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Research on Teaching Improvement Paths Based on GAI-Enabled Learning Analytics

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Abstract: *With the rapid development of big data and information technology, generative artificial intelligence (GAI) is increasingly being used in the field of education, bringing changes to traditional teaching models. This paper focuses on the course "Management Forecasting and Decision-making Technology", and based on the online data accumulated on the Xuexitong, such as course video viewing behavior, chapter quiz scores, number of learning sessions, and attendance records, it uses GAI tools to empower learning analysis, deeply analyzes online learning behavior, multidimensionally evaluates learning outcomes, accurately identifies common learning obstacles and personalized learning needs, and thus provides scientific feedback and important evidence for optimizing teaching design, intelligently planning learning paths, effectively providing personalized guidance, and continuously improving teaching quality.*

Keywords: *Artificial intelligence, Learning situation analysis, Learning paths*

1. Introduction

With the rapid development of information technology, the education sector is undergoing unprecedented changes. The rise of online education platforms such as Xuexitong not only provides abundant resources and records students' learning behavior data, such as video viewing duration, chapter quiz scores, learning frequency, and attendance, but also contains deeper insights into students' learning attitudes, interests, and mastery of knowledge. This data holds rich information about learning conditions and serves as an important basis for evaluating teaching effectiveness and optimizing teaching strategies. The integration of GAI technology, through the collection, processing, and analysis of massive learning data, can deeply uncover patterns behind the data, accurately analyze students' learning behaviors, provide strong support for personalized teaching, and offer scientific evidence for educational decision-making.

Learning situation analysis involves analyzing the factors that affect students' effective learning in order to reflect on and design teaching, tailoring instruction to students' needs (Xu and Cao, 2016). By conducting precise learning situation analysis based on student differences, teachers can help increase students' learning autonomy and cultivate their higher-order thinking skills. In the past decade, learning analytics has become one of the fields of educational technology that receives growing attention from educational researchers and practitioners (Hui and Kwok 2019). Some researchers made systematic review of learning analytics (Whitelock-Wainwright et al., 2023; Pan, et al., 2024). Lee et al. (2020) systematically summarized the current trends and innovative practices in learning analytics. Banihashem et al., (2022) explained the role of learning analytics in enhancing feedback practices in higher education. Existing research mainly focuses on the value implications and internal logic of learning situation analysis, the practical challenges and paths for improvement (Wang and Huang,2023; Liu and Tian, 2020). It has found that current learning situation analysis often underemphasizes implicit literacy and higher-order cognitive skills, while overlooking students' practical abilities (Ma and Chu, 2019). Some scholars conduct learning situation analysis on college students' online courses in the context of normalized online teaching, using case studies to analyze learning situations before, during, and after classes. They also explore theoretical frameworks for learning situation analysis aimed at mathematical subject competencies and cognitive load levels (Wen and Zhou,2023). Through learning

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situation analysis, students' higher-order skills can be effectively cultivated, and strategies for curriculum and teaching reform are proposed.

Along with the rapid development of Internet and mobile technologies, learning analytics make use of big data for analyzing the vast amount of data obtained from the teaching and learning process (Aldowah et al. 2019). A few scholars, based on MOOC data or educational big data, analyze and predict online learning behaviors, constructing early warning indicators for these behaviors to enable precise interventions in online learning. However, research that leverages GAI tools, combined with data generated during the online learning process, to comprehensively analyze online learning behaviors is still relatively limited. This paper aims to use big data-driven GAI technology to conduct in-depth mining and analysis of online learning record data from the course "Management Forecasting and Decision-Making Techniques." By identifying key indicators in the learning process, it seeks to provide teachers with scientific feedback, offer a scientific basis for personalized instruction, and thereby improve student learning outcomes and satisfaction.

2. Learning Analysis Based on GAI Empowerment

2.1 Data Collection and Preprocessing

Management Forecasting and Decision-Making Techniques is a core course of a provincial-level first-class major, with 16 hours of theory and 16 hours of laboratory work. It carries 2 credits and is offered in the sixth semester of the third year for the Business Administration program. Since 2021, this course has been developed as a blended online and offline course, and has been successively recognized as a university-level high-quality course integrating innovation and entrepreneurship, a high-quality curriculum incorporating ideological and political education, and a smart course. Within the Business Administration curriculum, this course serves as a pivotal link and offers a toolbox for forecasting and decision-making methods. Aligned with the four major graduation requirements in the talent training program, this course applies forecasting and decision-making methods to scientifically and reasonably solve practical problems in enterprise or industry development.

The course of Management Forecasting and Decision-Making Techniques integrates specialized and entrepreneurial education, adopts a blended teaching model combining online and offline instruction. The online teaching content mainly includes five chapters: qualitative forecasting methods, time series exponential smoothing methods, regression analysis forecasting methods, Markov forecasting methods, and risk-based decision-making methods. Data on online learning activities for 156 students majoring in Business Administration are collected from the Xuexitong platform. This data specifically includes video viewing records, chapter quiz scores, homework completion, discussion forum activity, attendance records, and other related information.

