World Journal of Educational Studies
Print ISSN: 2959-9989
Online ISSN: 2959-9997
DOI: https://doi.org/10.61784/wjes3153

DEEPSEEK'S ROLE IN EMPOWERING MATHEMATICS CURRICULUM REFORM IN HIGHER EDUCATION INSTITUTIONS—TAKING ECONOMIC MATHEMATICS AS AN EXAMPLE

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Abstract: This paper explores the challenges present in traditional university mathematics curricula, focusing on economic mathematics as a case study. It highlights issues such as the abstract nature of the content, conventional teaching methods, and outdated assessment practices. To address these challenges, the study harnesses the advanced data processing capabilities, intelligent interactive functionalities, and adaptive learning systems offered by DeepSeek. The research proposes a comprehensive approach to curriculum reform, emphasizing three key dimensions. Firstly, it introduces a personalized system to support lesson preparation, catering to individual student needs and learning styles. Secondly, it advocates for the development of an adaptive knowledge network that evolves over time, ensuring that the curriculum remains dynamic and relevant. Lastly, the study promotes the implementation of innovative deep flipped classroom practices to enhance student engagement and comprehension. By seamlessly integrating DeepSeek into the educational ecosystem encompassing teaching, learning, and assessment, this research aims to revolutionize mathematics curriculum reform. The incorporation of cutting-edge technology is expected to significantly improve teaching efficiency and elevate the overall quality of education in the field of mathematics.

Keywords: Higher education curriculum; DeepSeek; Reform pathway; Economic mathematics; Educational paradigm

1 INTRODUCTION

University mathematics courses face a dual predicament: teachers struggle to teach effectively, while students find learning daunting. Many mathematics courses overemphasise abstract theoretical derivations and proofs, with insufficient integration of practical application cases. This leads students to perceive mathematics as "of little use," making it difficult to connect learned knowledge with solving real-world problems [1-3]. The root causes include the following aspects:

First, Student Profile Analysis: 1. Varied Foundational Knowledge: Standardised teaching struggles to meet differentiated needs, as students enter university with significant disparities in mathematical background. Some may lack a deep understanding of certain concepts, hindering subsequent learning.2. Lack of interest and motivation: Confronted with dry theory and complex formulas, some students develop apprehension, lose interest, and may even experience "advanced mathematics dropout" phenomena. 3. Over-reliance on problem-solving techniques: Some students developed habits of rote memorising solution templates during secondary education. When faced with more open-ended, exploratory mathematical problems in university, they become disoriented [4].

Second, Regarding teaching content: 1. Limited mathematics teaching hours prevent coverage of certain topics. The Economics Mathematics course at this institution comprises 112 teaching hours, insufficient for in-depth exploration of mathematical models' specific applications in economics. 2. The linearised knowledge framework conflicts with interdisciplinary demands, resulting in disconnects from current academic frontiers or industry requirements.3. For economics majors, mathematics curricula are often overly generalised, failing to adequately address discipline-specific requirements. Consequently, certain topics prove excessively advanced or redundant for specialised students, while essential knowledge remains uncovered [5].

Third, Regarding teaching methods and approaches [6]: 1. "Cramming" pedagogy: Some lecturers persist with traditional "blackboard-and-lecture" formats, prioritising knowledge transmission over heuristic teaching, discussion, and student engagement. This fosters passive learning, stifling independent thought and exploratory spirit. 2. Lack of interaction and feedback: Large class sizes hinder lecturers' ability to monitor individual progress and comprehension, resulting in insufficient personalised guidance. Students have limited opportunities to pose questions and receive timely feedback.

Fourth, Regarding assessment models [7]: Mid-term and end-of-term examinations carry disproportionate weight, emphasising memorisation of knowledge points and computational skills. This fails to effectively evaluate students' mathematical reasoning, problem-solving abilities, and innovative capabilities, while data collection on the learning process remains one-dimensional.

Addressing these issues requires systematic reform, including updating pedagogical approaches, optimising the curriculum framework, refining teaching methods, increasing practical components, leveraging modern information

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technology, and enhancing teacher training. The objective is to make mathematics courses more engaging, fostering students' mathematical literacy and their ability to apply mathematical concepts to solve real-world problems.

