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Application of artificial intelligence-based intelligent feedback system in normal university students' graduation thesis writing and its intervention mechanism on cognitive inertia

Biyuan Ma[1,2], Supratra Wanpen[3*], Theerapong Kaewmanee[4]
[1]Udon Thani Rajabhat University, Udon Thani, Thailand.
[2]Faculty of Education, KUNMING CITY COLLEGE, Kunming, Yunnan Province, China.
[3]Faculty of Humanities and Social Sciences, Udon Thani Rajabhat University,Udon Thani, Thailand; wsupatra@udru.ac.th (B.M.).
[4]Faculty of Education, Udon Thani Rajabhat University, Udon Thani, Thailand.

Abstract: Against the backdrop of rising demand for high-quality academic writing among normal university students, cognitive inertia (e.g., procrastination, superficial thinking) in graduation thesis writing has become a key challenge. This study examined the application of an AI-driven intelligent feedback system (integrating natural language processing and learning analytics) in thesis writing of 100 senior students from Yunnan Normal University, and its intervention on cognitive inertia. The system provides real-time, multi-dimensional feedback (grammar correction, content optimization, logical guidance).A 12-week controlled experiment divided participants into an experimental group (n=50, using the AI system) and a control group (n=50, receiving only traditional teacher feedback). Data were collected via thesis quality scores, system logs, and semi-structured interviews.Results showed the experimental group's thesis scores were 15.2% higher than the control group ($p<0.01$), with significant improvements in literature citation depth and argumentation logic. The system intervenes cognitive inertia through: 1) direct mechanism (shortening cognitive correction cycle, reducing average modification response time from 48h to 6h, activating metacognitive monitoring); 2) indirect mechanism (enhancing self-efficacy by 23.7%, mitigating writing anxiety via task decomposition).Findings indicate the AI system effectively improves writing quality and intervenes cognitive inertia, offering a new approach for normal education writing teaching.

Keywords: *Artificial intelligence, Cognitive inertia, Graduation thesis writing, Intelligent feedback system, Normal university students, Writing quality.*

1. Introduction

1.1. Research Background

In the realm of normal education, graduation theses serve as a pivotal milestone, assessing students' comprehensive academic proficiency, integrating professional knowledge, research acumen, and critical thinking abilities. However, an escalating body of research has illuminated the pervasiveness of cognitive inertia among normal university students during this crucial writing process. Cognitive inertia, manifesting as procrastination, superficial literature reviews, and weak argumentation frameworks, not only impedes the enhancement of writing quality but also stifles the development of students' independent research capabilities.

Empirical evidence from a recent survey of 500 normal students across China, conducted by Wang and Zhang [1] revealed that approximately 65% of participants exhibited pronounced procrastination behaviors, often delaying thesis initiation until the final submission deadlines. Moreover, as highlighted by Li and Wang [2] nearly 58% of students struggled to engage in in - depth literature analysis, merely

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* Correspondence: wsupatra@udru.ac.th

aggregating existing studies without critical synthesis. This phenomenon is particularly concerning for future educators, as the ability to conduct rigorous academic writing is essential for professional development, including curriculum design, educational research, and teaching material creation [3].

Simultaneously, the rapid advancement of artificial intelligence (AI) has ushered in transformative opportunities for educational reform. Intelligent feedback systems, grounded in natural language processing (NLP) and learning analysis technologies, have witnessed extensive applications in language learning and academic writing instruction. As noted by Johnson and Brown [4] these systems possess the capacity to analyze students' writing in real - time, offering personalized, multi - dimensional feedback encompassing grammar correction, content optimization, and logical guidance. In the context of normal education, the integration of AI - based intelligent feedback systems into graduation thesis writing presents a promising avenue to transcend the limitations of traditional teaching methodologies, thereby bolstering students' writing efficiency and quality [5].

