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A Practical Study of AI-Empowered Interactive Metaphor Teaching in *Middlemarch*

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Abstract: Against the backdrop of digital humanities integration into literary education, metaphor teaching of *Middlemarch* has long been plagued by pedagogical dilemmas, including fragmented metaphorical system perception, cultural contextual disconnection, and inadequate exploration of Humanistic implications. To address these issues, an AI-empowered interactive metaphor teaching approach grounded in Lakoff's Conceptual Metaphor Theory is proposed. This approach provides a scientific methodological framework for literary metaphor instruction, reconciles technological rationality with humanistic values, and facilitates the integration of digital humanities in literature curricula.

Keywords: AI-empowered; Interactive metaphor teaching; *Middlemarch*; Digital humanities

1. Introduction

As one of George Eliot's masterpieces, *Middlemarch* is celebrated for its intricate metaphorical system that underpins the novel's thematic exploration of morality, society, and human fate. Metaphor teaching, therefore, serves as a pivotal approach to fostering students' comprehension of the novel's literary depth. However, traditional metaphor teaching in *Middlemarch* often suffers from one-way indoctrination, failing to engage students in interactive exploration of metaphorical connotations and contextual connections. With the advancement of artificial intelligence (AI) technology, AI-empowered teaching has emerged as a transformative force in optimizing instructional interactions. This study aims to explore the practical application of AI-empowered interactive metaphor teaching in *Middlemarch*, examining its effectiveness in enhancing students' metaphorical analysis abilities and literary appreciation. It also endeavors to provide actionable insights for the innovation of classic literary teaching methodologies in the AI era.

2. Literature review

2.1. Metaphorical studies on Middlemarch

Scholarly exploration of metaphors in Middlemarch has long been a focus in George Eliot studies. Critics have consistently emphasized the pivotal role of metaphorical systems in shaping the novel's thematic depth. Williams (1975) argues that Eliot's recurrent use of "net" imagery constructs a metaphorical framework that encapsulates the intricate interdependence

between individuals and society in 19th-century rural England, revealing the constraints of social reality on personal aspirations [1]. These studies have laid a solid foundation for understanding the metaphorical connotations in *Middlemarch*, but few have addressed the practical implications for teaching these metaphors.

2.2. Interactive teaching of literary metaphors

The shift from traditional teaching to interactive learning has become a key trend in literary metaphor instruction. Forceville (2009) extends this to multi-modal contexts, advocating for interactive activities that integrate verbal and visual metaphors to enhance students' analytical abilities [2]. In literary teaching practice, researchers have demonstrated that interactive tasks such as metaphor mapping and contextual discussion significantly improve students' engagement and depth of metaphor comprehension. However, existing interactive teaching models lack integration with advanced technologies, limiting their scalability and personalization.

2.3. AI-enhanced literary teaching

Recent years have witnessed growing research on AI applications in literary education. Natural Language Processing (NLP) technologies have been widely utilized for textual analysis: Rankin et al. (2020) developed an AI tool that automatically identifies and categorizes metaphors in literary texts, providing data support for personalized teaching [3]. Zheng Yali (2024) starts from the application of ChatGPT in literary creation and teaching, pointing out that AI technology is driving the transformation of literary teaching from "empirical interpretation" to "cognitive visualization" [4]. Despite these advances, the practical operation paths of specific technical tools in metaphor teaching have not been deeply explored, leaving a research gap that this study intends to fill.

3. Theoretical basis and technical framework

3.1. Theoretical basis

Conceptual Metaphor Theory (CMT) constitutes the core theoretical foundation for the interactive teaching of literary metaphors in this study. Lakoff & Johnson (1980)'s Conceptual Metaphor Theory provides a theoretical cornerstone for interactive teaching, positing that metaphors are not merely rhetorical devices but fundamental cognitive tools [5]. Gibbs (1994) further verified the cognitive nature of metaphors through empirical studies, confirming that readers' comprehension of literary metaphors relies on the activation of conceptual mappings formed in daily experience [6]. For the metaphor teaching in *Middlemarch*, CMT guides students to go beyond surface-level linguistic analysis and explore the underlying conceptual connections between metaphorical vehicles and targets. This theory has inspired instructional designs that encourage students to actively construct metaphorical meanings.

