

Construction of a Process-based Evaluation System for Graduate Courses Driven by Industrial Engineering and Artificial Intelligence

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Abstract: Against the global backdrop of AI-integrated pedagogy, this paper develops an intelligent graduate course management framework by synthesizing Industrial Engineering (IE) optimization with AI technologies. To address passive classroom engagement and fragmented exam preparation, the study employs Lark Minutes for automated interaction quantification and an Ordinary Least Squares (OLS) model for performance prediction. This enables a tiered early-warning system and AI-driven personalized interventions. Results demonstrate that the model significantly enhances participation and provides precision academic support, offering a scalable pathway for higher education's digital transformation.

Keywords: Industrial Engineering; Artificial Intelligence; Ordinary Least Squares (OLS); Pedagogical Scoring System; Process-based Evaluation

1. Introduction

The "Education Powerhouse Construction Plan Outline (2024-2035)" advocates for AI-driven transformation in teaching, learning, and research[1]. As a key catalyst, Large Language Models (LLMs) demonstrate immense potential for higher education[2], yet challenges remain in postgraduate sectors, such as passive participation and inadequate evaluation metrics. To fulfill the university's role in preparing students for a digital-first industry[3], this paper develops a process-oriented evaluation system. By synthesizing Industrial Engineering (IE) optimization with AI technologies, the framework provides a scalable, data-driven solution for the digital transformation of graduate education. As artificial intelligence evolves progressively from an observer to an adopter and further to an innovator, students' ability of critical thinking and academic contribution is also continuously enhanced[4].

2. Core Framework Construction

2.1 Real-time Classroom Interaction: Intelligent Scoring via Lark Minutes and Bitable

Graduate education quality is fundamentally reflected in the depth of classroom engagement. However, traditional seminars often suffer from superficial interaction and a scarcity of high-order questioning or critical thinking. Moreover, the lack of immediate feedback loops in conventional scoring systems fails to incentivize independent inquiry.

To bridge this gap, this study introduces an automated quantification mechanism using Lark Minutes and Bitable. During sessions, the system records student discourse via speech-to-text technology, populating a multi-dimensional database in real-time. An AI-driven engine then assigns scores based on pre-defined rubrics, converting qualitative academic contributions into quantifiable process-based metrics.

The operational steps include:

1. AI-driven Transcription of Responses via Lark Minutes

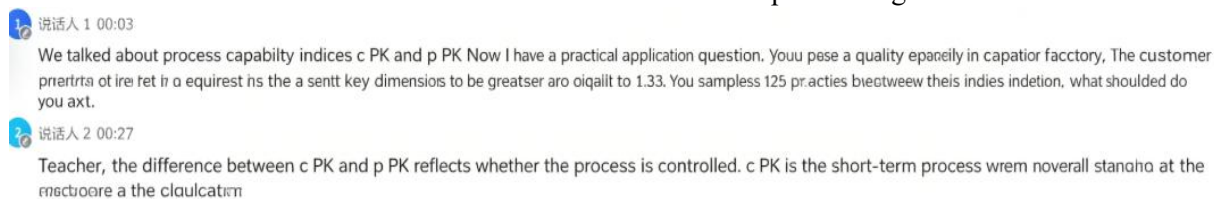


Fig. 1 Intelligent Interactive Question & Answer Extraction

2. Add points based on the situation of answering or asking questions

Group Sort Row Height Color Fill Generate Form				
A: Answer or Question Content	Contribution Value for Answering or Questioning	Contribution Value for Answering or Questioning...	Answer or Question...	AI Generate
PDCA Cycle Definition: PDCA...	Contribution Value for This Speech **...	Contribution Value Assessment for This Speech..	0.5	
Teacher, the difference between cPK and pPK...	Contribution Value for This Assessment **...	Contribution Value for This Assessment Assessment.	0.5	

Fig. 2 Intelligent Interactive Question & Answer Extraction

Dynamic Contribution Assessment: Assign scores based on the depth of inquiry and relevance of responses.

Evaluation Criteria & Scoring Rules (Cumulative c-value)

- Basic Participation: +0.5 (Accurate literature restatement / correct basic answers)
- Critical Thinking: +1.0~+1.5 (Flaw identification / in-depth follow-up questions)
- Innovative Contribution: $\geq +2.0$ (Cross-disciplinary application / original feasible solutions)
- Negative Adjustment: -0.5~-1.0 (Off-topic remarks / non-participation)

Fig. 3 c-Value Scoring Criteria for Classroom Performance

2.2 Pre-exam Precision Warning: OLS Prediction and Personalized Intervention

Graduate students are often negligent in final exam preparation, and insufficient personalized guidance has become a major obstacle to teaching quality improvement. Under traditional teaching evaluation, teachers only obtain students' final course results, which makes it impossible to early identify failing-risk students or formulate targeted personalized improvement strategies.