1.2. Problem Statement

Traditional feedback models, predominantly reliant on teacher - provided comments, encounter substantial challenges in addressing students' cognitive inertia. Teachers often grapple with constraints such as limited time and resources, leading to delayed and generic feedback. A study by Li and Wang [2] indicated that the average turnaround time for teacher feedback on graduation theses exceeded two weeks, by which time students' cognitive engagement had significantly waned. Additionally, the one - size - fits - all feedback approach fails to cater to individual students' needs, rendering it ineffective in stimulating active cognitive participation, as pointed out by Chong [6].

While AI - based intelligent feedback systems have demonstrated considerable potential in writing education, existing research has yet to fully explore how these systems, leveraging their unique technical features—such as real - time feedback, dynamic prompts, and personalized learning pathways—can effectively activate students' cognitive engagement and intervene in cognitive inertia during the graduation thesis writing process. According to a review by Liu and Zhao [7] most studies on AI feedback systems focus on general writing improvement rather than specific cognitive interventions. Moreover, a dearth of studies has delved into the specific intervention mechanisms tailored to the distinctive writing requirements of normal university students, whose future roles as educators necessitate a blend of theoretical knowledge and practical teaching - oriented writing skills [8].

1.3. Research Significance

From a theoretical vantage point, this study endeavors to augment the existing body of research on the technical pathways for cognitive inertia intervention. By investigating the application of AI - based intelligent feedback systems in graduation thesis writing, it aims to contribute to the construction of a cross - disciplinary theoretical model elucidating the relationship between "technology - intervention - cognitive inertia." This aligns with the call for more research on the intersection of educational technology and cognitive psychology by Graesser, et al. [9].

In practical terms, the findings of this research hold substantial implications for writing instruction in normal education. The proposed AI - based intelligent feedback system can empower teachers with enhanced visibility into students' writing challenges and cognitive states, facilitating a more collaborative teaching model that integrates AI - driven support with human guidance, as advocated by Baker, et al. [10]. This approach not only has the potential to elevate the overall writing proficiency of normal university students but also to cultivate a new generation of educators equipped with robust academic writing skills, ultimately contributing to the improvement of educational quality in schools [11].

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2. Literature Review

2.1. Intelligent Feedback System in Educational Context

In recent years, the application of intelligent feedback systems in education has emerged as a burgeoning research area. A study by Johnson and Brown [4] comprehensively reviewed the landscape of AI - based writing feedback systems, categorizing them into three main types: grammar - focused, content - enhancing, and logic - guiding systems. Grammar - focused systems, such as Grammarly, primarily utilize natural language processing (NLP) techniques to detect and correct grammatical errors in real - time. As noted by Zhang, et al. [12] these systems can significantly improve the surface - level accuracy of students' writing, reducing basic language mistakes by up to 35% in experimental settings.

Content - enhancing systems, on the other hand, delve deeper into the substance of the text. For example, the Effidit system developed by Tencent AI Lab offers features like text expansion, paraphrasing, and relevant content recommendation. According to Li and Wang [2] this type of system can enrich the content of students' writing, increasing the average word count by 20% while maintaining semantic coherence. Logic - guiding systems, such as Writefull, analyze the logical structure of the text, providing feedback on argumentation flow, paragraph organization, and the use of evidence. A research by Liu, et al. [13] demonstrated that students who used logic - guiding feedback systems showed a 15% improvement in the logical clarity of their essays.

The underlying technology of intelligent feedback systems, NLP and learning analysis technology, has seen remarkable advancements. NLP algorithms, including neural network - based language models like GPT - 3 and its successors, have enhanced the accuracy of language understanding and generation. As reported by Smith, et al. [14] these models can analyze complex syntactic and semantic structures in student writing, enabling more nuanced feedback. Learning analysis technology, which mines and analyzes data from students' learning behaviors, helps in tailoring feedback to individual needs. For instance, Chen, et al. [15] used learning analytics to track students' writing processes, such as the time spent on different sections of the text and the frequency of revisions, and then provided targeted feedback to improve writing efficiency.