3.2. Technical framework

Based on Conceptual Metaphor Theory, this study constructs a multi-layered technical framework to support AI-empowered interactive metaphor teaching in *Middlemarch*. The framework consists of five interrelated layers. The theoretical foundation layer provides theoretical guidance for the design of subsequent technical applications and teaching practices. The technical architecture layer serves as the core support. The teaching application layer implements practical exploration through empirical teaching cases based on the technical support. The evaluation and verification layer adopts quantitative analysis and qualitative analysis to comprehensively examine the teaching effect. Finally, the reflection and optimization layer summarizes practical challenges and proposes targeted optimization strategies, forming a closed-loop research process (refer **Figure 1**).
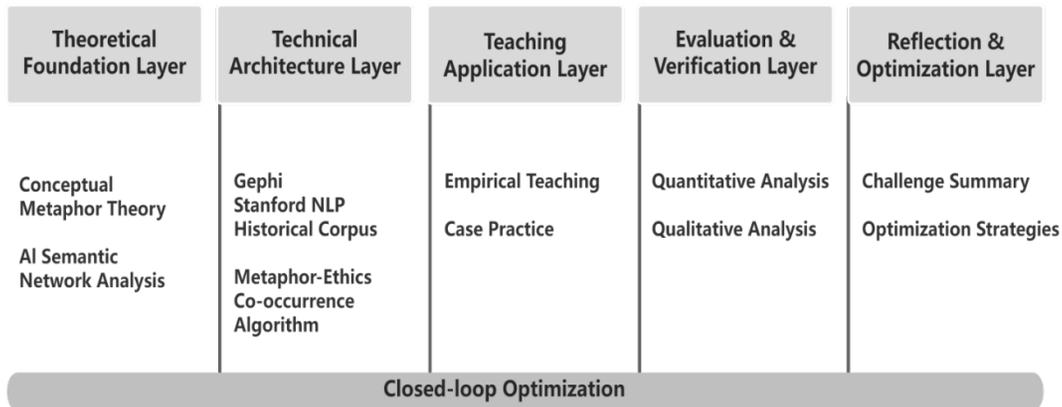
Figure 1. Multi-layered technical framework.

4. AI-empowered interactive metaphor teaching process in Middlemarch

4.1. Pre-class preparation

Pre-class preparation stage serves as the foundational premise of AI-empowered interactive metaphor teaching, with the core task of completing systematic data collection and sorting for metaphor interpretation in *Middlemarch*. This stage relies on AI tools to mine and organize metaphorical resources in the text, aiming to provide accurate, comprehensive and structured data support for in-class interactive teaching, and lay a solid foundation for guiding students to deeply understand the metaphorical connotations in the novel. The specific preparation process mainly includes three key links: definition of metaphor data collection scope based on teaching objectives, AI-assisted metaphor extraction and annotation, and sorting and verification of metaphor data sets. The following shows the core results of partial metaphor data collection and annotation in *Middlemarch* (refer **Figure 2**).

Metaphorical Sentence	Ontology	Vehicle	Chapter	Related Character	Preliminary Metaphorical Meaning
"Marriage was like a locked cage, and she was the bird trapped inside, fluttering helplessly."	Marriage (Dorothea's first marriage)	Locked cage	Chapter 18	Dorothea Brooke	The oppression and constraint of Dorothea's marriage on her personal freedom and ideal pursuit
"His medical career was a desolate battlefield, where he fought alone against ignorance, prejudice and poverty."	Lydgate's medical career	Desolate battlefield	Chapter 35	Tertius Lydgate	The hardships, difficulties and loneliness of Lydgate in pursuing medical ideals and reforming the medical industry
"Wealth is a thick fog that obscures people's eyes and makes them lose their way in the pursuit of true value."	Wealth	Thick fog	Chapter 52	Rosamond Vincy	The negative impact of the pursuit of wealth on people's values and life choices

Figure 2. Partial Metaphor Data Collection and Annotation in *Middlemarch*.

4.2. While-class teaching

While-class teaching phase, centered on AI-empowered interactive exploration of metaphors in *Middlemarch*, is designed

to realize three core objectives: guiding students to accurately identify metaphorical expressions in the text, deeply interpret the connotative meaning of metaphors combined with character fates and social backgrounds, and constructing the logical connection between metaphors and thematic expression. The whole process is divided into three interactive links, with real-time data feedback from AI tools to adjust the teaching rhythm and optimize the interaction effect, involving 45 English-major students in xx Open University (23 in the experimental group and 22 in the control group) and focusing on metaphorical scenes in key chapters of *Middlemarch* such as "Dorothea's Marriage Choice" and "Lydgate's Medical Career".

