making.

3.1.2. Deep Application of Intelligent Algorithms and Generation of Insights

On a solid data foundation, machine learning and data mining algorithms are used to transform raw data into management insights with guiding significance. For example, the CART decision tree algorithm can be used to build an academic risk early warning model. This algorithm constructs decision trees by learning historical data, and when new student data is input, the system can determine their academic risk level along the decision tree and identify key influencing factors [5]. In addition, logistic regression, random forests, association rule mining, clustering algorithms, etc., are widely applied in scenarios such as teaching quality analysis, student group segmentation, and resource demand prediction, providing a scientific basis for management decisions.

3.2. Developing Efficient and Practical Human-Machine Collaborative Management Tools

Human-machine collaborative management tools are the direct carriers of AI-empowered teaching management, with their core goal being to improve management efficiency and quality through intelligent means while maintaining human dominance and creativity.

3.2.1. AI Teaching Assistants: Intelligent Upgrade of Teaching Support Services

AI teaching assistants realize real-time intelligent answers to student questions through natural language processing and knowledge graph technologies. They can not only understand students' diverse questioning methods but also provide personalized learning suggestions and resource recommendations based on students' historical learning data. For example, during the course review stage, AI assistants can analyze students' wrong question records, precisely locate knowledge weaknesses, and push relevant micro-lecture videos and exercises, helping students prepare for exams efficiently. Meanwhile, AI assistants can also assist teachers in teaching preparation, such as automatically generating course PPTs, organizing teaching cases, etc., greatly reducing teachers' workload and improving the intelligence level of teaching support services.

3.2.2. Intelligent Document Processing: Efficiency Revolution in Administrative Paperwork

Traditional teaching management paperwork, such as teaching plan compilation, course syllabus review, student grade filing, teaching evaluation report writing, etc., often relies on manual operations, suffering from low efficiency, high error rates, and lengthy processes. Intelligent document processing technology realizes full-process intelligence in paperwork through natural language processing (NLP), optical character recognition (OCR), intelligent template matching, and automated generation technologies. For example, AI can automatically parse course information in teaching plans, compare it with training programs, and quickly identify whether credit settings, prerequisite courses, etc., comply with regulations; in the grade filing link, AI can automatically capture student grade data from multiple systems, verify and integrate it, and generate standardized transcripts; in teaching evaluation, AI can analyze teacher self-evaluation reports and student evaluation data, automatically generating comprehensive assessment reports containing quantitative indicators and qualitative descriptions. Intelligent document processing systems will shorten document processing time while significantly reducing human error rates, allowing management personnel to devote more energy to high-value management and decision-making work.

3.3. Designing Agile and Responsive Flexible Systems and Processes

Technology empowerment is not simply "automating existing processes" but requires building matching flexible systems and process frameworks to ensure that AI applications can quickly respond to changes in management requirements while avoiding the risks of technology abuse. Technical tools must be embedded in management systems to maximize their utility.

3.3.1. Intelligent Review Modules

Intelligent review modules achieve automated compliance checks of teaching management documents through preset rule libraries and machine learning models. For example, the "Course Exemption Intelligent Review" module digitizes and codes exemption rules; after students submit applications, the AI review module automatically compares them against rules, with qualified applications passing immediately, achieving process automation and management flexibility [6]. This module can not only handle course exemption applications but also be widely applied to the review of various teaching management documents, such as teaching plan changes and textbook selection. Through natural language processing technology, AI can understand document content, compare it with preset rules, quickly identify non-compliant areas, and provide modification suggestions. The application of intelligent review modules greatly improves review efficiency, reduces review biases caused by human factors, and ensures the compliance and accuracy of teaching management documents. Additionally, intelligent review modules have self-learning capabilities and can continuously optimize rule libraries based on actual review situations, improving the accuracy and adaptability of reviews.

3.3.2. Rule Engines and Robotic Process Automation (RPA)

For more standardized processes, rule engines and robotic process automation (RPA) technologies can be introduced to configure business logic in systems or let software robots simulate manual operations to automatically complete tasks such as data synchronization and form filling, ensuring efficient and accurate processes. Taking cross-institutional elective course credit recognition as an example, in the traditional mode, students need to manually fill out application forms, collect grade certifications, and go through multi-level departmental approvals, a process that takes up to several weeks. RPA robots can automatically capture students' course selection records and grade data from the educational administration system, generate application forms based on preset credit conversion rules (such as course categories, class hour correspondence), and complete automatic credit recognition through API interfaces with target institution systems. RPA will shorten the processing time of this process and reduce error rates. More importantly, flexible process design supports "exception handling" mechanisms. When the system encounters special situations not covered by rules, it can automatically trigger human intervention channels, ensuring management flexibility is not constrained by technical rigidity.