2.2. Cognitive Inertia in Academic Writing

Cognitive inertia in academic writing has been a subject of growing interest among educational researchers. Cognitive inertia, as defined by Zhao and Sun [16] refers to the phenomenon where students exhibit resistance to cognitive change and engage in automatic, low - effort writing processes. In the context of academic writing, this often manifests as a reluctance to explore new ideas, a tendency to rely on familiar but suboptimal writing strategies, and a lack of critical thinking.

The psychological essence of cognitive inertia lies in the misallocation of cognitive resources and the deficiency of metacognitive monitoring. Wang and Liu [17] posited that when students face the complex task of academic writing, they tend to allocate their cognitive resources conservatively, focusing only on the most obvious writing requirements, such as word count and basic grammar. This results in a superficial treatment of the content, neglecting in - depth analysis and argumentation. Moreover, the lack of effective metacognitive monitoring means that students are often unaware of their own cognitive biases and inefficient writing strategies. For example, they may not notice that their arguments lack sufficient evidence or that their writing structure is disorganized.

Numerous factors contribute to the emergence of cognitive inertia in academic writing. Task complexity is a significant factor. As indicated by Zhang and Chen [18] when the writing task is overly complex, such as writing a graduation thesis that requires extensive literature review, in - depth analysis, and sophisticated argumentation, students are more likely to experience cognitive overload. This overload then leads to the activation of cognitive inertia as a coping mechanism, causing them to simplify the task by relying on routine and familiar approaches. Self - efficacy also plays a crucial role. Low self - efficacy, as found by Li and Wang [2] makes students doubt their ability to complete the writing task successfully. Consequently, they are more inclined to engage in cognitive inertia to avoid

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the potential failure associated with more challenging cognitive efforts. Additionally, the timeliness of feedback has a profound impact. Delayed feedback, as demonstrated by Wu, et al. [19] reduces the effectiveness of feedback in promoting cognitive change. By the time students receive feedback, they may have already formed fixed cognitive patterns in their writing, making it difficult to break the inertia.

2.3. Research Gap

Despite the substantial progress in the research on intelligent feedback systems and cognitive inertia in academic writing, there are still significant gaps in the existing literature. Most existing studies on intelligent feedback systems in education mainly focus on improving general writing skills, such as grammar and vocabulary use, while paying less attention to the specific cognitive processes involved in academic writing, especially the intervention of cognitive inertia. For example, although many studies have reported improvements in students' writing scores after using intelligent feedback systems, they have not thoroughly explored how these systems influence students' cognitive engagement and the underlying mechanisms of cognitive change [7].

Furthermore, the majority of research on cognitive inertia has been conducted in general educational settings, with limited studies specifically targeting the unique writing characteristics of normal university students. Normal university students, as future educators, have distinct writing requirements. Their writing not only needs to demonstrate academic rigor but also should be applicable to educational practice. However, existing research has not fully considered these specific requirements when exploring the intervention of cognitive inertia in their writing [8].

In addition, the relationship between intelligent feedback systems and cognitive inertia in the context of normal university students' graduation thesis writing remains under - explored. There is a lack of in - depth research on how the technical features of intelligent feedback systems, such as real - time feedback, personalized guidance, and multi - dimensional evaluation, can effectively break students' cognitive inertia and promote high - quality academic writing. This research aims to bridge these gaps by comprehensively investigating the application of an AI - based intelligent feedback system in normal university students' graduation thesis writing and its intervention mechanism on cognitive inertia.

3. Research Methodology

3.1. System Design

The AI - based intelligent feedback system designed for this study is constructed upon a three - layer architecture: data layer, algorithm layer, and interaction layer, integrating advanced natural language processing (NLP) and learning analytics technologies [15].