2 ARTIFICIAL INTELLIGENCE TECHNOLOGY BRINGS PARADIGM SHIFT TO EDUCATION

Artificial intelligence (AI) technology is driving a profound paradigm shift in education, transcending mere tool enhancement to redefine the essence of education, teaching models, learning approaches, and assessment systems [8,9]. As an advanced AI tool, DeepSeek exhibits the following key technical characteristics:
(1) Strong versatility. DeepSeek aims to possess robust general capabilities, handling diverse tasks including natural language understanding, code generation, and multimodal comprehension.
(2) Superior Discipline-Specific Knowledge Modelling. By optimising model architecture and training strategies, DeepSeek achieves more efficient model training within constrained computational resources. This is crucial for reducing AI development costs and accelerating model iteration.
(3) High-Quality Datasets. DeepSeek's capability to train high-performance models necessitates substantial investment in data collection, cleansing, annotation, and curation, resulting in the construction of extensive, high-calibre training datasets.

3 DEEPSEEK'S TECHNICAL PATHWAY FOR EMPOWERING CURRICULUM REFORM

Traditional teaching models often prioritise the transmission of theoretical knowledge in mathematics courses, leaving students with notable deficiencies in practical application skills and innovative thinking. Leveraging its robust data processing, analysis, and predictive capabilities, DeepSeek can precisely discern students' learning progress and requirements, thereby providing robust support for personalised teaching [10,11]. We pursue the technical pathway for curriculum reform through the following three dimensions:

3.1 Personalised Lesson Preparation Support System

Teachers can achieve efficient and precise instructional design through DeepSeek's AI-assisted functions. The platform's built-in economic mathematics knowledge graph automatically links syllabus requirements to real-world applications. When inputting keywords such as "consumer surplus theory," the system not only recommends classic case studies (e.g., dynamic pricing models for high-speed rail tickets) but also generates customised exercise sets based on the latest industry data. Furthermore, DeepSeek demonstrates strong interdisciplinary integration capabilities.For instance, when explaining the Lorenz curve income distribution model, it can simultaneously retrieve Gini coefficients from the World Bank's public database for comparative analysis, transforming abstract concepts into tangible economic indicators. This intelligent resource integration mechanism effectively addresses the shortcomings of traditional textbooks lagging behind practical developments.

3.2 Adaptive Evolution of Knowledge Network Architecture

The dynamic knowledge graph, built upon deep learning algorithms, transcends the limitations of static tree structures. By continuously tracking students' learning trajectories and employing reinforcement learning techniques, the system dynamically optimises connection weights between knowledge points. For instance, when detecting widespread difficulties in understanding "comparative static analysis," it automatically reinforces prior knowledge such as the law of diminishing marginal utility and elasticity coefficient calculations through targeted revision prompts.Of particular note is its predictive capability: by recognising patterns in historical data, it anticipates potential cognitive gaps in solving optimisation problems under complex constraints, enabling proactive intervention. This self-evolving knowledge system genuinely realises the educational principle of tailored instruction.

3.3 Practical Breakthroughs in Deep Flipped Classroom Implementation

The hybrid reality teaching environment created with DeepSeek has completely dismantled the boundaries of traditional classrooms. During the pre-class phase, students revise derivative concepts and use AR modules to preview knowledge points such as relative rates of change and elasticity. Meanwhile, teachers utilise intelligent dashboards to monitor the class's preparatory progress through heatmaps, precisely identifying common difficulties.Classrooms transform into immersive inquiry workshops: during discussions on elasticity, the system instantly generates relevant economic problems. By encouraging students to explore commonalities and problem-solving approaches, visual knowledge maps emerge. This "cognitive apprenticeship" model shifts knowledge construction from passive reception to active creation.