4. Challenges and Response Strategies for Local Institutions

While AI empowerment has broad prospects, local undergraduate institutions face unique challenges in implementation, requiring precise strategies to ensure steady progress.

4.1. Data Silos

Data silos are the primary obstacle to AI applications. It is costly and difficult for local institutions to build data centers independently. A better strategy is to promote regional collaboration. Led by local governments or educational alliances, city-level or regional educational cloud platforms can be built, establishing unified data exchange standards, mandating or encouraging institutions within the region to connect, achieving data interconnection and interoperability. Through regional platforms, not only can internal silos be broken, but cross-institutional data sharing can also be realized, laying the foundation for regional teaching alliances and credit mutual recognition.

4.2. Insufficient Digital Literacy Among Faculty

Teachers are key executors of AI applications, and their digital literacy directly determines application effectiveness. The response strategy is customized and systematic training. The "Teacher AI Capability Map" divides teacher capabilities into three levels: the basic level focuses on tool operation, such as using KimiChat and other AI assistants to aid in lesson preparation; the advanced level emphasizes data interpretation, enabling teachers to understand AI-provided learning analysis reports and adjust teaching strategies accordingly; the innovation level encourages teachers to explore deep integration of AI with curriculum design and develop new AI-integrated courses. Through layered training, different teachers' needs are met, achieving a leap from "able to use" to "good at using" to "creating." Training forms should be diversified, covering online self-learning, offline workshops, expert lectures, inter-institutional exchanges, etc. Online platforms provide flexible learning time and space, allowing teachers to self-learn basic operations of AI tools through micro-courses, MOOCs, etc.; offline workshops are practice-oriented, organizing teachers to discuss AI teaching cases, simulate teaching scenarios, etc., strengthening their practical operation abilities; industry experts are invited to give lectures on campus, sharing the latest trends and application cases of AI in education, broadening teachers' horizons; inter-institutional exchange activities are organized, allowing teachers to visit institutions with significant AI application effects to learn from advanced experiences. Additionally, establishing incentive mechanisms is crucial. Incorporating teachers' AI application abilities into performance evaluation systems and providing material rewards and honorary recognition to teachers who perform outstandingly in AI teaching innovation, such as establishing an "AI Teaching Innovation Award," stimulates teachers' enthusiasm and initiative to improve their digital literacy.

4.3. Ethical Risks

The widespread application of AI brings ethical risks such as data privacy, algorithmic bias, and responsibility definition. The response strategy lies in both technical safeguards and institutional norms. Technically, implement "double-blind data de-identification," hiding teacher and student identity information during the data analysis stage to protect privacy. Institutionally, establish bidirectional evaluation mechanisms, such as the anonymous post-class supervision evaluation at the University of Science and Technology Beijing, allowing students to appeal and provide feedback on AI supervision results, ensuring the fairness and transparency of algorithms. Meanwhile, the auxiliary positioning of AI tools must be clearly defined, with their decision results serving only as reference, and the final decision authority remaining with humans, avoiding "algorithmic hegemony."

4.4. Limited Resources

Local institutions have limited funds and cannot replicate the "heavy asset" model of top universities. The wise choice is to adopt a lightweight open-source technology stack. For example, using open-source Moodle as a learning platform, combined with Neo4j graph database to build student relationship networks, can establish a powerful data foundation at extremely low cost. In implementation strategy, priority should be given to "small but beautiful" applications, such as "AI Academic Early Warning System" (hardware investment < 500,000 yuan) or "Virtual Training Module," projects that are urgently needed, have controllable investment, show quick results, and can rapidly accumulate successful experiences, winning support and time for subsequent more comprehensive platform transformation.

5. Conclusion

AI empowerment in teaching management at local undergraduate institutions is not only a technological innovation but also a profound reshaping of educational concepts, management models, and governance systems. Through deep applications in core scenarios, solid implementation of key technologies, and effective responses to practical challenges, local undergraduate institutions can significantly improve management efficiency, promote educational equity, and optimize talent cultivation quality. In the future, with continuous technological evolution and institutional improvement, AI will drive teaching management to transform comprehensively from experience-driven to data-driven, from extensive management to precise governance, from closed operation to open collaboration, providing a powerful engine for local undergraduate universities to achieve connotative, high-quality development in the new era.

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