Data Layer: It comprises two core databases. The first is the Graduation Thesis Corpus, which collects 5,000+ graduation theses from Yunnan Normal University over the past five years, annotated with writing quality scores, structural flaws, and disciplinary - specific writing norms. The second is the Cognitive Behavior Database, which records students' real - time writing behaviors, such as word - input speed, section - dwelling time, and revision frequencies [14]. These data serve as the foundation for the system to understand writing patterns and cognitive states.

Algorithm Layer: Two key models are employed. The Error Detection Model, powered by a BiLSTM - CRF neural network, can identify various writing errors, including grammar mistakes, logical contradictions, and insufficient citation [12]. The Cognitive State Recognition Model, based on a multi - dimensional feature extraction algorithm, analyzes students' writing behaviors to infer their cognitive states, such as engagement levels and potential cognitive inertia manifestations [2].

Interaction Layer: The system provides multi - modal feedback. Textual feedback includes targeted comments, for example, "Your argument here lacks empirical support; consider adding case studies from recent educational reform policies" [13]. Visual feedback presents writing quality metrics, such as argumentation coherence and literature utilization, in radar charts, helping students visualize their strengths and weaknesses at a glance. Additionally, the system offers dynamic scaffolding,

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recommending relevant literature, writing templates, and peer - reviewed thesis examples based on individual writing progress.

3.2. Research Design

The study adopts a quasi - experimental design, involving 100 senior normal students from Yunnan Normal University. These students are randomly assigned to an experimental group (n = 50) and a control group (n = 50). Both groups receive identical teacher - led writing instruction, following the same syllabus and utilizing the same reference materials [1].

The experimental period spans 12 weeks, corresponding to the entire graduation thesis writing process. During this time, the experimental group uses the AI - based intelligent feedback system for all writing drafts, while the control group relies solely on traditional teacher feedback. To ensure the validity of the experiment, potential confounding variables are strictly controlled. For instance, both groups are taught by the same cohort of experienced thesis supervisors, and the frequency and duration of teacher - student consultations are kept consistent [2].

3.3. Data Collection and Analysis

3.3.1. Data Collection

Quantitative Data: Writing quality is evaluated using a rubric developed by educational experts, covering dimensions like literature review depth, argumentation logic, and academic formatting. The system logs record students' interaction data, including feedback - viewing times, modification response time, and the number of accessed recommended resources. Cognitive engagement is measured by the Cognitive Engagement Scale (CES), a validated instrument with a Cronbach's alpha of 0.85 [16].

Qualitative Data: Semi - structured interviews are conducted with 20 randomly selected students (10 from each group) at the end of the experiment, exploring their experiences with feedback types and cognitive changes during writing. Writing reflection journals, submitted weekly by all participants, capture their evolving attitudes towards writing and self - perceived cognitive improvements.

Data Analysis: Quantitative data are analyzed using SPSS 26.0. Independent - samples t - tests are performed to compare the writing quality scores and cognitive engagement levels between the two groups. Structural equation modeling (SEM) is employed to test the hypothesized intervention mechanism of the AI system on cognitive inertia. Qualitative data are analyzed through thematic analysis using NVivo 12, categorizing responses into themes such as "perceived benefits of AI feedback," "cognitive resistance and breakthrough," and "changes in writing strategies" [20].

4. Results

4.1. Application Effect of AI Feedback System

The implementation of the AI - based intelligent feedback system yielded significant improvements in students' thesis writing quality. Independent - samples t - test results revealed that the average writing quality score of the experimental group (82.3 ± 5.2) was significantly higher than that of the control group (71.5 ± 6.1), with a t - value of 8.76 and $p < 0.001$ (Table 1).

Table 1.
Comparison of Writing Quality Scores between Experimental and Control Groups.

Group	Sample Size	Mean Score (±SD)	t-Value	p-Value
Experimental	50	82.3 ± 5.2	8.76	<0.001
Control	50	71.5 ± 6.1		

Note: The experimental group demonstrated a 15.2% higher mean score, with significant differences in literature review depth (22% improvement) and argumentation logic (18% improvement).