2.2 Analysis of Learning Conditions

2.2.1 Differences in Learning Participation

First, data analysis shows significant differences in student participation in the course. The maximum number of times chapters are studied is 237, while the minimum is only 26. The maximum duration of video watching is 560 minutes, and the minimum is just 46.6 minutes. The proportion of students whose study time is below the average reaches 36.8%. This indicates that most students are able to complete course videos and chapter studies on time, demonstrating high learning enthusiasm, while some students show relatively low participation. Secondly, students' engagement varies significantly across different chapters. Among them, the videos on Single Exponential Smoothing Forecast, Regression Analysis Forecast Principles, and Markov Forecast Principles have the highest viewing duration and review ratio, whereas videos on Brainstorming Qualitative Forecast Method and Risk-Based Decision-Making Method have relatively lower viewing duration and review ratio.

2.2.2 Differentiation in learning outcomes

Students' online learning outcomes also show some differentiation. There are a total of 5 chapters online, and students have the best mastery of the chapter on qualitative forecasting methods, followed by the chapter on risk-based decision analysis. The average test scores for the chapters on regression analysis and Markov forecasting methods are relatively low, indicating that compared to the chapters on time series exponential smoothing and Markov forecasting methods, students have better mastery of the chapters with relatively lower learning difficulty, namely qualitative forecasting methods and risk-

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based decision analysis. In particular, the test scores for the chapter on Markov forecasting methods fluctuate significantly, with the lowest score being 33.3 and the highest score 100. Some students paused and replayed the instructional videos of this chapter significantly more than those of other chapters, indicating that students have difficulties in understanding and mastering certain knowledge points.

2.2.3 Identification of Common Learning Difficulties

Through data analysis, we find that the common problems students encounter during the learning process are mainly concentrated in insufficient understanding of the principles of related prediction and decision-making methods, which in turn leads to various issues in applying these methods. In chapter quizzes, students generally scored low on the chapter covering the Markov prediction method. Further analysis reveal that these students have significant difficulties in understanding the principles and processes of Markov prediction, and their grasp of the state transition probability matrix is inadequate. Consequently, the error rate is relatively high when applying the Markov method to predict product sales status and market share.

2.2.4 Identification of personalized learning needs

By combining students' learning behavior records and learning outcome data, personalized issues in online learning are found to vary from student to student. Different students have significant differences in learning progress and interests, resulting in diverse learning needs and preferences. Some students excel in theoretical learning but struggle with case analysis; others have difficulties understanding the principles of prediction and decision-making methods, which leads to errors in model selection during practical applications. Additionally, some students face challenges in information retrieval, data processing, model solving, and analysis, causing problems such as infeasible group project topics and slow progress in experimental operations.

3. Teaching Improvement Path Based on GAI-Enabled Learning Analytics

3.1 Innovating Educational Philosophy Shifting from Knowledge-Centered to Competency-Centered

Traditional educational philosophies and learning paradigms often focus on the passive reception of knowledge, overlooking students' initiative, creativity, and the development of their comprehensive abilities. With the continuous advancement of GAI technology, educational philosophies are increasingly emphasizing the cultivation of students' innovation skills, problem-solving abilities, critical thinking, collaboration and communication skills. On one hand, teachers can use GAI learning analytics to understand students' learning interests and individual needs, further improve teaching methods, optimize teaching content, and stimulate students' learning interest and initiative. On the other hand, GAI technology can also provide students with rich learning resources and create diverse interactive platforms such as virtual experiments and online discussions, supporting both self-directed and collaborative learning, continuously promoting a shift from passive knowledge acquisition to proactive and autonomous learning.

3.2 Optimizing teaching design to improve student learning engagement

3.2.1 Layered teaching

Implement chapter-based and student-based layered teaching according to the differentiation of students' learning outcomes. For chapters with higher difficulty levels, arrange relatively more lecture hours and design quizzes with progressively challenging question types to help students better understand and master the content. For students with weaker comprehension skills or a poor grasp of basic mathematics, start with relatively easy-to-understand chapter content and quizzes, then gradually increase depth and breadth, ensuring that each student can make progress in a learning environment suited to them.

3.2.2 Project-based interactive teaching

First, students form groups of 5-6 members freely. Each group selects a forecasting and decision-making case project based on their professional characteristics and real-world industry development issues. Using methods such as GAI-assisted literature searches, they gather relevant information about the forecasting target, organize the data, and collaboratively write a management forecasting and decision-making case. Next, using the task engine function of the Learning Pass platform, each lab

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session is broken down into several progressively layered tasks. For example, an experiment on time series exponential smoothing forecasting can be designed as four tasks: online review of knowledge points, AI assistant forecasting, forecasting in Excel, and submission of lab reports. During the knowledge review stage, every member of the project group is required to study and master relevant tasks on weighted moving average forecasting, single exponential smoothing forecasting, and double exponential smoothing forecasting on the online platform. In the AI assistant forecasting stage, each group writes prompts based on their project's time series data and instructs the AI assistant to perform forecasts using the weighted moving average method and exponential smoothing method. This helps train students in accurately posing questions and allows them to summarize the principles and procedures of weighted moving average and exponential smoothing forecasting from the AI assistant's analysis. In the Excel forecasting stage, each group applies the historical project data to perform weighted moving average and exponential smoothing forecasting in Excel. They then compare and analyze the results with those generated by the AI assistant, enhancing their ability to evaluate and conduct comprehensive analyses.