Different from the traditional final-grade-only evaluation system, this paper constructs a multi-dimensional least squares grade prediction model based on IE data-driven precise control. Taking students' whole-cycle learning data (daily assignments, tests and performance) as input, the model predicts final exam scores, issues early warnings for at-risk students, and provides AI customized improvement schemes, so as to support teachers' precise teaching interventions. This approach aligns with the principle that customized learning paths provided by adaptive systems significantly improve efficiency by focusing on specific weak points rather than rote learning[5].

The residual plot of the final exam is as follows:

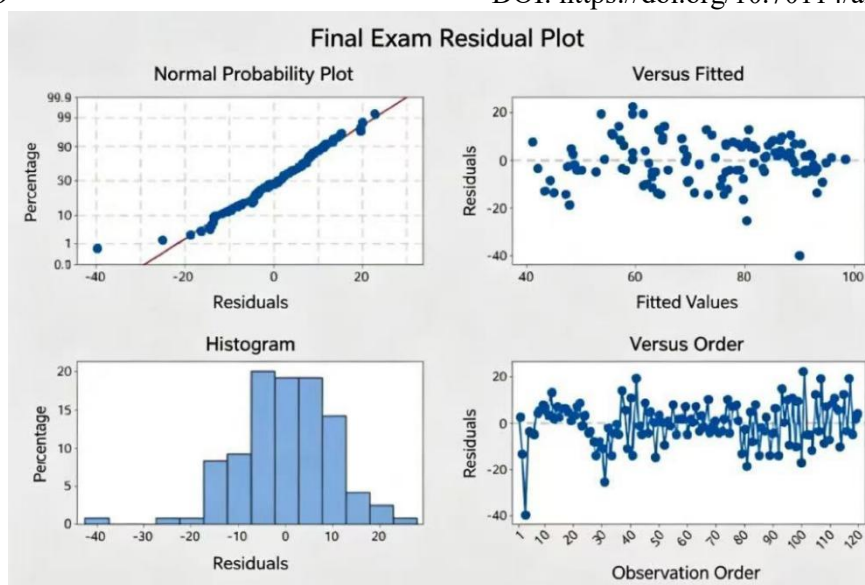


Fig4. Final Exam Residual Plot

The predictive equation is formulated as:

$$\begin{aligned} \text{FinalScore} = & 28.9 - 0.458*T2 + 0.118*T4 + 6.957*CE + 13.14* \\ & \text{Absence} + 0.0096*T2*T4 - 0.1184*T2*\text{Absence} - 0.0656*T4*CE \end{aligned} \quad (1)$$

Based on the predictive outcomes, this study establishes a Three-tier Risk Classification and Intervention Framework.

Tier I (Critical, <60): AI triggers intensive remediation and phased recovery targets.

Tier II (Moderate, 60–75): AI identifies knowledge gaps through granular deficiency analysis.

Tier III (Stable, >75): AI provides advanced enrichment to catalyze research growth.