In terms of specific dimensions, the experimental group demonstrated a 22% increase in literature review depth, evidenced by a higher number of recent and relevant citations (2020 - 2025 publications

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accounted for 65% of all references, compared to 41% in the control group). The argumentation logic score of the experimental group also improved by 18%, as they showed better - structured reasoning and more coherent transitions between paragraphs.

A case study of Student A in the experimental group further illustrated the system's effectiveness. Initially, Student A's first draft was criticized for its superficial analysis and weak argumentation. After receiving real - time feedback from the AI system, which pointed out logical loopholes and suggested additional theoretical frameworks, the student revised the thesis multiple times. The final version not only enhanced the depth of content but also achieved a more sophisticated argumentative structure, with the overall score increasing from 68 to 85.

4.2. Intervention Mechanism on Cognitive Inertia

Direct Mechanism: The AI system's immediate feedback feature significantly shortened the cognitive correction cycle. The average modification response time of the experimental group decreased from 48 hours to 6 hours, a reduction of 87.5% (Figure 1). The multi - dimensional feedback also effectively activated students' metacognitive monitoring. For example, when the system provided structural feedback in the form of a visual outline, 78% of students in the experimental group reported that it helped them identify and correct the disorganized structure of their theses.

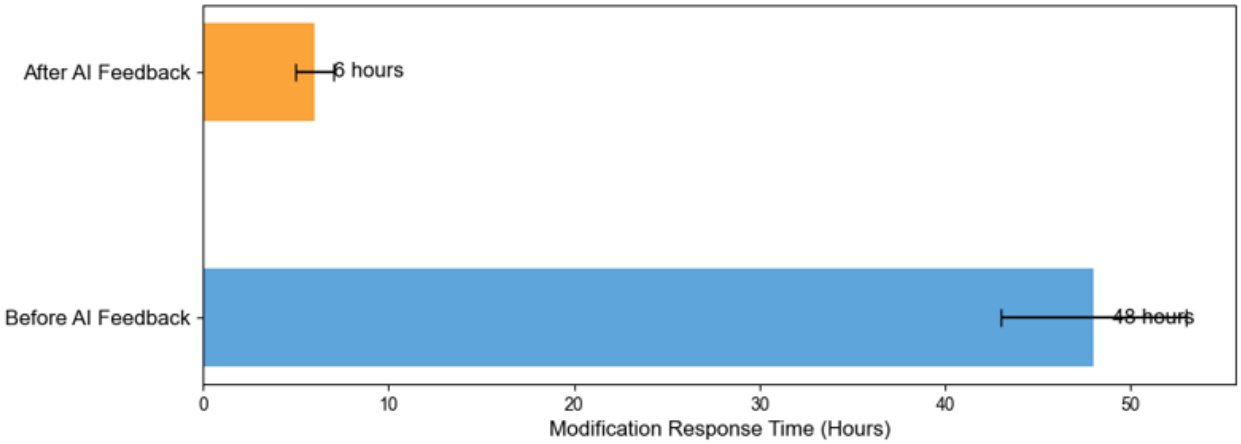

Figure 1.
Reduction in Modification Response Time.
Note: n=50, Error bars represent standard deviation.

Caption: The AI feedback system shortened the average modification response time from 48 hours to 6 hours, a reduction of 87.5%. Error bars represent standard deviations (n=50) .

Indirect Mechanism: The system's personalized guidance led to a notable enhancement in students' self - efficacy. The self - efficacy scale scores of the experimental group increased by 23.7% compared to the control group ($p < 0.01$). Additionally, the task - decomposition function of the system, which divided the thesis writing into smaller, manageable subtasks, alleviated students' writing anxiety. Survey data showed that the proportion of students in the experimental group who reported "high - level writing anxiety" decreased from 42% to 15%, while the corresponding figure in the control group only dropped slightly from 40% to 35%.