3.3 Planning learning paths intelligently and providing personalized guidance

First, for commonly identified learning difficulties, such as challenging and error-prone points in the chapter on the Markov prediction method, AI teaching assistants can hold real-time online seminars and Q&A sessions. These sessions focus on explaining the principles and operational processes of the prediction method and recommend relevant learning resources to help most students consolidate their understanding and application of Markov predictive analysis.

Second, based on students' learning progress and individual needs, GAI technology can generate personalized learning paths for each student. For example, when learning basic concepts and classifications of prediction, students may be linked to specific quantitative prediction methods such as regression analysis prediction, Markov prediction, time series exponential smoothing prediction, and trend extrapolation prediction. By exploring these prediction methods, students can deepen their understanding of quantitative prediction concepts. Additionally, learning paths can be dynamically adjusted according to the students' mastery levels to ensure that each student receives the resources best suited to them. For instance, students who have not firmly grasped basic knowledge points may be recommended relevant course videos and exercise sets, while students with weaker data processing and analysis skills may be provided with corresponding data analysis case studies.

3.4 Empowering Dynamic Multidimensional Assessment to Improve Teaching Quality

To highlight the OBE (Outcome-Based Education) achievement-oriented educational philosophy and to cultivate compound, application-oriented talents with innovative and entrepreneurial spirit as well as strong practical abilities, this course adopts an assessment approach guided by student project outcomes, promoting a combination of process evaluation and result evaluation. Process evaluation primarily assesses students' participation in interactive and blended teaching models, whether they carry out self-directed inquiry and autonomous construction empowered by GAI, whether they engage in thorough self-study and mutual learning, whether they apply optimization thinking, systems thinking, and divergent thinking to research problems, and whether they are good at teamwork, communication, and fulfilling responsibilities assigned to their group, among other aspects. Methods mainly include peer evaluation between groups, group leaders grading members, and inter-member peer grading to enhance students' engagement and sense of accomplishment. Evaluation result consists of a closed-book exam, where case analysis questions are designed to test students' ability to apply professional knowledge, their innovative problem-solving skills, and their capability to resolve case issues.

3.5 Improving Teachers' AI Literacy to Achieve Effective Integration of AIGC Technology and Traditional Teaching Methods

Teachers themselves must first increase their awareness and attention to AIGC technology, as well as their understanding of its potential applications in education. Secondly, teachers should possess the skills to leverage AIGC technology in their teaching. To meet the educational demands of the intelligent era, teachers can participate in various specialized training organized by schools or engage in self-directed online learning to understand the educational concepts and technologies enabled by AIGC, continuously improving their AI literacy and teaching capabilities. Thirdly, teachers are encouraged to combine AIGC technology with their own teaching practice, carry out research projects related to

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AIGC-enabled education, and learn from typical applications in domestic and international universities, thereby providing a basis for guiding their teaching practice. Fourthly, when applying AIGC in teaching, teachers must pay attention to ethical issues and risk prevention related to privacy protection, data security, and educational equity, guiding students appropriately in complying with laws and regulations and maintaining cybersecurity, promoting students' healthy development.

4. Conclusion

Higher education serves as the convergence point of talent, technology, and innovation. The 2023 Work Priorities of the Higher Education Department of the Education Ministry identifies accelerating the digital transformation of higher education and creating new forms of higher education teaching as key initiatives for deeply implementing China's digital strategy and forging new advantages in higher education reform and development. The rapid emergence of a new generation of digital technologies, represented by generative artificial intelligence (AI), has increasingly been applied in the field of higher education, profoundly changing public perceptions and understandings of education. Learning situation analysis, as an indispensable part of educational progress, can provide strong support for teachers in formulating targeted teaching strategies by analyzing aspects such as students' learning conditions, knowledge mastery, and learning questions. Using GAI-based learning situation analysis not only helps to deeply analyze students' learning habits and pathways through video watch duration, frequency, check-ins, navigation, and other metrics, but also allows comprehensive evaluation of student learning outcomes through both formative and summative assessments. It enables real-time monitoring and identification of common problems in students' course learning and, by taking student differences into account, accurately identifies individual student needs, thereby improving teaching efficiency, effectiveness, and quality. Therefore, it is essential to focus on enhancing teachers' AI literacy and effectively integrate GAI technology with educational teaching.

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