4 PRACTICAL CASE STUDY: DEEPSEEK-BASED TIERED TUTORING MODEL FOR ECONOMIC OPTIMISATION PROBLEMS

4.1 Teaching Objectives

(1) Knowledge Level: Proficient mastery of methods for solving constrained optimisation (e.g., Lagrange multiplier method) and unconstrained optimisation problems.

(2) Competency Level: Cultivate students' ability to abstract mathematical models from economic phenomena and translate mathematical results back into economic language.
(3) Conceptual Level: Strengthen "marginal thinking" and "optimisation intuition", understanding the economic significance of Lagrange multipliers.

4.2 Teaching Preparation and Infrastructure

Design a template library for "prompt words". Provide students with standardised question templates to ensure efficient and accurate interaction with DeepSeek.
Template 1: Problem Decomposition and Modelling
I have an economics problem: A consumer has a budget of 100 yuan. Good x costs 2 yuan, and good y costs 5 yuan. Their utility function is

$$U\left(x,y\right) = x^{\frac{1}{2}} \bullet y^{\frac{1}{2}} \tag{1}$$

How should they allocate their expenditure to maximise utility? Please assist in resolving:
(1) Identify the objective function and constraints within this problem;
(2) Formulate this optimisation problem mathematically;
(3) Explain the potential economic significance of the parameterλ within the Lagrange function in this scenario.
Template 2: Step-by-step solution and verification
I have established the Lagrange function

$$L = x^{\frac{1}{2}} \bullet y^{\frac{1}{2}} + \lambda\left(100 - 2x - 5y\right) \tag{2}$$

Please guide me through deriving the first-order conditions and solving for the optimal values of x , y , andλ. After each step, verify the accuracy of my calculations.
Template 3: Exploring Economic Intuition
I have determined the optimal solution to be: x *=25, y *=10, λ *=0.025. Please address the following:
(1) Why does utility maximise at this point? Explain from the perspective of the ratio of marginal utility to price;
(2) If the budget increases by 1yuan, by approximately how much would utility increase? How does this relate to the value of λ.
(3) If the utility function changes to , $U(x,y) = x + y$ how would the solution differ.

4.3 Establishing a Repository of Classic Case Studies

Prepare a series of economic optimisation problems ranging from straightforward to challenging, covering microeconomics (consumer theory, producer theory) and financial mathematics (portfolio optimisation).
The classroom implementation process (taking "utility maximization" as an example) is shown in Table 1.

Table 1 Classroom Implementation Process

Phase	Core Task and Objective	Teacher Role andActivities	Student Role andActivities	Intervention Method and Purpose	Outputs and Key Outcomes
Phase One: Problem Introduction and Economic Modelling (approx. 15 minutes)	Translate real-world economic problems into mathematical models. Objective: Identify core elements of optimisation problems (objective functions, constraints).	Facilitator: 1. Present a relatable real-world case study. 2. Guide students through questioning to identify key variables: income (budget), commodity prices, satisfaction (utility). 3. Formulate a general mathematical model.	Participants: 1. Understand the case context; respond to the teacher's questions. 2. Engage in discussion to grasp the mathematical expressions for "utility maximisation" and "budget constraints".	No intervention at this stage. Purpose: This stage emphasises teacher-student interaction and foundational concept building, avoiding technical distractions that hinder the development of economic intuition.	1.Clear articulation of the economic problem statement. 2. Standard mathematical model presented on course materials.
Stage Two: Group Exploration and AI-Assisted Solution (approx. 25 minutes)	Method mastery: Solve the model using the Lagrange method and understand its economic implications. Objective: Obtain mathematical solutions and conduct preliminary interpretation.	Facilitators and Monitors: 1. Divide students into groups. 2. Distribute the "Prompt Template Library" and clarify the task. 3. Circulate among groups, addressing student queries regarding modelling and AI usage to prevent misdirection.	Explorers. 1.Use Template 1 to verify with DeepSeek that the group's model is correctly established. 2. Employ Template 2 to have DeepSeek validate computational steps. 3. Employ Template 3 to inquire about its fundamental economic implications.	Intelligent Teaching Assistant. 1. Instant Feedback: Provides standardised modelling confirmation and computational verification based on the student's prompt words. 2. Personalised guidance: Corrects common error patterns. 3. Offer preliminary explanations.	1. Correct mathematical solution processes from each group. 2. DeepSeek dialogue records (demonstrating thought processes and error correction). 3. Preliminary understanding of optimal solutions and their economic implications.
Phase Three: Whole-class discussion and teacher-led synthesis (approx. 20 minutes)	Deepening understanding and critical thinking: Moving beyond computation to explore model insights, assumptions, and limitations. Objective: Elevate mathematical outcomes into economic insights.	Facilitator and Elevator: 1. Facilitate discussion: Invite 1-2 groups to share their solution process and insights provided by the AI. 2. Correcting and Deepening: Address any mechanical or one-sided aspects in AI explanations. 3. Framework Synthesis: Summarise the universal "Modelling-Solving-Interpretation" framework.	Presenters and Reflectors: 1. Present findings on behalf of the group. 2. Listen to analyses from other groups and the teacher, comparing them with one's own understanding. 3. Respond to critical questions posed by the teacher to grasp the model's limitations.	The teacher demonstrates and critiques a typical interaction between a group and DeepSeek. Purpose: 1. Demonstrate effective utilisation of AI. 2. Highlight the limitations of AI outputs to cultivate students' critical utilisation skills.	1. Complete and rigorous economic conclusions. 2. Systematic understanding of the optimisation analytical framework. 3. Recognition that mathematical models simplify reality, with clear awareness of their assumptions and scope of application.