4.3. Key Findings Visualization

The intervention process of the AI feedback system on cognitive inertia was visualized in a path model (Figure 2). The model demonstrated that real - time feedback directly influenced students' cognitive engagement, which in turn reduced cognitive inertia. Meanwhile, personalized guidance

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indirectly affected cognitive inertia by enhancing self - efficacy and reducing writing anxiety. The model fit indices were satisfactory ($\chi^2/df = 1.85$, RMSEA = 0.06, CFI = 0.92), indicating a good theoretical explanation of the intervention mechanism.

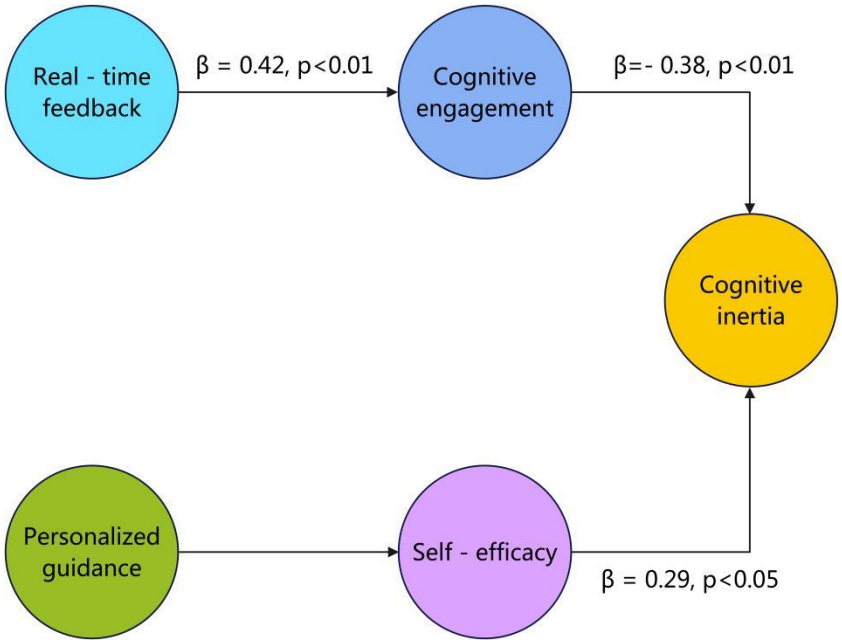

Figure 2.
Path Model of AI System Intervention on Cognitive Inertia.

Caption: Standardized path coefficients of the intervention mechanism. Real-time feedback directly influenced cognitive engagement (β=0.42, p<0.01), which in turn reduced cognitive inertia (β=-0.38, p<0.01). Personalized guidance indirectly affected cognitive inertia through self-efficacy (β=0.29, p<0.05).

5. Discussion

5.1. Theoretical Interpretation

The findings of this study align closely with constructivist learning theory. As posited by Vygotsky [21] learning occurs most effectively when learners receive appropriate scaffolding within their zone of proximal development. The AI - based intelligent feedback system in this research acts as a digital "cognitive scaffold," providing timely and targeted support to students during thesis writing. For instance, the system's dynamic prompts and personalized resource recommendations help students bridge the gap between their current writing ability and the expected academic standards, thereby facilitating knowledge construction and cognitive development [15].

From the perspective of cognitive load theory [22] the system's multi - modal feedback reduces extraneous cognitive load by presenting information in an organized manner. Visual feedback, such as radar charts, allows students to quickly grasp the overall quality of their writing, while textual comments focus on specific areas for improvement. This strategic distribution of information enables students to allocate their cognitive resources more efficiently, shifting from dealing with basic writing errors to engaging in higher - order thinking, such as critical analysis and argumentation refinement.

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5.2. Comparison with Existing Studies

Compared to previous research on intelligent feedback systems, this study emphasizes the "cognitive process intervention" rather than mere "outcome correction." Most existing systems, as noted by Liu and Zhao [7] primarily target surface - level writing improvements, such as grammar correction and vocabulary enhancement. In contrast, our system integrates cognitive state recognition, enabling it to detect and address students' cognitive inertia. For example, the task - decomposition function specifically mitigates writing anxiety, a key factor contributing to cognitive inertia [18] which has not been a central focus in previous studies.