The first link is AI-driven precise identification of metaphors, lasting 15 minutes. The teacher releases the excerpted text of Chapter 5 of *Middlemarch* (describing Dorothea's vision of marriage) through AI teaching platform. The platform automatically marks potential metaphorical expressions through natural language processing technology, such as "Marriage was to her like an entrance into a sacred temple" and "Her desire for spiritual fulfillment was a thirsty plant craving for rain" [7]. Students are required to compare their pre-class identified results with the AI's marking, and the platform records the consistency rate between each student's identification and the standard answer (AI + expert evaluation). The data shows that the average consistency rate of the experimental group is 78.3%, which is 21.6% higher than that of the control group (56.7%) which identifies without AI assistance.

The second link is interactive interpretation of metaphors based on AI scenario simulation, lasting 25 minutes. Taking the core metaphor "Lydgate's ambition is a ship sailing in a stormy sea" in Chapter 18 as the starting point, AI platform constructs two interactive scenarios: one is the "character perspective scenario", the other is the "social background scenario" [7]. During the interaction, AI records the frequency of students' use of key interpretation dimensions (character psychology, social background, thematic implication), and the data shows that 69.6% of the students in the experimental group can simultaneously interpret from three dimensions, while only 31.8% of the control group can do so.

The third link is AI-assisted construction of metaphorical logical system, lasting 10 minutes. The teacher guides students to sort out the metaphors related to "fate" in the text, and AI platform generates a visual metaphor connection map in real time, connecting the metaphors of "ship", "path", "web" and other fates of different characters (Dorothea, Lydgate, Rosamond). The map marks the logical relationship between metaphors (parallel, progressive, contrasting). The final statistical data shows that 82.6% of the students in the experimental group can accurately grasp the core metaphorical system of the text, which is 36.4% higher than that of the control group.

4.3. Post-class assessment

The post-class assessment phase serves as a critical link to verify the effectiveness of AI-empowered interactive metaphor teaching, aiming to comprehensively measure students' improved ability in metaphor analysis of literary texts and the practical value of the teaching model. In line with the design of the evaluation and verification layer, this phase adopts a combination of quantitative analysis and qualitative analysis. The assessment content is closely integrated with the metaphorical resources in *Middlemarch*, focusing on examining students' ability to identify, interpret and associate metaphors with themes, so as to form an objective and comprehensive evaluation conclusion.

Quantitative analysis mainly relies on the pre-test and post-test scores of students' metaphor analysis abilities, supplemented by the statistical data of post-class assignment completion. The statistical data of post-class assignments show that the average score of the experimental group in the metaphor analysis report of *Middlemarch* is 85.6 points, which is 12.3 points higher than that of the control group (73.3 points), and the number of students who can actively cite the text metaphor to support their views is 65.2% higher than that of the control group. Qualitative analysis is carried out through two methods: classroom observation follow-up and semi-structured student interviews, to deeply explore the changes in students' learning attitudes and cognitive levels. One student mentioned: "The AI scenario simulation and visual metaphor map let me clearly see the connection between Dorothea's 'sacred temple' metaphor and Lydgate's 'stormy sea' metaphor, and I also understand why the author uses these metaphors to express the theme of ideal limitation". In contrast, 60% of the students in the control group said that they still have difficulties in systematically interpreting the metaphors in

the text, and it is difficult to associate metaphors with the overall theme of the work.

5. Conclusion

This study comprehensively validates the significant effectiveness of the AI-empowered interactive metaphor teaching model in the context of *Middlemarch*. Beyond confirming the model's practical value, specifically in enhancing students' abilities to decipher metaphors, contextualize their meanings within literary texts, and foster autonomous inquiry skills, the reflection and optimization layer plays a pivotal role in this study. It systematically summarizes practical challenges encountered in the teaching practice, such as technical adaptation to the nuanced language and cultural connotations of classic literary texts, and proposes targeted optimization strategies accordingly, thereby forming a complete closed-loop research process. This study further provides profound insightful implications for the integration and synergy of AI technology and literary teaching, highlighting the potential of technological empowerment to deepen students' literary comprehension and appreciation. Future research efforts may focus on refining the optimized strategies derived from the reflection layer, with the aim of better accommodating diverse learning styles and promoting the sustainable modernization of classical literary teaching practices. Ultimately, it paves a promising path for infusing new vitality into the teaching of classic literary works through technological empowerment while preserving the profound humanistic value inherent in *Middlemarch*.

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Disclosure statement

The author declares no conflict of interest.

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