4.4 Post-class Assignments and Assessment Design

"AI Teaching Assistant" guided assignments: (1) Assign a moderately challenging optimisation problem; (2) Require students to submit a report containing: their dialogue log with DeepSeek (demonstrating thought processes); reflections on the assistance provided by DeepSeek; and a final exposition of the problem and economic intuition in their own words.

Creative Modelling Project: Students select an economic phenomenon to construct an optimisation model. Utilise DeepSeek as a tool to validate and solve their self-created model.

Assessment Methodology: Formative Assessment (50%): Classroom participation, group collaboration, quality of AI interaction, assignment reports; Final Examination (50%): Traditional closed-book examination assessing understanding of core methods and concepts without AI assistance, ensuring foundational proficiency.

4.5 The Teacher's Core Role and Risk Management

Preventing "Lazy Thinking": Clearly stipulate that interaction logs with DeepSeek form part of the assessment. Encourage critical use and prohibit direct copying and pasting of answers.

Cultivating Prompt Engineering Skills: Dedicate course time to teaching students how to formulate clear, in-depth questions—a core competency for future work.

Maintaining Academic Rigour: Teachers remain the ultimate knowledge authority. They must regularly review DeepSeek outputs and proactively alert/educate students regarding potential errors or limitations.

Through this implementation approach, DeepSeek is deeply integrated into the entire closed loop of "teaching, learning, practising, and assessing," truly empowering curriculum reform while enhancing teaching efficiency and depth.

5 CONCLUSIONS

In summary, the DeepSeek-driven reform of the Economic Mathematics curriculum represents not merely a superficial technological overlay, but a systemic transformation of educational paradigms. It reconfigures teacher-student roles, liberating educators from repetitive tasks to become learning designers; reshapes knowledge transmission, transforming fragmented information into structured cognitive networks; and reconstructs assessment frameworks, ensuring process-based growth receives its due emphasis.The essence of this transformation lies in leveraging intelligent technology as an intermediary to achieve complementary strengths between human educators and artificial intelligence, jointly cultivating future talent equipped with both mathematical rationality and economic insight. With the continuous iteration of technology and its deep integration into educational practice, we have reason to believe this reform model will open new possibilities for the intrinsic development of higher education.

In the future, a long-term mechanism for the deep integration of intelligent technology and economic mathematics courses can be further explored, and a personalized teaching system that meets the needs of different majors can be constructed. Strengthen the application research of artificial intelligence in the dynamic adjustment of courses, analysis of learning behaviors and precise teaching intervention, and improve the assessment system that combines process evaluation with value-added evaluation.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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