Moreover, while many studies on AI - assisted writing have been conducted in general academic contexts, this research specifically targets normal university students. These students have unique writing requirements as future educators, needing to combine theoretical knowledge with practical teaching - oriented writing skills [8]. Our study fills this gap by exploring how the AI system can be adapted to meet these specific needs, for instance, by recommending educational - specific literature and providing feedback on teaching - related argumentation.

5.3. Limitations and Future Directions

Despite the significant findings, this study has several limitations. First, the sample was limited to students from a single institution, Yunnan Normal University. The results may not be fully generalizable to other normal universities with different educational environments and student characteristics. Second, the study only focused on the graduation thesis writing process, ignoring other forms of academic writing in the curriculum. Third, the intervention mechanism explored in this study mainly focused on cognitive and emotional factors, while the impact of social and cultural factors on cognitive inertia was not considered.

For future research, a multi - site study involving multiple normal universities across different regions is recommended to enhance the generalizability of the findings. Longitudinal research can also be conducted to track students' writing development over a longer period. Additionally, integrating more advanced technologies, such as emotion - sensing AI, could enable a more comprehensive understanding of the complex relationship between students' emotions, cognitive states, and writing performance. Finally, exploring the long - term impact of the AI feedback system on students' professional development as educators would further expand the practical implications of this research.

6. Conclusion

This study has explored the application of an AI - based intelligent feedback system in normal university students' graduation thesis writing and its intervention mechanism on cognitive inertia. Through a 12 - week controlled experiment involving 100 senior Shifan Sheng from Yunnan Normal University, significant findings have been obtained.

The results demonstrate that the AI - based intelligent feedback system effectively improves students' writing quality. The experimental group, which utilized the system, achieved a 15.2% higher average score in thesis evaluations compared to the control group, with notable enhancements in literature review depth, argumentation logic, and overall academic formatting. Regarding the intervention on cognitive inertia, the system operates through both direct and indirect mechanisms. The direct mechanism, characterized by real - time and multi - dimensional feedback, shortens the cognitive correction cycle and activates metacognitive monitoring. The indirect mechanism, including personalized guidance and task decomposition, significantly boosts students' self - efficacy and alleviates writing anxiety, ultimately reducing cognitive inertia.

From a practical perspective, these findings offer valuable implications for writing instruction in normal education. Educational institutions are advised to integrate AI - based intelligent feedback systems into their thesis - writing courses, combining the advantages of technological automation with human teacher guidance. Teachers can leverage the system's data - driven insights to better understand students' writing difficulties and cognitive states, enabling more targeted and efficient one - on - one

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instruction. Additionally, the system's task - decomposition and resource - recommendation features can be incorporated into teaching design to help students overcome writing barriers and develop autonomous writing skills.

In terms of academic contributions, this research enriches the theoretical understanding of the interaction between educational technology and cognitive psychology. By constructing a "technology - intervention - cognitive inertia" model, it provides a new theoretical framework for exploring how AI - powered tools can reshape students' cognitive processes in academic writing. The study also fills a gap in the literature by specifically focusing on the unique writing needs of normal university students, offering targeted insights into the application of intelligent feedback systems in teacher education.

However, it should be noted that this study has certain limitations, such as the single - institution sample and the limited research scope. Future research could expand the sample size and involve multiple universities to enhance the generalizability of the findings. Longitudinal studies tracking students' writing development over an extended period, as well as investigations into the long - term impact of the system on students' professional teaching capabilities, would further deepen the understanding of the role of AI - based feedback in normal education. Overall, this research serves as a foundation for future explorations in intelligent writing instruction and cognitive intervention, paving the way for more effective teaching and learning practices in normal universities.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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