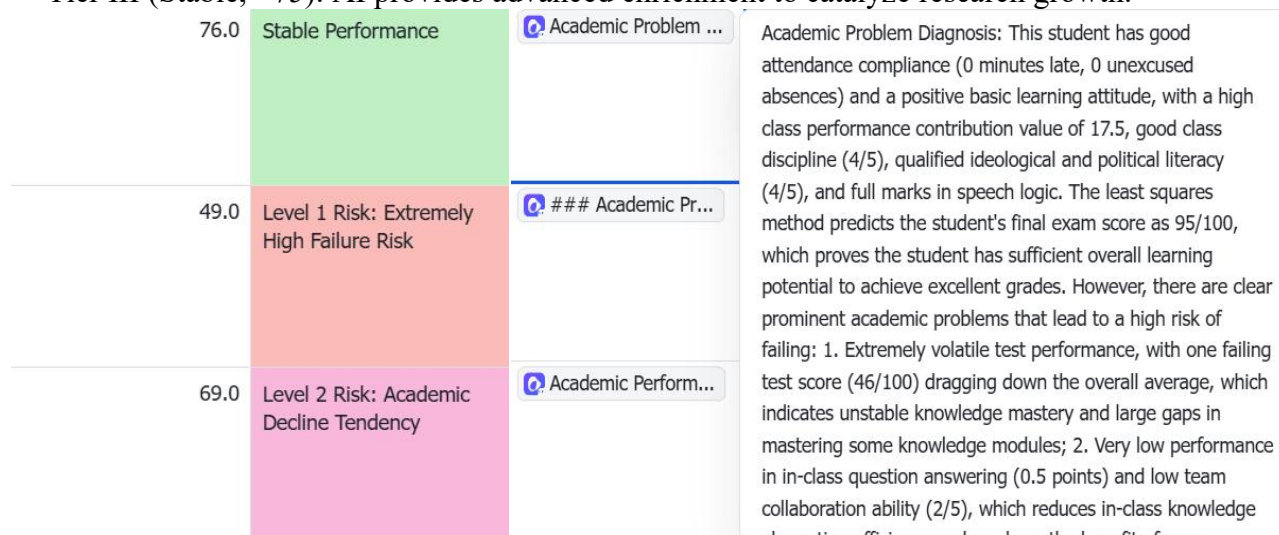


Fig5. Intelligent Graded Academic Risk Diagnosis & Warning

3. Practical Value and Innovation

As artificial intelligence evolves from an observer to an adopter and further to an innovator, learners' abilities of critical thinking and academic contribution are continuously improved[6]. As Kang and Yi pointed out, AI has the potential to foster a more dynamic literacy landscape, enabling university students to generate more nuanced and contextually appropriate outputs[7]. This research integrates Industrial Engineering (IE) optimization with AI technology to build an educational management model. By utilizing Lark Minutes and multidimensional tables, the study establishes a quantifiable classroom contribution scoring system. Additionally, it employs the least squares

method to predict grades and implement a three-level risk assessment, offering personalized improvement plans and a new cross-disciplinary perspective for IE in higher education.

4. Conclusion

Guided by digital transformation policies, this research integrates Industrial Engineering (IE) with AI to construct an intelligent pedagogical system featuring real-time incentives and predictive warnings. By addressing classroom passivity and exam negligence, this framework provides a scalable solution for postgraduate education. Future work will focus on algorithmic optimization and cross-disciplinary expansion. Ultimately, embedding AI into pedagogical frameworks fosters innovation and equips graduates for the digital age, thereby contributing to societal sustainability[8].

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References

- [1] M. Núñez-Canal, M.d.l.M. de Obesso Arias, C.A. Pérez-Rivero, and I. Álvarez-de-Mon, Stakeholder engagement and strategic innovation in higher education through AI competency. *Journal of Innovation & Knowledge*, 2026. 13: p. 100920. DOI: <https://doi.org/10.1016/j.jik.2025.100920>.
- [2] R.M. Perez, M. Shimogawa, Y. Chang, X. Li, H.A.T. Phan, J.G. Marmorstein, E.S.K. Yanagawa, and E.J. Petersson, Large language models for education: An open-source paradigm for automated Q&A in the graduate classroom. *Computers and Education: Artificial Intelligence*, 2026. 10: p. 100546. DOI: <https://doi.org/10.1016/j.caeai.2026.100546>.
- [3] D. Lee M. Arnold, A. Srivastava, K. Plastow, P. Strelan, F. Ploeckl, D. Lekkas, and E. Palmer, The impact of generative AI on higher education learning and teaching: A study of educators' perspectives. *Computers and Education: Artificial Intelligence*, 2024. 6: p. 100221. DOI: <https://doi.org/10.1016/j.caeai.2024.100221>.
- [4] T.N. Mahmud, Y.T. Jadotte, and D. Lane, Advancing AI Competency in Graduate Medical Education: A Developmental Framework. *AJPM Focus*, 2026. 5(4): p. 100484. DOI: <https://doi.org/10.1016/j.focus.2026.100484>.
- [5] S. Joe Qin, AI for education: The digital transformation of a liberal arts institution – implementation at Lingnan University. *Computers and Education: Artificial Intelligence*, 2026. 10: p. 100592. DOI: <https://doi.org/10.1016/j.caeai.2026.100592>.
- [6] C.M. Stewart, P. Nugent, R. Williams Newman, M. Burns, J. Jeremiah, and G. Barrio, Preparing educational leaders for the age of AI: Lessons from a graduate course combining curriculum innovation and institutional inquiry. *The International Journal of Management Education*, 2026. 24(1): p. 101313. DOI: <https://doi.org/10.1016/j.ijme.2025.101313>.
- [7] J. Kang and Y. Yi, Beyond ChatGPT: Multimodal generative AI for L2 writers. *Journal of Second Language Writing*, 2023. 62: p. 101070. DOI: <https://doi.org/10.1016/j.jslw.2023.101070>.
- [8] k. Bagherimajd and K. khajedad, Designing a model of sustainable education based on artificial intelligence in higher education. *Computers and Education: Artificial Intelligence*, 2025. 9: p. 100439. DOI: <https://doi.org/10.1016/j.caeai.2025.100439>.